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# Determinants of Intraindustry Trade Between the United States and Industrial Nations

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# DETERMINANTS OF INTRAINDUSTRY TRADE BETWEEN THE UNITED STATES AND INDUSTRIAL NATIONS

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This paper investigates determinants of intraindustry trade between the United States and twenty-two industrial nations. Included here are country-level characteristics suggested by modern models of monopolistic competition and trade and industry-level variables relating to imperfect competition, scale economies, and product differentiation. Country-level determinants of intraindustry trade include relative factor endowment differences, relative country size differences, distance, trade orientation, and the trade balance. Measures of factor intensity, scale economies, market structure, and product differentiation are included as country-level variables. Findings generally support predictions of modern trade theories. [F1]

## 1. INTRODUCTION

During the 1960s, several researchers including Drèze (1961), Verdoorn (1960), and Balassa (1965) observed trade patterns induced by customs union formation in Western Europe did not lead to greater interindustry specialization as predicted by the traditional factor endowments model. Instead, researchers found the most rapidly growing component of trade between industrial nations was comprised of two-way exchanges of goods falling under the same industry classification, a phenomenon known as intraindustry trade. Because such trade is not easily explained by the factor endowments model, considerable research effort has been devoted to providing possible explanations of the phenomenon.

Recent theoretical studies have attempted to explain intraindustry trade using models of monopolistic competition with increasing returns. Krugman (1979, 1980) and Lancaster (1980) first developed these models. Monopolistically competitive firms produce differentiated products using increasing returns to trade

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Helpman (1987) uses a model of monopolistic competition and international trade to explore the role of country characteristics in determining the intraindustry trade share. Consider a two-country, two factor model with one homogeneous goods sector and one differentiated goods sector.[5] Relative factor endowments and the economic size of trading nations are shown to influence the share of intraindustry trade. The most important difference between two countries lies in their relative factor endowments. When both countries share identical capital-to-labor endowment ratios, no trade is motivated by relative factor abundance. INTER equals zero and the intraindustry trade index (GL) equals one. When a reallocation of productive factors does not alter the relative size of countries, but increases (decreases) the disparity in relative factor endowments, the volume of INTRA will decrease (increase). A proportional reallocation of productive factors that makes two countries more (less) unequal in economic size is shown to reduce (increase) the volume of INTRA.[6] The index will tend to decrease (increase) with greater (smaller) differences in relative factor endowments and differences in economic size between two countries.

Many studies have examined industry-level determinants of intraindustry trade. Because trade among industrial nations accounts for the largest proportion of intraindustry trade, theoretical and empirical studies have used models of monopolistic competition with increasing returns to explain intraindustry trade.[7] Each industry is defined to include a wide range of products produced with the same factor intensity under conditions of increasing returns. Scale economies force firms in each industry to specialize in a subset of products to realize efficient scale operations. An autarky equilibrium results with firms producing differentiated products. Intraindustry specialization, combined with diverse consumer tastes creates two-way trade within the same industry classification. Intraindustry trade is expected to be greater in industries where imperfectly competitive firms produce differentiated or nonstandardized products under conditions of increasing returns.

## 3. DETERMINANTS OF INTRAINDUSTRY TRADE

Variables suggested by models of monopolistic competition and trade are used to identify country and industry-level determinants of intraindustry trade in

[5]The model is summarized in Hummels and Levinsohn, 1995; Helpman and Krugman, 1985; and Helpman, 1981.

[6]For example, a proportional reallocation of factors will expand both the number of firms producing and the varieties produced of a given good in one country and reduce them in the other country. Making countries more unequal in size, all else equal, will have a negative effect on intraindustry trade.

[7]See Ethier (1982, 1979), Helpman (1981), Krugman (1983, 1981, 1980, 1979), Lancaster (1980), Dixit and Norman (1980) and Dixit and Stiglitz (1977).

bilateral trade between the U.S. and 22 industrial nations. Helpman (1981) relates the share of intraindustry trade to country differences in both relative factor endowments and relative country size. The more countries differ in relative factor endowments, the smaller the intraindustry trade share, all else equal. As the size of the trading partner grows, the U.S. and a trading partner become more similar in size. The size of the trading partner will have a positive effect on the intraindustry trade share. We expect the intraindustry trade share will be negatively correlated with differences in factor endowments, based on the capital-to-labor endowment ratio (KLDIFF), the skilled worker share of the workforce (SLDIFF), and the land-to-labor endowment ratio (TLDIFF). The intraindustry trade share is expected to be positively correlated with size (GDP) of the trading partner.

Distance between trading partners is used as a proxy for costs of information necessary for trading nonstandardized products. According to Balassa and Bauwens (1987), more information is required on characteristics of nonstandardized products than on characteristics of standardized goods. Frictions associated with overcoming distance will deter trade proportionally more for substitutable nonstandardized products than for standardized goods. The intraindustry trade share is expected to be negatively correlated with distance (DIST) between the U.S. and a trading partner.

Trade orientation will also influence the intraindustry trade share. Falvey's (1981) model shows countries with lower trade barriers will have higher intraindustry trade shares. Following Stone and Lee (1995), Balassa and Bauwens (1987), and Balassa (1986), trade orientation is proxied by the residuals from a regression of per capita trade (exports plus imports) on per capita income and population. The intraindustry trade share is expected to be positively correlated with trade orientation.

Grubel and Lloyd (1975) note their measure of intraindustry trade might be affected by a country's trade imbalance. This effect is expected to be greater the larger the share of net trade and the smaller the share of intraindustry trade in total trade. The GL index should be negatively correlated with the trade imbalance so estimated coefficients in the regression equation will be biased if the trade imbalance is correlated with the explanatory variables. Following Stone and Lee (1995), we include a measure of the trade imbalance to control for this possible bias. The share of intraindustry trade is expected to be negatively correlated with the trade imbalance (TIMB).

A variety of industry characteristics are expected to influence intraindustry trade. Monopolistic competition models of trade are based on scale economies, imperfect competition, and product differentiation. Considerable importance is attached to the role of scale economies in determining intraindustry trade. Scale economies force firms in each industry to specialize in a narrow range of products to realize efficient scale operations. Intraindustry specialization, combined with diverse consumer tastes, leads to imports of products in industry classifications in which a country enjoys a strong export position. The minimum efficient scale (MES) in each industry measures firm-level scale economies. We assume that incentives to engage in intraindustry specialization to realize efficient scale operations will increase with the degree of scale economies enjoyed. The intraindustry trade share is expected to be positively correlated with MES.

Models of intraindustry trade have adopted a market structure of monopolistic competition because internal economies of scale are inconsistent with perfect competition. Monopolistically competitive markets have a large number of firms, each producing a slightly differentiated product variety and enjoying a small market share. Each firm believes the other producer will not respond to its pricing and output decision. Entry is unrestricted, ensuring economic profits will be zero in the long run. Features of this market structure are proxied by the four-firm seller concentration ratio (CR4), expressing the percent of shipment values accounted for by the four largest firms, the number of establishments in the industry (ESTAB), and product differentiation proxied by the advertising-to-sales (AS) ratio. Advertising is intended to differentiate products, shift the demand function, and/or change the price elasticity of demand for the product. The share of intraindustry trade is expected to be negatively correlated with the four-firm seller concentration ratio, and positively correlated with both the number of establishments and advertising intensity.

Two factors will serve as additional proxies for potential gains from intraindustry specialization. One measure is the sectoral dispersion index (DSPH) that reflects the diversity of industry consumers. Lower values of this index are associated with industries that serve a wide variety of industrial consumers and are likely to do so with nonstandard, made-to-order products. The intraindustry share is expected to be negatively correlated with the sectoral dispersion index.

Capital intensity of production also proxies potential gains from intraindustry specialization. The capital-to-labor ratio reflects the technology-based pressures for expanding trade. Capital intensive industries will enjoy a technological advantage over trading partners and will be the exporter of new products. Strong export performance will lead to greater interindustry trade. Factor intensity influences the range of products produced in the industry. The scope for producing a product in a variety of trading partners will be greater the more labor intensive (less technologically sophisticated) the industry. We expect the intraindustry trade share will be negatively correlated with the ratio of capital-to-labor used in production.

International transportation charges (TRANS) measure the tradability of an industry's products. Bulky products of relatively low unit values tend to incur high ad valorem shipping charges. High international transportation charges concentrate production in one country or another, based on the location of raw materials, intermediate inputs, and on factor cost differences. Because the country with the most pronounced cost advantage is typically the exporter, there is less potential for intraindustry trade when transportation charges are high. The intraindustry trade share is expected to be negatively correlated with ad valorem international transportation charges.

A final variable is included to proxy categorical aggregation. Several studies have argued that intraindustry trade should fall when finer levels of product aggregation are used to define industries. This leads to the expectation that large industries comprised of many product groups should have more intraindustry trade than industries with only a small number of product groups. Following Marvel and Ray (1987), categorical aggregation is proxied by the value of industry shipments, assuming more categorical aggregation is involved in industries with higher shipment values. The intraindustry trade share is expected to be positively correlated with the value of industry shipments.

## 4. ESTIMATION METHODS

We use limited dependent variable techniques to investigate determinants of the share of intraindustry trade in U.S bilateral trade with 22 industrial nations. Our data set is a cross section of countries and industries with panel properties. Most studies apply a logistic transformation to the dependent variable and use ordinary least squares. This approach involves dropping observations with zero values for the dependent variable. The distribution of the GL index is observed for only a limited range of values and is clustered at zero. Balassa and Bauwens (1987) note values of zero intraindustry trade are important. Nearly 20 percent of the observations in our data set show complete interindustry specialization, with either exports or imports being zero. When the dependent variable is zero for a significant fraction of the observations conventional regression methods will fail to account for the qualitative difference between zero (limit) and continuous (non-limit) observations.

We begin by estimating a tobit model,

$$Y_{ij}^{*} = \alpha + \beta_i X_i + \beta_j X_j + \varepsilon_{ij}, \tag{4}$$

where $\varepsilon_{ij} \sim N[0, \sigma^2]$ across $i$ industries and $j$ countries. $Y_{ij}^{*}$ is clustered at zero. Both the initial hurdle to intraindustry trade and continuous increases in the share of intraindustry trade are captured in the index function $Y_{ij}^{*}$ with the variable $Y$ being the observed value for the Grubel-Lloyd index.

A more general approach involves using a probit model to analyze the process underlying achievement of intraindustry trade. A dummy variable is defined for $Y_{ij}^{*}$. Observations consist of whether intraindustry trade occurred ($Y = 1$) or not ($Y = 0$). Random errors are assumed to have a multivariate normal distribution.

Adjusted regression coefficients explain factors underlying the hurdle to starting two-way trade.

Studies that apply a logistic transformation to the dependent variable and use ordinary least squares drop observations with zero values for the dependent variable. Our final set of estimates is obtained in this manner. Results will allow us to consider the robustness of findings from limited dependent variable techniques, and will facilitate a comparison of our findings with those of previous studies.

Most studies focus on country and/or industry level determinants of intraindustry trade without accounting for unobservable factors that may vary systematically across observations. The importance of factor endowment differences, country size, distance between countries, and other country-level factors can be explicitly controlled for in a regression. Additional intangibles such as industrial policy, managerial know-how, home demand bias, industry-specific border-related hindrances, or unmeasurable product quality characteristics may also be important determinants of intraindustry trade. The final set of estimates incorporates panel data techniques with random effects to account for unobservable country and industry-level effects. We relax the classical regression assumption on $\varepsilon_{ij}$ and allow for random effects on two dimensions. A generalized least squares estimator is used to estimate the random effects models.

## 5. RESULTS

The Grubel-Lloyd (GL) index forms the basis for the dependent variable in each of the regression specifications tested. Because our data set includes observations with zero values for the GL index, we first consider observations with intraindustry and interindustry trade and treat GL as both a continuous and dichotomous variable.

Table 1 reports results from the limited dependent variable analysis on the full sample of observations including those with zero values for the GL index. Tobit estimates appear in column 2. The propensity for starting and achieving greater shares of intraindustry trade is strongly influenced by a variety of country and industry-level determinants. Helpman shows the bilateral share of intraindustry trade will increase as two countries become more similar in factor composition. Relative factor abundance is found to exert an important influence on intraindustry trade. Highly significant negative coefficients on variables representing the differences in skilled workers' share of the workforce (SLDIFF) and land-to-labor endowment ratio differences (TLDIFF) in column 2 support the model's predictions. However, the highly significant positive coefficient on capital-to-labor endowment ratio differences (KLDIFF) is contrary to expectations of the

**Table 1.** Limited Dependent Variable Regressions for Intraindustry Trade

| | Tobit Model | Probit Model |
|---|---|---|
| KLDIFF | 0.014[a] | -0.087[a] |
| | (0.005) | (0.029) |
| SLDIFF | -0.044[a] | -0.124[a] |
| | (0.004) | (0.026) |
| TLDIFF | -0.033[a] | -0.055[c] |
| | (0.005) | (0.029) |
| GDP | 0.107[a] | (0.612)[a] |
| | (0.004) | (0.082) |
| DIST | -0.033[a] | -0.027 |
| | (0.008) | (0.069) |
| TO | 0.087[a] | 0.250[a] |
| | (0.015) | (0.082) |
| TIMB | -0.788[a] | -4.057[a] |
| | (0.103) | (0.843) |
| MES | -0.038 | -0.287 |
| | (0.059) | (0.334) |
| CR4 | -0.0011[a] | -0.004[b] |
| | (0.0002) | (0.002) |
| ESTAB | 0.0001 | 0.014 |
| | (0.0023) | (0.014) |
| DSPH | -0.180[a] | -1.011[a] |
| | (0.015) | (0.135) |
| AS | 0.705[a] | 3.956[a] |
| | (0.232) | (1.378) |
| KL | -0.288[a] | -1.788[a] |
| | (0.050) | (0.350) |
| TRANS | -0.304[a] | -0.412[a] |
| | (0.017) | (0.156) |
| VS | 0.009[a] | 0.164[a] |
| | (0.003) | (0.028) |
| $\sigma$ | 0.495[a] | |
| | (0.023) | |
| Var GDP | -0.066[a] | -0.050[b] |
| | (0.008) | (0.021) |
| Constant | 0.090 | -2.703 |
| | (0.093) | (0.618) |
| $\chi^2$ | 91.07 | 1651.63 |
| n obs. | 7745 | 7745 |

Note: The dependent variable in the Tobit model is GL. The dependent variable in the Probit model equals 1 if GL > 0 and 0 if GL = 0. Numbers in parentheses are heteroskedasticity-consistent standard errors. Test statistics identified with [a] are statistically significant at .01, with [b] are statistically significant at .05, and [c] are statistically significant at .10 (two-tail test).

**Table 2.** Combined Country and Industry Effects in Traditional Intraindustry Trade Regressions

| | OLS with Multiplicative Heteroskedasticity Correction | Panel Data GLS with Random Country Effects | Panel Data GLS with Random Industry Effects |
|---|---|---|---|
| KLDIFF | 0.197[a] | 0.167[a] | 0.185[a] |
| | (0.029) | (0.068) | (0.030) |
| SLDIFF | -0.138[a] | -0.140[c] | -0.137[a] |
| | (0.041) | (0.085) | (0.041) |
| TLDIFF | -0.174[a] | -0.186[a] | -0.169[a] |
| | (0.028) | (0.058) | (0.028) |
| GDP | 0.219[a] | 0.228[a] | 0.248[a] |
| | (0.024) | (0.039) | (0.022) |
| DIST | -0.357[a] | -0.366[a] | -0.362[a] |
| | (0.046) | (0.100) | (0.047) |
| TO | 0.166[c] | 0.105 | 0.190[b] |
| | (0.099) | (0.185) | (0.097) |
| TIMB | -5.279[a] | -5.651[a] | -5.293[a] |
| | (0.706) | (1.247) | (0.683) |
| MES | -1.039[a] | -1.046[a] | -0.985[c] |
| | (0.350) | (0.377) | (0.542) |
| CR4 | -0.008[a] | -0.008[a] | -0.008[a] |
| | (0.001) | (0.001) | (0.002) |
| ESTAB | 0.011 | 0.001 | 0.005 |
| | (0.012) | (0.001) | (0.019) |
| DSPH | -0.617[a] | -0.623[a] | -0.661[a] |
| | (0.099) | (0.105) | (0.154) |
| AS | 2.786[b] | 2.699[c] | 3.504 |
| | (1.416) | (1.504) | (2.239) |
| KL | -1.046[a] | -1.053[a] | -1.201[b] |
| | (0.312) | (0.332) | (0.480) |
| TRANS | -2.900[a] | -2.849[a] | -2.498[a] |
| | (0.238) | (0.253) | (0.256) |
| VS | -0.110[a] | -0.109[a] | -0.113[a] |
| | (0.023) | (0.024) | (0.036) |
| $\sigma$ | 2.787[a] | | |
| | (0.179) | | |
| Var GDP | -0.120[a] | | |
| | (0.021) | | |
| Constant | 3.955[a] | 3.878[a] | 3.743[a] |
| | (0.544) | (1.053) | (0.596) |
| $R^2$ | 0.11 | 0.11 | 0.11 |
| LM Statistic | 6.53 | 31.71 | 301.98 |
| Wald Statistic | 2332.40 | | |
| n obs. | 6263 | 6263 | 6263 |

Note: The dependent variable is the logistic transformation of the GL index, ln(GL/1-GL). Numbers in parentheses for the first model are heteroskedasticity-consistent standard errors. Test statistics identified with [a] are statistically significant at .01, with [b] are statistically significant at .05, and [c] are statistically significant at .10 (two-tail test).

Finally, Table 2 reports highly significant negative coefficients on VS. Table 1 reports highly significant positive coefficients on the VS variable. The latter is consistent with results of previous studies.

## 6. CONCLUDING REMARKS

This paper investigates country and industry-level determinants of intraindustry trade. Included here are country-level characteristics suggested by models of monopolistic competition and trade, and industry variables relating to imperfect competition, scale economies, and product differentiation. Observations are included for complete interindustry trade, where either the value of exports or imports is zero. Results are remarkably similar and robust across the various econometric models.

Helpman's theoretical expectation that the bilateral share of intraindustry trade will increase as two countries become more similar in factor composition holds for the land-to-labor ratio and the skilled labor share ratio, but not the capital-to-labor endowment ratio. Here, the bilateral share of intraindustry trade is found to increase as the capital-to-labor endowment ratios of two countries diverge. This result is at odds with the traditional factor endowments-based explanation of trade. Additional country-level determinants perform as expected. We do not find a positive relationship between the intraindustry trade share and scale economies. This result does not invalidate models of monopolistic competition with increasing returns. Helpman (1998) reminds us that the existence of scale economies, not the degree of scale economies is important.

A theory that focuses only on factor endowments and country size differences cannot be expected to provide a complete explanation of intraindustry trade. When we include a variety of country and industry-level determinants and focus on industrial nations that account for most of intraindustry trade, the overall explanatory power of each set of estimates is not very high. It is not clear what additional influences should be included to move trade theory in a direction more consistent with reality. Perhaps theoretical and empirical models should focus more attention on determinants of intraindustry trade related to multinationals and ways regional integration schemes distort flows by influencing the production location decision.[15]

## APPENDIX

### Data Definitions and Sources

[15]Attempts to incorporate multinational influences into modern trade theory are underway. See, for example, Carr, Markusen, and Maskus (2001).

### *Country-level*

KLDIFF is the log of the absolute difference in the capital-to-labor endowment ratios between the U.S. and a trading partner. TLDIFF is the log of the absolute difference in land-to-labor endowment ratios between the U.S. and a trading partner. These variables are used in Hummels and Levinsohn (1995). SLDIFF is the log of the absolute difference in the skilled-to-total labor endowment ratios between the U.S. and a trading partner.

Estimates of the 1992 net capital stock are based on real gross fixed capital formation data reported in Organization for Economic Cooperation and Development (1999). Capital stock figures are expressed in billions of U.S. dollars at 1990 prices and exchange rates. Following Hummels and Levinsohn (1995, p. 835) and Leamer (1984), we assume the initial 1960 capital stock is 250 percent of GDP, sum investment figures, and apply depreciation factors of 13.3%.

Skilled workers are defined to include managers and administrators, professional, technical, and related workers. Labor refers to total employment. Figures for 1992, expressed in thousands of workers, are from International Labor Organization (1996).

Land endowments (hectares) are from Leamer (1984). Following Hummels and Levinsohn (1995), we use Leamer's land 2+land3+land4.

GDP is the log of a U.S. trading partner's 1992 real gross domestic product. Data, expressed in billions of U.S. dollars at 1990 prices and exchange rates, are from Organization for Economic Cooperation and Development (1999).

Following Balassa (1986), Balassa and Bauwens (1987), and Stone and Lee (1995), trade orientation (TO) is proxied by the residuals from a regression of per capita merchandise trade (exports plus imports) on per capita income and population (thousands). The trade imbalance $(TIMB_j) = |X_j - M_j| / (X_j + M_j)$, where $X_j$ and $M_j$ are merchandise exports and imports of trade partner j in world trade. See Stone and Lee (1995). Merchandise trade figures from Organization for Economic Cooperation and Development (1999) are in billions of U.S. dollars at 1990 prices and exchange rates.

DIST is the log of distance (kilometers) between capital cities. These data are from Fitzpatric and Modlin (1986).

Twenty-two U.S. trading partners are in the data set. Included here are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

### *Industry-level*

Export and import figures used to construct the GL index, and TRANS, the ad valorem international transport charges, are from the U.S. Bureau of the Census (1993).

MES is the minimum efficient scale, defined as average sales per firm for firms in the midpoint class size (defined by product shipments) as a percent of 1992 shipment values. ESTAB is the number of establishments expressed in thousands. KL, the capital-to-labor intensity ratio, is expressed in millions of U.S. dollars of capital per worker. VS is the log of the value of industry shipments, expressed in millions of dollars. These figures pertain to 1992 and are from the U.S. Bureau of the Census (1995). CR4, the 1987 four-firm seller concentration ratio, is reported in U.S. Bureau of the Census (1992).

The sectoral dispersion index, $DSPH_i = \sum_{k=1}^{n} s_{i,k}^2$, where $s_{i,k}$ is the share of industry *i*'s sales to two-digit consuming industry *k*. See Lustgarten (1975). AS is the advertising-to-sales ratio. These variables pertain to 1987 and are calculated from U.S. Department of Commerce (1994).

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