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Characteristics of Commodities and International Trade: Two Hypotheses

By
Masahiro Endoh

Abstract

There exists a hypothesis that proximity and common language/colonial ties are more important for differentiated products than for homogeneous products in forming price information and matching international buyers and sellers. The gravity-model analysis, however, is not able to show strong evidence to support this hypothesis. In this paper, the author presents the result that machinery, transport equipment and miscellaneous manufactured articles, which are classified into differentiated products, have lost price information effect, which causes the hypothesis lack of empirical support. The degree of price information effect on trade of commodities depends not on their differentiation, but on their industrial origin.

Key Words

network hypothesis; monopolistic competition hypothesis; price information effect; substitution effect; gravity model

1. Introduction

The purpose of this paper is to reexamine a network hypothesis of international trade proposed and investigated originally by Rauch (1999), to suggest an alternative hypothesis concerning the substitution of commodities, and to demonstrate what commodities support what hypotheses by using gravity-typed threshold Tobit model and two criteria of commodity classification.

The existence of business and social networks that operate across national borders affects a variety of transnational economic activities. The measurement of network effect attracts many researchers, employing case studies, descriptive approaches, or econometric methods to present their results, which are surveyed by Rauch (2001). Among others, Rauch (1999) takes up trading networks out of various kinds of international networks for a research target and proposes the hypothesis that proximity and common language/colonial ties are more important for differentiated products than for homogeneous products in matching international buyers and sellers. To substantiate the validity of his hypothesis, he divides commodities into three groups by the degree of differentiation, and estimates trade of each group by gravity-model equation. His classification of commodities is widely acknowledged to be useful and practical, and is employed by other researchers: Feenstra et al (2001), Erkel-Rousse and Mirza (2002), Hutchinson (2002), Curtis and Chen (2003), Evans (2003), Chen (2004), Eden and Rodriguez (2004), Feenstra and Hanson (2004), and Endoh (2005), for example. Rauch's (1999) network hypothesis seems reasonable and his classification has become a common asset of academia. However, his econometric results in Tables 4–9 do not show strong evidence to support this hypothesis, and his way of adjusting estimated figures, the results of which we can see in Table 10, is not convincing. Rauch's hypothesis and/or his commodity classification shall be reexamined.

In this paper, I present another hypothesis, called the monopolistic competition hypothesis, which explains other characteristics of international trade. It also shows that industry criterion based on Standard International Trade Classification (SITC) complements well Rauch's differentiation criterion for classifying commodities in order to understand 'price information effect' and 'substitution effect.' It follows from the analysis developed in this paper, that machinery, transport equipment and miscellaneous manufactured articles, which are classified as differentiated products, have little price information effect, which makes Rauch's result ambiguous. This paper also shows that the network hypothesis of trade is appropriate to the trade of crude materials, while the monopolistic competition hypothesis is appropriate to the trade of mineral fuels.

The following section explains Rauch's (1999) hypothesis and commodity classification, and then proposes the monopolistic competition hypothesis and SITC as complementary proposals. Section 3 shows the gravity-typed threshold Tobit model, the method of empirical analysis used in this paper. Section 4 performs this model with Rauch's commodity classification and interprets the results in a way differing from his intention. Section 5 employs SITC and discusses the empirical results in order to demonstrate what commodities support what hypothesis. Section 6 presents the main conclusions of this paper.

2. Two hypotheses, two classification criteria

Classification means the allocation of items to groups according to 'type,' and the definition of 'type' reflects the purpose of classification or the hypothesis about characteristics of items. One classification, however, sometimes becomes unsuitable to analyze along an original purpose, or allows us another interpretation of each group against original meaning. In this section, I explain first Rauch's classification, as well as his hypothesis about the buyers/sellers network in international trade. Secondly, I explain another hypothesis, named the monopolistic competition hypothesis, derived from his same classification, and thirdly, examine another classification, that of SITC, which helps to understand the effectiveness of the two hypotheses.

2.1. Network hypothesis versus monopolistic competition hypothesis

Rauch (1999) divides commodities into three groups at the four-digit SITC level, based on the characteristics of information that matches international buyers and sellers. His first category, 'organized exchange commodities,' is for commodities traded by specialized traders that centralize price information. He refers to the second category as 'reference priced commodities' that are not traded on organized exchanges, but have some reference prices quoted in trade publications. Third category is called 'differentiated commodities' and is composed of branded or differentiated products. Even if they belong to the same SITC four-digit category, they can be disaggregated into types by design, form, brand, or producer.

Rauch explains that proximity and common language/colonial ties between countries affect the commodity trade categorized into three groups in a way different from each other. These factors are more important for differentiated products, because "the heterogeneity of manufactures along the dimensions of both characteristics and quality interferes with the ability of their prices to signal relative scarcity" (Rauch, 1999, p.7) and therefore the process of searching among international sellers/buyers networks "is strongly conditioned by proximity and preexisting 'ties'" (Rauch, 1999, p.8). The network/search model applies, he argues, most strongly to differentiated products and most weakly to organized exchanges. This argument is built up from the examination of how traders form price information of each commodity and at what extent they use it for matching buyers and sellers. Therefore, the 'network hypothesis' about the effects of proximity and common language/colonial ties on volume of trade focuses on the 'price information effect' of each group of commodities.

This classification of commodities, however, allows us to build up an alternative hypothesis by considering how commodities differ from others and at what extent they possess monopolistic power under competitive circumstance of world market. Regarding his criterion as measures of the degree of product differentiation, 'organized exchange commodities', 'reference priced commodities' and 'differentiated commodities' could mean, respectively, homogeneous commodities slightly differentiated by producers, allowing buyers to easily substitute one product for another; semi-differentiated commodities; and heterogeneous commodities differentiated by producers as a source of monopolistic power, and thus hard to substitute[1].

Based on this view of 'substitution effect,' expectations of importance for three groups of proximity and common language/colonial ties are in reverse order to that based on the 'price information effect.' In the former case, the more heterogeneous the commodities are, the smaller the elasticity of substitution between the commodities of any pair of goods, and therefore, the more eager countries want to import all kinds of them. This holds true even if producers are located remotely, in which case c.i.f. prices of their commodities become rather high, or even if the languages of two trading countries are different, hindering them from contacting and promoting communication. On the other hand, the more homogeneous the commodities are, the larger the elasticity of substitution between the commodities, and therefore, the fewer commodities countries want to import from countries distantly located or countries where languages are different. That is because c.i.f. prices of products from distantly located countries tend to be high due to transportation costs, or the prices of commodities made in countries with different languages are hard to converge due to the lack of ease in communication. Thus, commodities from these countries are easily substituted for

[1]Product differentiation could come from a monopolistic competition model, with firm-level product differentiation (Spence, 1976; Dixit and Stiglitz, 1977), and also from an Armington formulation, with national-level product differentiation (Armington, 1969a, 1969b). Feenstra, Markusen and Rose (2001) find that 'differentiated' goods fit the prediction of a monopolistic competition model. Therefore, I proceed an analysis of this paper assuming product differentiation comes from a monopolistic competition.

products from countries that locate closely or employ the same languages.

This ‘monopolistic competition hypothesis’ suggests that proximity and common language/colonial ties affect most strongly trade of organized exchange commodities, followed by trade of reference priced commodities, and least strongly by trade of differentiated commodities. This order is reversed in the network hypothesis, where distance and language play a more important role in the trade of differentiated commodities.

2.2. Differentiation criterion versus industry criterion

As mentioned in the previous section, Rauch (1999) employs the degree of differentiation as a criterion of grouping commodities. If his price information effect, however, depends not only on the degree of differentiation among commodities, but also on other characteristics of commodities, it is insufficient to use only three categories of his classification to analyze the network hypothesis. His ambiguous results of regression analyses seem to show the plausibility of this supposition. Among many other candidates for complementary criterion of commodity classification, industry criterion based on SITC is a simple, widely used and effective tool, because the way of distributing and consuming goods is largely affected by the industry they are originated from. Here, I propose SITC as another criterion of classification, and see the composition of commodity groups classified by two criteria.

Being commonly used as classification of tradable goods, SITC categorizes goods chiefly by industrial origin and by stage of fabrication. Here, commodities are divided into five groups at the one-digit SITC level: 1) SITC 0 (Food and live animals)+SITC 1 (Beverages and tobacco), named ‘food’, 2) SITC 2 (Crude materials)+SITC 4 (Animal and vegetable oils, fats and waxes), named ‘crude materials’, 3) SITC 3 (Mineral fuels), 4) SITC 5 (Chemicals)+SITC 6 (Manufactures classified chiefly by material), named ‘less differentiated manufactures’, and 5) SITC 7 (Machinery and transport equipment) +SITC 8 (Miscellaneous manufactures)+SITC 9 (Commodities not classified), named ‘more differentiated manufactures.’ This classification is used in Section 5 in order to shed further light on the characteristics of goods.

On the other hand, the Rauch criterion divide them into three groups: 1) organized exchange commodities, containing tea (SITC 0741), soybeans (SITC 2222), unwrought copper and copper alloys (SITC 6821) and the like, 2) reference priced commodities, including cigarettes (SITC 1222), cyclic hydrocarbons (SITC 5112), ferro-alloys (SITC 6716) and the like, and 3) differentiated commodities, including asbestos (SITC 2784), motor vehicles for transport of goods/materials (SITC 7821), watches, watch movements and cases (SITC 8851), for example. Because ambiguity inevitably arises in these classifications, he tries to utilize a classification system in both a ‘conservative’ and ‘liberal’ manner, with the former minimizing the number of commodities classified as either organized exchange or reference priced, and the latter maximizing those numbers.

Table 1 reports the matrix of the share of each commodity classification to total value of trade among the sample countries for both Rauch and SITC classifications in 1970 and 1995. Concerning the Rauch classification, differentiated products account for over half of the total trade in both conservative and liberal aggregation in 1970, which share the rise further in 1995. On the other hand, both organized exchange commodities and reference priced commodities occupied around a fifth to a quarter of total trade

Table 1. Shares of commodity categories in value of total trade (percent)

1970 (total trade: 247,679 millions US$)		Conservative aggregation			Liberal aggregation		
		Org.	Ref.	Dif.	Org.	Ref.	Dif.
	subtotal	20.15%	23.31%	56.54%	25.37%	21.13%	53.50%
SITC01	13.18%	6.59%	5.04%	1.55%	7.57%	4.33%	1.27%
SITC24	10.98%	4.23%	4.25%	2.49%	7.06%	1.81%	2.11%
SITC3	7.91%	6.29%	0.60%	1.02%	6.29%	1.40%	0.22%
SITC56	27.79%	3.04%	13.43%	11.32%	4.45%	13.43%	9.91%
SITC789	40.15%	0.00%	0.00%	40.15%	0.00%	0.15%	40.00%

1995 (total trade: 4,232,925 millions US$)		Conservative aggregation			Liberal aggregation		
		Org.	Ref.	Dif.	Org.	Ref.	Dif.
	subtotal	10.67%	19.18%	70.15%	13.89%	18.96%	67.15%
SITC01	8.52%	2.79%	4.22%	1.51%	3.40%	3.77%	1.36%
SITC24	4.99%	1.44%	2.09%	1.45%	2.84%	0.91%	1.24%
SITC3	6.35%	4.70%	1.19%	0.46%	4.70%	1.58%	0.07%
SITC56	25.32%	1.26%	11.67%	12.39%	2.48%	11.40%	11.45%
SITC789	54.82%	0.48%	0.00%	54.34%	0.48%	1.30%	53.03%

in 1970, decreasing their shares in 1995. As for SITC, SITC789 amounts to about a half of total trade and SITC56 about a quarter. Three other groups occupy around ten percent of total trade respectively in 1970, and these shares decrease in 1995. Each SITC group shows its distinctive shares from three Rauch groups. SITC01 and SITC24 are both composed mainly of organized exchange commodities and reference priced commodities. These two groups roughly account for the same shares in the case of conservative aggregation, while in the case of liberal aggregation, the share of reference priced commodities in SITC24 decreases dramatically. About 75 percent of SITC3 consists of organized exchange goods, and about 50 percent of SITC56 of reference priced goods. SITC789 is composed almost entirely of differentiated products.

3. Gravity-typed threshold Tobit model

Attempts to derive the gravity model from various assumptions include Anderson (1979), Bergstrand (1985), Helpman and Krugman (1985), Bergstrand (1989) and Deardorff (1998). Here, however, rather than explain its possible foundations and derivations, I will show the estimation procedure of gravity-typed threshold Tobit model based on Eaton and Tamura (1994) instead.

In the standard gravity equation, the logarithm of dependent variable is linear homogeneous in the logarithms of explanatory variables. Eaton and Tamura (1994) assumes, however, that for each dependent variable V_{ijk}, bilateral volume of trade between country i and country j of commodity group k, the logarithm of $a_k + V_{ijk}$ is linear homogeneous, where a_k is an intercept parameter that they estimate, because V_{ijk} is bounded below by zero, and some observations achieve this bound. Following the lead of previous researches, I estimate the equations

$$V_{ijk}=\max[-a_k+\alpha_k(GDP_iGDP_j)^{\beta_k}(PGDP_iPGDP_j)^{\gamma_k} \times DISTANCE_{ij}^{\delta_k}\exp(\varepsilon_k ADJACENT_{ij}+\zeta_k LINKS_{ij}+u_{ijk}),0] \tag{1}$$

where GDP_i and GDP_j denote GDP of country i and j, $PGDP_i$ and $PGDP_j$ denote per capita GDP of country i and j, $DISTANCE_{ij}$ equals the great circle distance between the principal cities of countries i and j, $ADJACENT_{ij}$ takes the value of one if countries i and j share a land border, and zero otherwise, $LINKS_{ij}$ takes the value of one if countries i and j share a common language or colonial tie, and zero otherwise, and u_{ijk} is a normal error term associated with the dependent variable V_{ijk}.

Equation (1) will be estimated by maximum likelihood. To derive the maximum likelihood function, we define the variable V^*_{ijk} where

$$V^*_{ijk}=-a_k+\alpha_k(GDP_iGDP_j)^{\beta_k}(PGDP_iPGDP_j)^{\gamma_k} \times DISTANCE_{ij}^{\delta_k}\exp(\varepsilon_k ADJACENT_{ij}+\zeta_k LINKS_{ij}+u_{ijk}) \tag{2}$$

Hence

$$\begin{aligned} V_{ijk}&=V^*_{ijk} && \text{if } V^*_{ijk}>0 \\ V_{ijk}&=0 && \text{otherwise.} \end{aligned}$$

Rearranging this relationship and taking natural logarithms of each side to obtain

$$\begin{aligned} \ln(\alpha_k+V^*_{ijk})&=\ln\alpha_k+\beta_k\ln(GDP_iGDP_j)+\gamma_k\ln(PGDP_iPGDP_j) \\ &\quad+\delta_k\ln DISTANCE_{ij}+\varepsilon_k ADJACENT_{ij}+\zeta_k LINKS_{ij}+u_{ijk} \\ &\equiv Z'_{V_{ijk}}\theta_k+u_{ijk} \end{aligned} \tag{3}$$

Assuming that $u_{ijk}\sim N(0,\sigma^2)$, the density function for V^*_{ijk} is

$$f(V^*_{ijk})=\phi(u_{ijk})\left|\frac{\partial u_{ijk}}{\partial V^*_{ijk}}\right|=\phi(u_{ijk})\frac{1}{a_k+V^*_{ijk}}$$

where

$$\phi(u_{ijk})=\frac{1}{(2\pi\sigma^2)^{1/2}}\exp\left[-\frac{u^2_{ijk}}{2\sigma^2}\right]=\frac{1}{(2\pi\sigma^2)^{1/2}}\exp\left\{\frac{-[\ln(a_k+V_{ijk})-Z'_{V_{ijk}}\theta_k]^2}{2\sigma^2}\right\}$$

Hence,

$$\Pr(V_{ijk}=0)=\Pr(u_{ijk}\geq\ln a_k-Z'_{V_{ijk}}\theta_k)=1-F_{ijk}$$

$$\Pr(V_{ijk}>0)\cdot f(V_{ijk}|\,V_{ijk}>0=F_{ijk}\frac{f(V_{ijk})}{F_{ijk}}=\phi(u_{ijk})\frac{1}{a_k+V_{ijk}}$$

where F is the normal cumulative density function. The log-likelihood function is therefore:

$$\begin{aligned} \ln L(V_{ijk},Z'_{V_{ijk}};\theta_k,a_k)&=\sum_{V=0}\ln(1-F_{ijk}) \\ &\quad-\sum_{V>0}\left\{-\ln(a_k+V_{ijk})-\frac{(\ln 2\pi+\ln\sigma^2)}{2}-\frac{[\ln(a_k+V_{ijk})-Z'_{V_{ijk}}\theta_k]^2}{2\sigma^2}\right\} \end{aligned} \tag{4}$$

The maximum likelihood estimates of a_k and θ_k maximize $\ln L(V_{ijk},Z'_{V_{ijk}};\theta_k,a_k)$.

Rauch's (1999) network hypothesis could be represented in the coefficients of

DISTANCE and *LINKS* in equation (3): $|\delta_o| < |\delta_r| < |\delta_d|$ and $\zeta_o < \zeta_r < \zeta_d$, where 'o' represents 'organized exchange commodities' group, 'r' stands for 'reference priced commodities' group, and 'd' symbolizes 'differentiated commodities' group, respectively. However, in the monopolistic competition hypothesis, those relationships are reversed: $|\delta_o| > |\delta_r| > |\delta_d|$ and $\zeta_o > \zeta_r > \zeta_d$.

4. Benchmark results and some interpretations

In this section, Rauch classification is used to obtain benchmark results, and in the next section, SITC is employed for empirical analyses as a complement classification to acquire more meaningful results of the nature of commodities.

Equation (4) is estimated to use cross-sectional data for trade flow of each category among 63 countries through temporal cross-section data analysis, for every five years from 1970 to 1995[2]. Samples of countries and principal independent variables are the same as those chosen by Frankel (1997) and Rauch (1999), which enables readers to compare results[3]. Data set consisting of these countries covers 78% of world population and 91% of world trade in 1970, and also 80% of world population and 92% of world trade in 1995[4]. Since the dependent variable, i.e. the value of trade, is recorded in current dollars, I employ current dollars of GDP and per capita GDP in each sample country as independent variables.

Table 2 presents the summary of regression results for all coefficients of independent variables in equation (1) estimated from 1970 to 1995 using Rauch commodity classification in both conservative and liberal manners. This is called benchmark results. It is apparent that most coefficients of independent variables, except those of *ADJACENT*, possess high statistical significance throughout the analyzing period.

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[2]The data sources are as follows:

Volume of trade: National Bureau of Economic Research, U.S.A., World Trade Flows 1970-1992 (CD-ROM), and Institute of Governmental Affaires, University of California, Davis, World Trade Flows 1980-1997 (CD-ROM). International Trade Division, Statistics Canada, furnishes originals of both data.

GDP, GDP per capita: United Nations, Statistical Yearbook. GDP per capita is obtained by GDP / population.

Distance: G. L. Fitzpatrick and M. J. Modlin (1986), *Direct-Line Distances: International Edition* (Metuchen, NJ: The Scarecrow Press).

Adjacency, language tie, and colonial tie: *Worldmark Encyclopedia of the Nations, 9th ed*. (Farmington Hills, MI: Gale Research). A pair of two countries is considered to adopt a common language in this paper if this is the national language, official language, primary language, or the language corresponding to them, of both two countries. Also, a pair of countries is considered to have a colonial tie if one of the two countries has a history of conquering the other country and governing it as an overseas colony after World War I.

[3]The 63 countries and main cities used in the gravity equation are: Algeria (Algiers), Argentina (Buenos Aires), Australia (Sydney), Austria (Vienna), Belgium-Luxemburg (Brussels), Brazil (Sao Paulo), Bolivia (La Paz), Canada (Ottawa), Chile (Santiago), China (Shanghai), Colombia (Bogot?), Denmark (Copenhagen), Ecuador (Quito), Egypt (Cairo), Ethiopia (Addis Ababa), Finland (Helsinki), France (Paris), Ghana (Accra), Greece (Athens), Hong Kong (Hong Kong), Hungary (Budapest), Iceland (Reykjavik), India (New Delhi), Indonesia (Jakarta), Iran (Teheran), Ireland (Dublin), Israel (Jerusalem), Italy (Rome), Japan (Tokyo), Kenya (Nairobi), Kuwait (Kuwait), Libya (Tripoli), Malaysia (Kuala Lumpur), Mexico (Mexico City), Morocco (Casablanca), Netherlands (Amsterdam), New Zealand (Wellington), Nigeria (Lagos), Norway (Oslo), Pakistan (Karachi), Paraguay (Asuncion), Peru (Lima), Philippines (Manila), Poland (Warsaw), Portugal (Lisbon), Saudi Arabia (Riyadh), Singapore (Singapore), South Africa (Pretoria), South Korea (Seoul), Spain (Madrid), Sudan (Khartoum), Sweden (Stockholm), Switzerland (Geneva), Taiwan (Taipei), Thailand (Bangkok), Tunisia (Tunis), Turkey (Ankara), United Kingdom (London), United States (Chicago), Uruguay (Montevideo), Venezuela (Caracas), West Germany (Bonn), Yugoslavia (Belgrade). In this paper, the term 'countries' refers to both countries and regions.

[4]The data set used in the estimation below is available on request.

Table 2. Regression results 1970–95, dependent variables classified by Rauch criterion

1970	Conservative aggregation			Liberal aggregation		
	Org.	Ref.	Dif.	Org.	Ref.	Dif.
Intercept	−3.385**	−5.857**	−8.819**	−3.975**	−6.284**	−8.910**
	(0.916)	(0.751)	(0.821)	(0.832)	(0.728)	(0.825)
$\ln GDP_iGDP_j$	0.673**	0.821**	0.958**	0.694**	0.844**	0.964**
	(0.031)	(0.027)	(0.027)	(0.028)	(0.025)	(0.026)
$\ln PGDP_iPGDP_j$	0.249**	0.410**	0.508**	0.303**	0.413**	0.504**
	(0.034)	(0.029)	(0.031)	(0.031)	(0.029)	(0.031)
$\ln DISTANCE_{ij}$	−0.586**	−0.889**	−0.957**	−0.614**	−0.917**	−0.962**
	(0.076)	(0.064)	(0.069)	(0.070)	(0.062)	(0.070)
$ADJACENT_{ij}$	0.451	0.470 #	0.247	0.476	0.521 #	0.232
	(0.387)	(0.272)	(0.310)	(0.350)	(0.304)	(0.319)
$LINKS_{ij}$	0.906**	0.824**	1.131**	0.933**	0.857**	1.096**
	(0.186)	(0.132)	(0.151)	(0.175)	(0.133)	(0.151)
Threshold	1.501	1.481	0.420	2.752	1.184	0.289
($US Thous.)	(2.043)	(0.962)	(0.561)	(2.463)	(0.765)	(0.525)
Log Likelihood	−15024.3	−15320.9	−16989.7	−16042.3	−14849.9	−16824.0

1975	Conservative aggregation			Liberal aggregation		
	Org.	Ref.	Dif.	Org.	Ref.	Dif.
Intercept	−3.301**	−4.360**	−8.105**	−3.361**	−5.161**	−7.998**
	(1.032)	(0.767)	(0.807)	(0.939)	(0.766)	(0.804)
$\ln GDP_iGDP_j$	0.763**	0.799**	0.941**	0.767**	0.856**	0.935**
	(0.035)	(0.026)	(0.028)	(0.031)	(0.026)	(0.028)
$\ln PGDP_iPGDP_j$	0.124**	0.285**	0.364**	0.143**	0.293**	0.363**
	(0.036)	(0.027)	(0.027)	(0.032)	(0.027)	(0.027)
$\ln DISTANCE_{ij}$	−0.652**	−0.911**	−0.878**	−0.649**	−0.990**	−0.882**
	(0.081)	(0.059)	(0.064)	(0.072)	(0.060)	(0.063)
$ADJACENT_{ij}$	0.200	0.380	0.270	0.207	0.325	0.259
	(0.372)	(0.262)	(0.246)	(0.341)	(0.257)	(0.245)
$LINKS_{ij}$	0.783**	0.774**	0.843**	0.825**	0.728**	0.863**
	(0.188)	(0.126)	(0.126)	(0.166)	(0.133)	(0.127)
Threshold	2.659	6.999*	6.150*	8.088	3.986*	5.604*
($US Thous.)	(3.244)	(2.977)	(2.627)	(5.945)	(1.896)	(2.549)
Log Likelihood	−17065.3	−17346.6	−19443.8	−18161.0	−16859.3	−19280.1

1980	Conservative aggregation			Liberal aggregation		
	Org.	Ref.	Dif.	Org.	Ref.	Dif.
Intercept	−4.163**	−5.112**	−7.536**	−5.118**	−4.721**	−7.906**
	(1.046)	(0.734)	(0.766)	(0.907)	(0.691)	(0.775)
$\ln GDP_iGDP_j$	0.838**	0.829**	0.895**	0.824**	0.858**	0.892**
	(0.034)	(0.025)	(0.027)	(0.030)	(0.025)	(0.027)
$\ln PGDP_iPGDP_j$	0.064 #	0.247**	0.338**	0.138**	0.207**	0.352**
	(0.036)	(0.024)	(0.025)	(0.031)	(0.024)	(0.025)
$\ln DISTANCE_{ij}$	−0.678**	−0.906**	−0.891**	−0.636**	−0.962**	−0.878**
	(0.078)	(0.054)	(0.060)	(0.068)	(0.052)	(0.061)
$ADJACENT_{ij}$	0.480	0.326	0.172	0.451	0.325	0.219
	(0.464)	(0.242)	(0.244)	(0.369)	(0.224)	(0.249)
$LINKS_{ij}$	0.586**	0.707**	0.826**	0.627**	0.583**	0.838**
	(0.188)	(0.119)	(0.124)	(0.165)	(0.108)	(0.128)
Threshold	3.477	24.529**	19.598*	17.223	26.300**	16.514*
($US Thous.)	(8.529)	(8.056)	(7.951)	(14.107)	(7.748)	(6.987)
Log Likelihood	−18363.8	−18645.2	−20951.3	−19458.5	−18211.5	−20826.6

1985	Conservative aggregation			Liberal aggregation		
	Org.	Ref.	Dif.	Org.	Ref.	Dif.
Intercept	−2.691**	−4.446**	−7.204**	−2.741**	−5.017**	−7.490**
	(0.960)	(0.709)	(0.740)	(0.861)	(0.684)	(0.745)
$\ln GDP_iGDP_j$	0.853**	0.822**	0.889**	0.835**	0.865**	0.877**
	(0.034)	(0.024)	(0.025)	(0.029)	(0.025)	(0.026)
$\ln PGDP_iPGDP_j$	0.010	0.252**	0.400**	0.059*	0.247**	0.426**
	(0.034)	(0.025)	(0.025)	(0.029)	(0.025)	(0.026)
$\ln DISTANCE_{ij}$	−0.800**	−0.954**	−1.014**	−0.799**	−1.000**	−1.013**
	(0.073)	(0.056)	(0.057)	(0.066)	(0.055)	(0.057)
$ADJACENT_{ij}$	0.439	0.514*	0.305	0.271	0.610**	0.311
	(0.362)	(0.233)	(0.263)	(0.299)	(0.233)	(0.266)
$LINKS_{ij}$	0.448**	0.360**	0.523**	0.491**	0.317**	0.538**
	(0.166)	(0.120)	(0.117)	(0.153)	(0.115)	(0.117)
Threshold	4.421	22.420*	21.184**	16.255	16.297*	16.567**
($US Thous.)	(6.626)	(9.575)	(7.009)	(12.874)	(6.995)	(5.990)
Log Likelihood	−18022.3	−18610.6	−20533.0	−19056.3	−18338.6	−20284.0

1990	Conservative aggregation			Liberal aggregation		
	Org.	Ref.	Dif.	Org.	Ref.	Dif.
Intercept	−2.705**	−4.095**	−7.788**	−3.321**	−4.753**	−8.335**
	(0.944)	(0.674)	(0.698)	(0.853)	(0.652)	(0.710)
$\ln GDP_iGDP_j$	0.800**	0.818**	0.911**	0.825**	0.854**	0.931**
	(0.031)	(0.021)	(0.022)	(0.028)	(0.022)	(0.023)
$\ln PGDP_iPGDP_j$	0.016	0.169**	0.282**	0.039	0.163**	0.292**
	(0.031)	(0.021)	(0.022)	(0.027)	(0.021)	(0.022)
$\ln DISTANCE_{ij}$	−0.761**	−0.897**	−0.858**	−0.758**	−0.916**	−0.880**
	(0.076)	(0.055)	(0.054)	(0.068)	(0.052)	(0.055)
$ADJACENT_{ij}$	0.792*	0.519**	0.402 #	0.680*	0.438*	0.320
	(0.380)	(0.230)	(0.230)	(0.353)	(0.216)	(0.230)
$LINKS_{ij}$	0.726**	0.856*	0.955**	0.764**	0.856**	0.931**
	(0.183)	(0.121)	(0.117)	(0.167)	(0.118)	(0.120)
Threshold	2.514	37.553**	21.535*	13.199	35.026**	15.782*
($US Thous.)	(7.538)	(12.249)	(9.180)	(12.637)	(9.632)	(7.850)
Log Likelihood	−18866.6	−20193.0	−22246.4	−19921.3	−20070.8	−21978.8

1995	Conservative aggregation			Liberal aggregation		
	Org.	Ref.	Dif.	Org.	Ref.	Dif.
Intercept	−2.600**	−4.745**	−7.622**	−2.422**	−5.114**	−7.754**
	(0.901)	(0.574)	(0.574)	(0.822)	(0.545)	(0.590)
$\ln GDP_iGDP_j$	0.931**	0.914**	0.994**	0.889**	0.960**	0.995**
	(0.031)	(0.020)	(0.021)	(0.028)	(0.019)	(0.021)
$\ln PGDP_iPGDP_j$	−0.117**	0.085**	0.169**	−0.055*	0.069**	0.176**
	(0.028)	(0.018)	(0.018)	(0.025)	(0.017)	(0.018)
$\ln DISTANCE_{ij}$	−0.898**	−0.926**	−0.874**	−0.875**	−0.984**	−0.886**
	(0.077)	(0.049)	(0.051)	(0.070)	(0.046)	(0.052)
$ADJACENT_{ij}$	0.421	0.462*	0.422 #	0.344	0.412*	0.413 #
	(0.384)	(0.232)	(0.222)	(0.356)	(0.206)	(0.229)
$LINKS_{ij}$	1.109**	1.023**	0.972**	1.061**	0.999**	0.994**
	(0.199)	(0.119)	(0.110)	(0.182)	(0.112)	(0.113)
Threshold	0.000	21.037**	19.691**	9.795	18.563**	12.619**
($US Thous.)	(5.883)	(6.039)	(5.589)	(7.584)	(4.771)	(4.442)
Log Likelihood	−19701.6	−21549.8	−23647.4	−20932.2	−21315.6	−23512.3

Standard errors computed from covariance of analytic first derivatives (BHHH) are in parentheses.
Number of observations: 1953
** significant at one percent level. * significant at five percent level. # significant at ten percent level.

Concerning the coefficients of GDP_iGDP_j and $PGDP_iPGDP_j$, they show a clear relationship in which the value of each coefficient rises as it moves from organized to differentiated commodities (exceptions are three cases out of 24: the coefficients of GDP_iGDP_j in 1980, 1985 and 1995 by conservative aggregation). The relationship among the values of coefficients of GDP_iGDP_j is consistent with the result of Feenstra, Markusen and Rose (2001), which shows that the elasticity of bilateral trade with respect to exporter income becomes higher than that with respect to importer income, and that the sum of two values of elasticity, i.e. the value of coefficient of GDP_iGDP_j, becomes high, as commodities differentiate more from each other, with theoretical analysis and empirical result.

We now examine the validity of two hypotheses by comparing coefficients of both *DISTANCE* and *LINKS* in each case. First, for the estimates of *DISTANCE* coefficients, there are two cases out of six that have coefficients in a relationship of $|\delta_o|<|\delta_r|<|\delta_d|$ and is no case of $|\delta_o|>|\delta_r|>|\delta_d|$, both in conservative aggregation and in liberal aggregation. Second, for *LINKS*, there are two cases out of six in conservative aggregation and one case out of six in liberal aggregation that show $\zeta_o<\zeta_r<\zeta_d$, while there is one case out of six that shows $\zeta_o>\zeta_r>\zeta_d$ both in conservative and liberal aggregations. Third, there is no case that conforms to either the network hypothesis or the monopolistic competition hypothesis for both *DISTANCE* and *LINKS* at one time. It shows that the monopolistic competition hypothesis is not valid across three groups, but also not so the appropriate is network hypothesis.

How can we interpret this rather ambiguous result? Four possible approaches are examined. The first measure is the adjustment of coefficients. Rauch (1999) adopts the adjustment of *DISTANCE* coefficients using the relationship of these coefficients and 'transportability' (the ratio of the difference between c.i.f. and customs values to the customs value for imports). He splits differentiated commodities into more and less transportable groups, applies gravity equation separately in order to estimate the sensitivity of those coefficients to differences in transportability, and then uses this estimate to compute supposed coefficients hypothesizing that each commodity groups has the same transportability. The main assumptions of this method are: 1) the distance coefficients are additively separable functions of search costs and transportation costs, 2) search costs are equal within a commodity category, and 3) transportation costs have a log-linear relationship with transportability. This measure is a tactful trial to extract the effect of search cost as one source of price information effect by eliminating the effect of transportation costs as one source of substitution effect. It seems extreme, however, to assume that more transportable as well as less transportable groups have the same search costs, and also that the estimates of the sensitivity calculated from the difference within the differentiated commodities group are applicable even to the adjustment between the organized exchange or reference priced commodities group and differentiated commodities group. In addition, he does not show the way to adjust *LINKS* coefficients. Therefore, I seek another method which enables us to interpret the results of both *DISTANCE* and *LINKS* coefficients together.

The second approach is that, instead of applying one hypothesis to the relationships of all three coefficient values of *DISTANCE* and *LINKS*, divide them into two parts and compare these estimates of each pair: pair of coefficients in the case of organized exchange commodities and reference priced commodities ($|\delta_o|$ and $|\delta_r|$, ζ_o

Table 3. Statistical significances of estimates differences, dependent variables classified by Rauch criterion

Distance	Conservative aggregation				Liberal aggregation			
	relations	$\delta_o \neq \delta_r$	$\delta_r \neq \delta_d$	$\delta_o \neq \delta_d$	relations	$\delta_o \neq \delta_r$	$\delta_r \neq \delta_d$	$\delta_o \neq \delta_d$
1970	$\lvert\delta_d\rvert > \lvert\delta_r\rvert > \lvert\delta_o\rvert$	3.050**	0.723	3.614**	$\lvert\delta_d\rvert > \lvert\delta_r\rvert > \lvert\delta_o\rvert$	3.240**	0.481	3.515**
1975	$\lvert\delta_r\rvert > \lvert\delta_d\rvert > \lvert\delta_o\rvert$	2.585**	-0.379	2.189*	$\lvert\delta_r\rvert > \lvert\delta_d\rvert > \lvert\delta_o\rvert$	3.638**	-1.241	2.435*
1980	$\lvert\delta_r\rvert > \lvert\delta_d\rvert > \lvert\delta_o\rvert$	2.403*	-0.186	2.164*	$\lvert\delta_r\rvert > \lvert\delta_d\rvert > \lvert\delta_o\rvert$	3.808**	-1.048	2.649**
1985	$\lvert\delta_d\rvert > \lvert\delta_r\rvert > \lvert\delta_o\rvert$	1.674#	0.751	2.311*	$\lvert\delta_d\rvert > \lvert\delta_r\rvert > \lvert\delta_o\rvert$	2.340*	0.164	2.454*
1990	$\lvert\delta_r\rvert > \lvert\delta_d\rvert > \lvert\delta_o\rvert$	1.450	-0.506	1.040	$\lvert\delta_r\rvert > \lvert\delta_d\rvert > \lvert\delta_o\rvert$	1.846#	-0.476	1.395
1995	$\lvert\delta_r\rvert > \lvert\delta_o\rvert > \lvert\delta_d\rvert$	0.307	-0.735	-0.260	$\lvert\delta_r\rvert > \lvert\delta_d\rvert > \lvert\delta_o\rvert$	1.301	-1.412	0.126

Links	Conservative aggregation				Liberal aggregation			
	relations	$\zeta_o \neq \zeta_r$	$\zeta_r \neq \zeta_d$	$\zeta_o \neq \zeta_d$	relations	$\zeta_o \neq \zeta_r$	$\zeta_r \neq \zeta_d$	$\zeta_o \neq \zeta_d$
1970	$\zeta_d > \zeta_o > \zeta_r$	0.360	-1.525	-0.937	$\zeta_d > \zeta_o > \zeta_r$	0.346	-1.188	-0.705
1975	$\zeta_d > \zeta_o > \zeta_r$	0.040	-0.387	-0.265	$\zeta_d > \zeta_o > \zeta_r$	0.456	-0.734	-0.182
1980	$\zeta_d > \zeta_r > \zeta_o$	-0.544	-0.692	-1.066	$\zeta_d > \zeta_r > \zeta_o$	0.223	-1.523	-1.010
1985	$\zeta_d > \zeta_o > \zeta_r$	0.430	-0.973	-0.369	$\zeta_d > \zeta_o > \zeta_r$	0.872	-1.347	-0.234
1990	$\zeta_d > \zeta_r > \zeta_o$	-0.593	-0.588	-1.054	$\zeta_d > \zeta_r > \zeta_o$	-0.450	-0.446	-0.812
1995	$\zeta_o > \zeta_r > \zeta_d$	0.371	0.315	0.603	$\zeta_o > \zeta_r > \zeta_d$	0.290	0.031	0.313

Listed are asymptotic t statistics.
** significant at one percent level. * significant at five percent level. # significant at ten percent level.

and ζ_r), and pair of coefficients in the case of reference priced commodities and differentiated commodities ($|\delta_r|$ and $|\delta_d|$, ζ_r and ζ_d). It is interesting to see that all twelve cases have the relationship of $|\delta_o|<|\delta_r|$ and eight cases show $|\delta_r|>|\delta_d|$ in the case of *DISTANCE*, while nine cases have the relationship of $\zeta_o>\zeta_r$ and ten cases show $\zeta_r<\zeta_d$ in the case of *LINKS*. From this result, it may be said that the network hypothesis accommodates to relationships $|\delta_o|$ and $|\delta_r|$ as well as ζ_r and ζ_d, while the monopolistic competition hypothesis accommodates to relationships $|\delta_r|$ and $|\delta_d|$ as well as ζ_o and ζ_r. The fault of this interpretation lies in the fact that it is an eclectic way of reasoning, entailing difficulty displaying a sound economic foundation.

The third attempt involves choosing a pair of two estimates that are significantly different, and on which we ought to focus our attention. For this purpose, tested is the null hypothesis that one estimate is equal to another, $H_0: \eta_i=\eta_j$, where $\eta=\delta$ or $\eta=\zeta$, $i \neq j$. Since I assume the disturbance terms among equations equal to zero, it is natural to assume that covariance of coefficient estimates are also equal to zero. Therefore, we can test the hypothesis by asymptotic t statistics $t=(\eta_i-\eta_j)/\sqrt{Var[\eta_i-\eta_j]}=(\eta_i-\eta_j)/\sqrt{(\sigma_i)^2+(\sigma_j)^2}$, where σ_i and σ_j are the standard errors of η_i and η_j, respectively. It follows standard normal distribution under the null hypothesis. Table 3 summarizes the results of this test. What follows from this table is: 1) difference of estimates between no pair of coefficients of *LINKS* is statistically significant, 2) difference of estimates between coefficients of *DISTANCE* in the case of organized exchange commodities and those in the case of reference priced commodities or those in the case of differentiated commodities is statistically significant in the 70s and 80s, but 3) this significance diminishes in the 90s. Rauch's classification does not provide a satisfactory explanation as to what brings about these features.

Lastly, the fourth examination is to consider another classification, based on the idea that using Rauch classification alone may not be sufficient to distinguish price information effect and substitution effect, or to show what the commodity group sensitive to price information effect or substitution effect is. This attempt is developed in the next section.

5. Industry criterion as a counterproposal

Table 4 displays the regression results in the case of SITC. This shows some interesting features of each commodity group. First, for the estimates of *DISTANCE* coefficients, it is remarkable that all the estimated years have the relationship of $|\delta_3|>|\delta_{56}|>|\delta_{01}|>|\delta_{24}|$, and the value of $|\delta_{789}|$ moves downward as time goes by, from between $|\delta_3|$ and $|\delta_{56}|$ in 1970, to between $|\delta_{01}|$ and $|\delta_{24}|$ in 1995, where the subscript figures of δ represent SITC one-digit classification. Statistical significance of difference between a pair of estimates is tested in the same manner as in the previous section, and the results are listed in Table 5. Examined from the largest absolute value of *DISTANCE* coefficient, $|\delta_3|$ is of different statistical significance from any other estimates of *DISTANCE* through the analyzing period, which means that the trade of mineral fuel is the most sensitive to distance among all commodities. Next, $|\delta_{56}|$ differs statistically significantly from $|\delta_3|$, $|\delta_{01}|$ and $|\delta_{24}|$ through the analyzing period, and also from $|\delta_{789}|$ in two cases out of six. and $|\delta_{01}|$ are $|\delta_{24}|$ not different from each other statistically significantly in all cases, and they are sometime different statistically significantly from $|\delta_{789}|$.

Second, for *LINKS*, Table 4 shows tendencies that ζ_{01} and ζ_3 compose a large value group, ζ_{24} and ζ_{56} compose a small value group, and the value of ζ_{789} locates between them. Some asymptotic t estimates listed in Table 5 have more values than those in Table 3, though the number of estimates significant at stricter than ten percent level is small. In the case of 1970, for example, the relationship of estimates is $\zeta_{01} > \zeta_{789} > \zeta_3 > \zeta_{56} > \zeta_{24}$ and the difference between ζ_{01} and the small value group (ζ_{56} and ζ_{24}) is statistically significant[5]. Another example is the case of 1985, where the relationship of estimates is $\zeta_3 > \zeta_{01} > \zeta_{789} > \zeta_{24} > \zeta_{56}$ and the difference between ζ_3 and the small value group (ζ_{24} and ζ_{56}) is statistically significant.

Considering the characteristics of each SITC group, SITC01 (food) has small $|\delta_{01}|$ and large ζ_{01}, which means that countries trade food well with the partner countries of common language or colonial ties as well as of distance. This result is brought on by manifold aspects of the characteristics of food consumption. On the one hand, some kinds of standardized foods (cereals, nuts, meat, coffee and tea, for example) are traded on organized exchanges worldwide with advanced transport technology. These commodities don't have high sensitivity to distance. The major part of them is manufactured into a variety of processed foods that are consumed directly by people without knowing where the stuff is coming from. On the other hand, the consumption of vegetables, fruit and many processed foods (cereal preparations, meat preparations, dairy products, for example) are closely related to their cultural or historical background. The habit of food consumption is formed over generations, and it is hard to change. The trade of these commodities, therefore, is considered to be highly sensitive to the factors of common language and colonial ties.

However, the result in the case of SITC56 (less differentiated manufactures) contrasts well with that in the case of SITC01: large $|\delta_{56}|$ and small ζ_{56}. Generally, the commodities of chemicals and some manufactures (organic chemicals, medical and pharmaceutical products, iron and steel, textile, for example) are standardized and their quality or performance is easy to rate, and therefore, those produced in one country are in competition with the same kind of commodities produced in other countries. When people decide what brand of these goods to use, the important factor is cost and performance, not cultural or historical affinity. This characteristic makes trade of SITC56 sensitive to *DISTANCE* and insensitive to *LINKS*. These findings show that both SITC01 and SITC56 accommodate neither to the network hypothesis nor to the monopolistic competition hypothesis.

SITC24 (crude materials) has small $|\delta_{24}|$ and small ζ_{24}. This shows that trade of materials (wood, cotton, synthetic fibers, ores, for example) is not so affected by factors of distance or of cultural and historical ties. Since this commodity group consists mainly of organized exchange commodities and reference priced commodities, this result accommodates to Rauch's network hypothesis. However, SITC3 (mineral fuels) has large $|\delta_3|$ and large ζ_3, showing clear contrast with the case of SITC24, although mineral fuels (petroleum and gas) consist mainly of organized exchange commodities similar to SITC24. The difference in results between the two cases reflects some features of natural resources belonging to each SITC group and their international network of production and distribution. One possible explanation is that

[5] Admitting to consider the significance at twenty percent level, differences between ζ_{01} and ζ_{56} or ζ_{24} are statistically significant also in the case of 1975, 1980 and 1985.

Table 4. Regression results 1970–95 dependent variables classified by SITC criterion

1970	SITC01	SITC24	SITC3	SITC56	SITC789
Intercept	−5.384**	−5.513**	3.931**	−5.349**	−11.695**
	(0.899)	(0.862)	(1.154)	(0.748)	(0.813)
$\ln GDP_i GDP_j$	0.742**	0.859**	0.432**	0.857**	1.000**
	(0.031)	(0.033)	(0.041)	(0.025)	(0.026)
$\ln PGDP_i PGDP_j$	0.341**	0.145**	0.248**	0.344**	0.585**
	(0.035)	(0.033)	(0.052)	(0.029)	(0.032)
$\ln DISTANCE_{ij}$	−0.724**	−0.669**	−1.146**	−0.901**	−0.920**
	(0.076)	(0.072)	(0.108)	(0.065)	(0.067)
$ADJACENT_{ij}$	0.580#	0.430	−0.087	0.357	0.329
	(0.351)	(0.323)	(0.404)	(0.316)	(0.330)
$LINKS_{ij}$	1.235**	0.694**	0.912**	0.808**	1.040**
	(0.168)	(0.170)	(0.254)	(0.139)	(0.145)
Threshold	0.426	0.000	0.016	2.833*	0.001
($US Thous.)	(0.794)	(0.620)	(0.919)	(1.230)	(0.385)
Log Likelihood	−14464.1	−14141.4	−8071.0	−15871.5	−15195.7

1975	SITC01	SITC24	SITC3	SITC56	SITC789
Intercept	−4.143**	−3.139**	−0.975	−4.384**	−11.555**
	(0.962)	(0.896)	(1.583)	(0.721)	(0.927)
$\ln GDP_i GDP_j$	0.777**	0.821**	0.668**	0.844**	1.036**
	(0.032)	(0.033)	(0.058)	(0.027)	(0.031)
$\ln PGDP_i PGDP_j$	0.163**	0.000	0.248**	0.242**	0.412**
	(0.033)	(0.031)	(0.063)	(0.026)	(0.032)
$\ln DISTANCE_{ij}$	−0.730**	−0.704**	−1.140**	−0.906**	−0.860**
	(0.076)	(0.070)	(0.130)	(0.055)	(0.072)
$ADJACENT_{ij}$	0.514	0.325	0.481	0.194	0.286
	(0.335)	(0.338)	(0.662)	(0.230)	(0.266)
$LINKS_{ij}$	0.983**	0.623**	0.981**	0.717**	0.857**
	(0.156)	(0.164)	(0.313)	(0.128)	(0.140)
Threshold	2.434	0.883	0.000	12.687**	0.597
($US Thous.)	(2.033)	(1.778)	(0.611)	(4.228)	(0.836)
Log Likelihood	−16457.3	−15542.9	−10401.0	−18140.1	−17966.3

1980	SITC01	SITC24	SITC3	SITC56	SITC789
Intercept	−4.915**	−4.327**	−1.019	−4.549**	−11.862**
	(0.886)	(0.884)	(1.824)	(0.779)	(0.879)
$\ln GDP_i GDP_j$	0.783**	0.822**	0.923**	0.894**	0.959**
	(0.029)	(0.032)	(0.069)	(0.027)	(0.031)
$\ln PGDP_i PGDP_j$	0.160**	0.004	0.031	0.193**	0.422**
	(0.029)	(0.031)	(0.069)	(0.025)	(0.029)
$\ln DISTANCE_{ij}$	−0.708**	−0.617**	−1.403**	−1.002**	−0.771**
	(0.068)	(0.066)	(0.146)	(0.059)	(0.066)
$ADJACENT_{ij}$	0.408	0.590	−0.128	0.109	0.318
	(0.297)	(0.369)	(0.669)	(0.239)	(0.277)
$LINKS_{ij}$	0.904**	0.575**	0.723*	0.639**	0.735**
	(0.146)	(0.157)	(0.334)	(0.123)	(0.140)
Threshold	9.313	0.358	0.004	23.304*	1.770
($US Thous.)	(7.036)	(4.976)	(2.472)	(9.762)	(2.647)
Log Likelihood	−17804.2	−17015.7	−11504.3	−19546.0	−19701.2

1985	SITC01	SITC24	SITC3	SITC56	SITC789
Intercept	-3.839**	-3.736**	0.846	-4.149**	-11.554**
	(0.820)	(0.859)	(1.656)	(0.704)	(0.827)
$\ln GDP_i GDP_j$	0.741**	0.769**	0.886**	0.875**	0.967**
	(0.027)	(0.031)	(0.063)	(0.025)	(0.028)
$\ln PGDP_i PGDP_j$	0.147**	0.044	0.026	0.228**	0.515**
	(0.028)	(0.030)	(0.061)	(0.024)	(0.028)
$\ln DISTANCE_{ij}$	-0.685**	-0.615**	-1.515**	-1.048**	-0.985**
	(0.064)	(0.066)	(0.133)	(0.055)	(0.064)
$ADJACENT_{ij}$	0.549#	0.810*	-0.073	0.313	0.315
	(0.288)	(0.365)	(0.510)	(0.252)	(0.272)
$LINKS_{ij}$	0.559**	0.322*	0.847**	0.287*	0.526**
	(0.139)	(0.148)	(0.275)	(0.121)	(0.134)
Threshold	15.241	3.180	0.005	27.312**	1.334
($US Thous.)	(9.497)	(5.261)	(3.801)	(10.177)	(2.466)
Log Likelihood	-17662.6	-16938.8	-11433.8	-19458.1	-19175.4

1990	SITC01	SITC24	SITC3	SITC56	SITC789
Intercept	-4.993**	-4.214**	1.919	-4.452**	-11.817**
	(0.824)	(0.810)	(1.641)	(0.626)	(0.786)
$\ln GDP_i GDP_j$	0.752**	0.806**	0.870**	0.892**	1.006**
	(0.027)	(0.026)	(0.061)	(0.021)	(0.026)
$\ln PGDP_i PGDP_j$	0.184**	-0.010	-0.109#	0.128**	0.351**
	(0.026)	(0.025)	(0.058)	(0.019)	(0.025)
$\ln DISTANCE_{ij}$	-0.735**	-0.626**	-1.448**	-0.931**	-0.838**
	(0.066)	(0.061)	(0.133)	(0.049)	(0.061)
$ADJACENT_{ij}$	0.699**	0.788**	0.218	0.492*	0.227
	(0.269)	(0.302)	(0.620)	(0.228)	(0.238)
$LINKS_{ij}$	0.846**	0.828**	1.020**	0.697**	0.920**
	(0.153)	(0.153)	(0.295)	(0.107)	(0.134)
Threshold	9.042	8.954	1.302	48.706**	2.091
($US Thous.)	(7.662)	(7.864)	(2.202)	(13.993)	(3.724)
Log Likelihood	-18809.9	-17806.4	-12521.2	-21012.2	-20958.2

1995	SITC01	SITC24	SITC3	SITC56	SITC789
Intercept	-3.951**	-5.400**	2.411#	-4.118**	-10.819**
	(0.733)	(0.753)	(1.443)	(0.525)	(0.647)
$\ln GDP_i GDP_j$	0.787**	0.946**	0.961**	0.968**	1.031**
	(0.025)	(0.028)	(0.060)	(0.020)	(0.023)
$\ln PGDP_i PGDP_j$	0.130**	-0.105**	-0.245**	0.039*	0.247**
	(0.023)	(0.026)	(0.049)	(0.017)	(0.020)
$\ln DISTANCE_{ij}$	-0.851**	-0.716**	-1.507**	-1.012**	-0.810**
	(0.063)	(0.067)	(0.121)	(0.045)	(0.057)
$ADJACENT_{ij}$	0.544#	0.663#	0.357	0.407*	0.367
	(0.305)	(0.347)	(0.537)	(0.201)	(0.239)
$LINKS_{ij}$	1.065**	1.006**	1.043**	0.862**	0.914**
	(0.143)	(0.160)	(0.270)	(0.100)	(0.121)
Threshold	5.237	1.161	0.011	48.403**	1.118
($US Thous.)	(3.739)	(3.054)	(3.066)	(9.430)	(1.472)
Log Likelihood	-20310.0	-18902.1	-13781.4	-22248.1	-22724.5

Standard errors computed from covariance of analytic first derivatives (BHHH) are in parentheses.
Number of observations: 1953
** significant at one percent level. * significant at five percent level. # significant at ten percent level.

Table 5. Statistical significances of estimates differences, dependent variables classified by SITC criterion

Distance	relations	$\delta_{01} \neq \delta_{24}$	$\delta_{01} \neq \delta_{3}$	$\delta_{01} \neq \delta_{56}$	$\delta_{01} \neq \delta_{789}$	$\delta_{24} \neq \delta_{3}$
1970	$\lvert\delta_3\rvert > \lvert\delta_{789}\rvert > \lvert\delta_{56}\rvert > \lvert\delta_{01}\rvert > \lvert\delta_{24}\rvert$	-0.525	3.196**	1.770#	1.935#	3.675**
1975	$\lvert\delta_3\rvert > \lvert\delta_{56}\rvert > \lvert\delta_{789}\rvert > \lvert\delta_{01}\rvert > \lvert\delta_{24}\rvert$	-0.252	2.723**	1.876#	1.242	2.953**
1980	$\lvert\delta_3\rvert > \lvert\delta_{56}\rvert > \lvert\delta_{789}\rvert > \lvert\delta_{01}\rvert > \lvert\delta_{24}\rvert$	-0.960	4.315**	3.266**	0.665	4.906**
1985	$\lvert\delta_3\rvert > \lvert\delta_{56}\rvert > \lvert\delta_{789}\rvert > \lvert\delta_{01}\rvert > \lvert\delta_{24}\rvert$	-0.761	5.623**	4.302**	3.315**	6.062**
1990	$\lvert\delta_3\rvert > \lvert\delta_{56}\rvert > \lvert\delta_{789}\rvert > \lvert\delta_{01}\rvert > \lvert\delta_{24}\rvert$	-1.213	4.802**	2.384*	1.146	5.618**
1995	$\lvert\delta_3\rvert > \lvert\delta_{56}\rvert > \lvert\delta_{01}\rvert > \lvert\delta_{789}\rvert > \lvert\delta_{24}\rvert$	-1.468	4.809**	2.080*	-0.483	5.719**

$\delta_{24} \neq \delta_{56}$	$\delta_{24} \neq \delta_{789}$	$\delta_{3} \neq \delta_{56}$	$\delta_{3} \neq \delta_{789}$	$\delta_{56} \neq \delta_{789}$
2.392*	2.552*	-1.944#	-1.778#	0.204
2.269*	1.553	-1.658#	-1.884#	-0.508
4.349**	1.650#	-2.547*	-3.944**	-2.609**
5.040**	4.025**	-3.245**	-3.591**	-0.747
3.898**	2.457*	-3.648**	-4.169**	-1.189
3.667**	1.069	-3.834**	-5.211**	-2.782**

Links	relations	$\zeta_{01} \neq \zeta_{24}$	$\zeta_{01} \neq \zeta_{3}$	$\zeta_{01} \neq \zeta_{56}$	$\zeta_{01} \neq \zeta_{789}$	$\zeta_{24} \neq \zeta_{3}$
1970	$\zeta_{01} > \zeta_{789} > \zeta_3 > \zeta_{56} > \zeta_{24}$	2.264*	1.061	1.958#	0.879	-0.713
1975	$\zeta_{01} > \zeta_3 > \zeta_{789} > \zeta_{56} > \zeta_{24}$	1.590	0.006	1.318	0.601	-1.013
1980	$\zeta_{01} > \zeta_{789} > \zeta_3 > \zeta_{56} > \zeta_{24}$	1.535	0.497	1.388	0.835	-0.401
1985	$\zeta_3 > \zeta_{01} > \zeta_{789} > \zeta_{24} > \zeta_{56}$	1.167	-0.935	1.476	0.171	-1.681#
1990	$\zeta_3 > \zeta_{789} > \zeta_{01} > \zeta_{24} > \zeta_{56}$	0.083	-0.524	0.798	-0.364	-0.578
1995	$\zeta_{01} > \zeta_3 > \zeta_{24} >_{789} \zeta > \zeta_{56}$	0.275	0.072	1.163	0.806	-0.118

$\zeta_{24} \neq \zeta_{56}$	$\zeta_{24} \neq \zeta_{789}$	$\zeta_{3} \neq \zeta_{56}$	$\zeta_{3} \neq \zeta_{789}$	$\zeta_{56} \neq \zeta_{789}$
-0.519	-1.549	0.359	-0.438	-1.155
-0.452	-1.085	0.781	0.362	-0.738
-0.321	-0.761	0.236	-0.033	-0.515
0.183	-1.022	1.864#	1.049	-1.324
0.702	-0.452	1.029	0.309	-1.300
0.763	0.459	0.629	0.436	-0.331

Listed are asymptotic t statistics.
** significant at one percent level. * significant at five percent level. # significant at ten percent level.

SITC24 is composed of some variety of crude materials, while only one SITC four-digit category (3330: Petrol, oils and crude oils) accounts for about fifty to seventy percent of SITC3, which makes SITC3 more homogenous and enlarges the elasticity of substitution. The distinctive structure of the oil industry, with several global oil companies wielding powerful influence on extracting, refining, and distributing, may be another reason why the closeness of distance and of cultural linkage with partner countries is important in deciding from which country to import petroleum and gas. This result conforms to the monopolistic competition hypothesis.

Lastly, SITC789 (more differentiated manufactures) has relatively decreasing estimates of $|\delta_{789}|$ and ζ_{789} through the analyzing period, while most of differentiated commodities belong to this group. It shows that SITC789 conforms somewhat well to the network hypothesis in 1970, but to the monopolistic competition hypothesis in 1995. Decreasing the role of buyers/sellers network in SITC789 trade and/or decreasing the elasticity of substitution between these commodities are the main reasons why Rauch (1999) fails to acquire the result aimed for. Moreover, steady decrease of $|\delta_{789}|$ compared with other estimates of *DISTANCE* throughout the analyzing period brings insignificance of difference between a pair of estimates listed in Figure 3 in the 90s. This result may reflect the progressive phenomenon of international fragmentation, which leads to the exchange of parts of a previously vertically integrated production process for other parts of the process that have been outsourced to other countries, explained by Jones et al (2002) for example. Fukasaku and Kimura (2002) show that fragmentation of production is advanced, especially in the electronics industry.

It follows from these results that classification by SITC is a simple but appropriate way to understand the roles of the international network among buyers and sellers in trade, and also to grasp the effect of distance or common language/colonial ties on it. From Table 4 it is revealed that each SITC group has a distinctive character: SITC24 is the group that the network hypothesis is appropriate for, SITC3 is what the monopolistic competition hypothesis is proper for, trade of SITC01 is sensitive especially to culture and history, while trade of SITC56 is sensitive especially to distance, and SITC789 has medium sensitivity to both factors. The nature of a business network dealing commodities or the elasticity of substitution between commodities affect international trade of them, and how they affect trade of each group depends not only on how they are differentiated from each other, but also on what industry or what stage of fabrication commodities in each group are produced from.

6. Conclusion

This paper shows that the differentiation of commodities has both price information effect and substitution effect on their international trade. The former is made more substantial by the network hypothesis and the latter by the monopolistic competition hypothesis. The degree of the two effects depends on commodities' industrial classification. It is true that Rauch's (1999) classification, grounded on characteristics of information that matches international buyers and sellers, explains well the relationship between volume of trade and national incomes or per capita incomes, illustrated clearly by Feenstra, Markusen and Rose (2001) and this paper. This classification, however, provides insufficient evidence for the network hypothesis. How the nature of the business network affects international trade of commodities depends not only on how they are differentiated from each other, but also on what industry or what stage of fabrication commodities in each group are produced from. Therefore, industry criterion is as appropriate as Rauch's criterion in understanding proximity and common language/colonial ties in international trade.

Regression results lead to the conclusion that crude materials is the group that the network hypothesis is appropriate for, mineral fuel is what the monopolistic competition hypothesis is proper for, trade of food is sensitive especially to culture and history, while trade of chemicals and manufactures classified by material is sensitive especially to distance. Machinery, transport equipment and miscellaneous manufactured articles, which are considered as differentiated products, have little price information effect, which makes Rauch's result ambiguous.

References

Anderson, J. E. (1979) A Theoretical Foundation for the Gravity Equation, *American Economic Review*, 69 (1), pp. 106–116.

Armington, P. A. (1969a) A Theory of Demand for Products Distinguished by Place of Production, *International Monetary Fund Staff Papers*, 16 (1), pp. 159–178.

Armington, P. A. (1969b) The Geographic Pattern of Trade and the Effect of Price Changes, *International Monetary Fund Staff Papers*, 16 (2), pp. 179–201.

Bergstrand, J. H. (1985) The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence, *Review of Economics and Statistics*, 67 (3), pp. 474–481.

Bergstrand, J. H. (1989) The Generalized Gravity Equation, Monopolistic Competition, and the Factor-Proportions Theory in International Trade, *Review of Economics and Statistics*, 71 (1), pp. 143–53.

Chen, N. (2004) Intra-national versus International Trade in the European Union: Why Do National Borders Matter? *Journal of International Economics*, 63 (1), pp. 93–118.

Curtis, J. M. and S. J. Chen (2003) Trade Costs and Changes in Canada's Trade Pattern, *World Economy*, 26 (7), pp. 975–991.

Deardorff, A. V. (1998) Determinants of Bilateral Trade: Does Gravity Works in a Neocrassical World? in: J. A. Frankel (Ed.), *The Regionalism of the World Economy*, pp. 7–22. (Chicago, IL: The University of Chicago Press).

Dixit, A. and J. E. Stiglitz (1977) Monopolistic Competition and Optimum Product Diversity, *American Economic Review*, 67 (3), pp. 297–308.

Eaton, J. and A. Tamura (1994) Bilateralism and Regionalism in Japanese and U.S. Trade and Direct Foreign Investment Patterns, *Journal of the Japanese and International Economies*, 8 (4), pp. 478–510.

Eden, L. and P. Rodriguez (2004) How Weak are the Signals? International Price Indices and Multinational Enterprises, *Journal of International Business Studies*, 35 (1), pp. 61–74.

Endoh, M. (2005) The Effects of the GSTP on Trade Flow: Mission Accomplished? *Applied Economics*, 37 (5), pp. 487–496.

Erkel-Rousse, H. and D. Mirza (2002) Import Price Elasticities: Reconsidering the Evidence, *Canadian Journal of Economics*, 35 (2), pp. 282–306.

Evans, C. L. (2003) The Economic Significance of National Border Effects, *American Economic Review*, 93 (4), pp. 1291–1312.

Feenstra, R. C. and G. H. Hanson (2004) Intermediaries in Entrepot Trade: Hong Kong Re-exports of Chinese Goods, *Journal of Economics and Management Strategy*, 13 (1), pp. 3-35.

Feenstra, R. C., J. R. Markusen and A. K. Rose (2001) Using the Gravity Equation to Differentiate Among Alternative Theories of Trade, *Canadian Journal of Economics*, 34 (2), pp. 430-447.

Frankel, J. A. (1997) *Regional Trading Blocs in the World Economic System* (Washington, D. C.: Institute for International Economics)

Fukasaku, K. and F. Kimura (2002) Globalization and Intra-Firm Trade: Further evidence, in P. J. Lloyd and H.-H. Lee (Eds.), *Frontiers of Research in Intra-Industry Trade*, pp. 237-272. (New York: Palgrave Macmillan).

Helpman, E. and P. R. Krugman (1985) *Market Structure and Foreign Trade: Increasing Returns, Imperfect Competition, and the International Economy* (Cambridge, MA: MIT Press)

Hutchinson, W. K. (2002) Does Ease of Communication Increase Trade? Commonality of Language and Bilateral Trade, *Scottish Journal of Political Economy*, 49 (5), pp. 544-556.

Jones, R. W., H. Kierzkowski and G. Leonard (2002) Fragmentation and Intra-Industry Trade, in P. J. Lloyd and H.-H. Lee (Eds.), *Frontiers of Research in Intra-Industry Trade*, pp. 67-86. (New York: Palgrave Macmillan).

Rauch, J. E. (1999) Networks versus Market in International Trade, *Journal of International Economics*, 48 (1), pp. 7-35.

Rauch, J. E. (2001) Business and Social Networks in International Trade, *Journal of Economic Literature*, 39 (4), pp. 1177-1203.

Spence, M. E. (1976) Product Selection, Fixed Costs, and Monopolistic Competition, *Review of Economic Studies*, 43 (2), pp. 217-236.