HOKKAIDO UNIVERSITY

Title	Intra-industry Trade;Theory and Empirical Evidence
Author(s)	ONO, Hiroshi
Citation	ECONOMIC JOURNAL OF HOKKAIDO UNIVERSITY, 24, 15-24
Issue Date	1995
Doc URL	http://hdl.handle.net/2115/30526
Type	bulletin (article)
File Information	24_P15-24.pdf

Instructions for use

Hokkaido University Collection of Scholarly and Academic Papers : HUSCAP

Econ. J. of Hokkaido Univ.,
Vol. 24 (1995), pp. 15～24

Intra-industry Trade ; Theory and Empirical Evidence*

Hiroshi ONO

The traditional trade theory, for instance, either typically represented by Ricardo or Heckscker-Ohlin models, explains the existence of trade merits among countries engaged through inter-industry trade. This theory emphasizes differences in technologies given and/or resource endowments among countries concerned. Therefore, it is expected to explain the trade patterns between countries in the North and in the South. However, rather trade among advanced countries is widely observed. Since in these countries they share both advanced and common technologies, more often than not, we witness so-called "intra-industry" trade. The purpose of this paper is; first to give an empirical evidence on intra-industry trade between Republic of Korea and Japan in resent years, and second to present several models to explain some topics related to intra-industry trade.

1. Introduction

The traditional trade theory, for instance, either typically represented by Ricardo or Heckscker-Ohlin models, explains the existence of trade merits among countries engaged through inter-industry trade. This theory emphasizes differences in technologies given and/or resource endowments among countries concerned. Therefore, it is expected to explain the trade patterns between countries in the North and in the South. However, rather trade among advanced countries is widely observed. Since in these countries they share both advanced and common technologies, more often than not, we witness so-called "intra-industry" trade. That is, Ford's Mustang runs in Japan, and at the same time, Toyota's Carolla does the same in the United States. While this is an intuitive example of intra-industry trade, measuring the degree of intra-industry trade is not an easy task. Usually, in the theoretical framework, an industry is defined synonymously as a market producing a homogeneous commodity. What is the meaning of being homogeneous? It is almost impossible to find two homogeneous goods in real world, which seems so easy in a theoretical world. We learn

* This paper was presented at the Fourth Joint Seminar between Yonsei University and Hokkaido University, held at Yonsei University, on July 1, 1994. I thank the participants of the seminar for their helpful comments.

that two goods are homogeneous in the following situation; suppose we go to a super market nearby and want to buy one orange. In front of us there are oranges which we can take. They are sold in the same price. Their shapes, sizes and so on are exactly the same. Therefore, we may flip the coin to decide choosing one. That is, they are perfectly substitute. This is quite unlikely to happen in real world. Now let us consider the case of buying a package of milk. Quite different from the case of oranges, we cannot distinguish the difference of milk. However, in Japan, they are not perfect substitutes. In Japan, each package of milk possesses a date on it, which differentiates packages of milk. According to my experience, fresh packages of milk are arranged into the back and hard to take. Of course, in the Arrow-Debreu abstract world, we can name packages of milk at particular date as one commodity and define the ones at different date as another commodity. The number of commodities classified is not a serious problem in the textbook. However, in the real world we must classify commodities and group some of them as belonging in the same industry. Therefore, measuring the degree of intra-industry always faces a criticism of inadequacy of classification of commodities and of sub-classification of commodities.

The purpose of this paper is; first to give an empirical evidence on intra-industry trade between Republic of Korea and Japan in recent years, and second to present several models to explain some topics related to intra-industry trade.

2. Intra-industry Trade between Republic of Korea and Japan

Let us compute the degree of intra-industry trade between Republic of Korea and Japan in recent five years. According to Grubel and Lloyd, the intra-industry ratio is defined as;

$$r=1-\frac{\Sigma|X_i-M_i|}{\Sigma[X_i+M_i]},$$

where X and M respectively stand for exports and imports.

This definition says that after successfully grouping commodities, we can compute how much cross-trading occurs in the same group and its share in the total trade. In the textbook world of inter-industry trade, there is no cross-tradings in each industry, r equals zero. In contrast to this, if a country both imports and exports commodities in the same industry at the same amount, then intra-industry ratio is one. Table 1 is made by using current data of three digit number commodities supplied by Japan Tariff Association. The total exports reaches a peak at 1991 and declines after that. The total imports seems in a declining phase. However, the intra-industry ratios show rather stable movements and an increasing tendency. We also provide the intra-industry ratio in each category. Table 2 shows that intra-industry ratios in categories 0, 100, and 600 are extremely low, implying one-way trade there. These are agricultural products, livestocks, and clothes. On the other hand, intra-industry ratios in categories 500 and 700 are high and over the average. These are fabrics and jewelry. The ratios in category 800 take more or less the same values with the overall ratios. One of the reasons is that the total volume of trade associated with commodities in category 800 is always more than half of the overall volume of trade. Of course, as Table 3 shows, quite different goods are included in as a same category. For instance, horses, swine, bovine animals, ducks, and so on are classified as belonging in the same category. Of course, we can sub-classify further such as swine, other than pure-bred breeding animals, weighting 50 kg or more, which is available and classified as 0103.92-000. How far we can go depends on how patient we are. However, at least we can recognize the importance of intra-industry trade.

3. Theoretical Explanations of Intra-industry Trade

Rowthorn (1992) analyzed the case of intra-industry trade by using a simple model, which introduces imperfect competition. In his framework, two monopolists, eg., called GM and Toyota, compete international duopolists. They have the same cost function and face the same consumer preference with the same country size. The monopolists have two alternative choices ; to enter the market or not. If they enter, he or she can either choose exporting or investing abroad. These moves can occur because of the existence of tariff (or transportation cost) and fixed cost. If demand is relatively low, the monopolist exports, because the one domestic factory can have enough supply. However, when the market size grows, the monopolist will realize that building factories oversea he or she can sell duty free good. Even if spending direct investment, it pays off. His model gives Nash equilibria, which endogenously determines the pattern of trade. At that time, the importance of market size is emphasized. However, because of symmetricity assumption, his model cannot explain the situation that either one exports and the other engages in direct investment. Of course, his model considers very special case of asymmetric situation where the identical firms exists in each country, but its numbers are different. Ono (1994) examined this case and has shown that the less competitive (more monopolistic) country invests oversea, even if the other country still continue to exporting. Furthermore, the opposite case never occurs. This model can be extend in several ways in this context.

Let us consider our model briefly, whose detailed analysis given in Ono (1994). We will assume that two identical economies, Country 1 and Country 2. The firms in each country are identical, with the number of firms in Country 1 and 2 denote by n_1 and n_2 respectively. Each firm produces the same homogeneous good given the same technology. The two countries' demand functions are the same and are of linear form.

$$P(D)=A-\frac{D}{B}, \tag{1}$$

where P is price, D is sales, and A and B are constants. It is assume that both markets, home and foreign, are segmented from each other. Firms produce theory output using a number of identical plants, and the cost of production for each plant is determined by the linear cost function,

$$C(Q)=Q+F, \tag{2}$$

where Q is output and F is a constant. As state in Rowthorn, the simple form of the cost function given implies that no firm has more than one plant in a given country. Those firms which operate one plant locate in the "home" country. Let us denote x_1, y_1 and z_1 as the home sales, exports and production abroad of firm i respectively. Given the cost function of exporting such as transportation costs and insurance fees, we make the assumption of iceberg so that the exporting cost is considered as shrinking of the product. Defining the rate of shrinkage as $\frac{m}{1+m}$, the actual amount of exports in the foreign market is equal to $\frac{1}{1+m}y_i$. Therefore, the total amount sold in Country 1 is equal to:

$$D_i=n_ix_i+\frac{n_jy_j}{1+m}+n_jz_j \quad i\neq j$$

However, as pointed out by Rowthorn, since the marginal cost of production and trade are constant, y_i and z_i will never be simultaneously positive. Keeping this in mind and $x_i>0$, we express the profits of firm, π_i as follows.
For $y_i>0$:

$$\pi?=P(D_i)x_i+P(D_j)\frac{y_i}{1+m}-(F+x_i+y_i). \tag{3}$$

For $z_i>0$:

$$\pi_i=P(D_i)x_i+P(D_j)z_i-(2F+x_i+z_i).$$

In this paper, we assume that the number of firms in the two countries is exogenously given and different.

Each firm is engaged in a non-cooperative game. There are two moves. On the first move, all of the firms simultaneously decide how many plants to establish and where to locate them. These decisions are made public and cannot be altered. There are three strategies in the first stage game which are classified by the number of plants: 0, 1, and 2. The number of plants of each firm also defines the location of plants, as only in the case of two plants, can firms engage in international investment. On the second move, firms simultaneously decide how much to produce. We assume in the second move that firms compete with each other in Cournot's fashion. Thus we can derive a three by three payoff matrix. Table 4 shows the payoffs resulting from various investment combinations. The entire game is specified by three parameters: market size, S, the trade barrier rate, λ, and competitive index, $\kappa(n)$; where $S \equiv \frac{(A-1)^2 B}{4F}$, $\lambda \equiv \frac{2m}{(A-1)}$, and $k(n) \equiv \left(\frac{n+1}{2}\right)^2$.

Figure 1 shows the parametric regions of Nash equilibria based on values of λ and S. In the following, we express a pair of strategic variables in the first move as, eg. (1, 2), where the first and the second element indicates the number of plants chosen for firms in Country 1 and Country 2 respectively.

However, we can not apply this model to intra-industry trade between Republic of Korea and Japan. The form of cost functions may be quite different between two countries. Like in trade of manufacturing goods, both countries may not possess the same technology assumed in Rowthorn and Ono. Let us consider the segmented market and constant marginal cost case, which enables to separate both domestic and foreign market. Ono (1993) examined this case as a duopoly game, which can be applied in this case. There are two firms, domestic and foreign, if we like. They can choose, either low running cost with large fixed cost or high runnnig cost with small fixed facility. Suppose that one of them has relatively large fixed cost, which enables it to reduce running burden of production. On the other hand, the other firm hires more workers with less fixed cost. Both firms can survive internationally. However, this possibility is relatively small. Both firms seems endogenously to take the same pattern of technologies, which may suggest dynamic race of catch-upping.

We also apply this model where the market size differs between countries. Consider the case of VER of autos between Japan and the United States. The market size of the United States is, suppose, twice as large as that of Japan. If there is no trade barriers and both GM and Toyota have the same technology. Under the above assumptions such as segmented markets, we expect that both GM and Toyota share the half of both the domestic and foreign market. However, since the Japanese market size is the half of the United States, from the national viewpoint we face a serious trade imbalances in autos. Of course, this may not be exactly happen between two countries. But, we can predict that sooner or later the VER will become ineffective. Once the Japanese firms built factories in the United States, which shows that they have committed, then their strategies are not of continuing export, but optimally of using the oversea facilities. It should be noted that the Japanese government announced the abolition of the VER in March of this year.

4. Concluding Remarks

We can point out some empirical findings ;

(1) while the total volume of trade seems shrinking, the intra-industry ratio tends to be stable and rather upward tendencies,

(2) looking down the categories, we find large variations. Agricultural products and clothes, in particular, show very low values, implying one-way trade pattern. On the other hand, category of 700, which include jewelry and iron and steel, shows very high intra-industry trade;

(3) trade of manufacturing products, classified as 800, shows in almost all sub-number categories Japanese excess exports. That is, if we assume vertical product differentiation of manufacturing products such as the models of Flam-Helpman and Falvey-Kierzkowski, one country produces low quality prodcts and the other, high quality. However, this may not be applied to the case of trade between Republic of Korea and Japan. Rather, Korean firms and Japanese firms employ different type of technologies and coexist in the market.

Since we have only taken five years data, our conclusions do not stand on the solid basis. We should extend our time span and find some general tendency. It will be very fruitful to extend this analysis to the relationship between the United States and Japan and compare these results with Korean's case.

In this paper I suggest several models, which explains both intra-industry trade and international investment. It is my present concern that using these models derives some meaningful empirical results and provides consistent evidence to justify them.

Professor of Economics, Hokkaido University

References

1. FALVEY, R. E. and H. KIERZKOWSKI. (1987). " Product Quality, Intra-Industry Trade and (Im)perfect Competition." in *Protection and Competition in International Trade* (ed. by KIERZKOWSKI).
2. FLAM, H. and E. HELPMAN.(1987). " Vertical Product Differentiation and North-South Trade." *American Economic Review*. December.
3. GRUBEL, H. G. and P. J. LLOYD.(1975). *Intra-Industry Trade*.
4. ONO, H. (1993). " Market Competitiveness and Trade Strategies of Firms under Oligopoly." *mimeo*.
5. ONO, H. (1994). " The Threat of Vertical Export Restraints and the Incentive for International Investment." *Discussion Paper*. Series A, No. 24. Hokkaido University.
6. ONO, H. (1994). " R&D Rivalrt, the Role of the Market Size and Social Welfare." *Economic Journal of Hokkaido University*. Vol. 23, 1994. pp. 1-12.
7. ROWTHORN, R. E. (1992). " Intra-Industry Trade and Investment under Oligopoly : The Role of Market Size." *Economic Journal*. Vol. 102, No. 411. pp. 402-414.

Table 1. Commodity Exports and Imports from 1989 to 1993

(million yen)

	Exports	Imports	$\sum_{i}^{?}\|Xi-Mi\|$	Intra-Industry Ratio
1989	2243478	1775099	2497799	0.3784
1990	2475831	1676232	2484005	0.4017
1991	2669863	1632445	2625129	0.3898
1992	2220176	1449037	2228947	0.3925
1993	2091269	1285619	1994294	0.4094

Japan Exports & Imports ; *Country by Commodity*, Japan Tariff Association

Table 2. Classified Commodity-Base Intra-industry Ratio

	Exports	Imports	$\sum_{i}^{?}\|Xi-Mi\|$	Intra-Industry Ratio
1. category of number 0				
1989	2874	17475	168769	0.0320
1990	3760	153170	149740	0.0458
1991	5418	143631	138585	0.1702
1992	3857	140581	137026	0.0513
1993	4138	118378	114250	0.0674
2. category of number 100				
1989	3505	64113	63986	0.0537
1990	4936	68248	67530	0.0772
1991	6176	70818	67934	0.1176
1992	6440	63025	59431	0.1444
1993	4823	52343	51178	0.1047
3. category of number 200				
1989	226884	132189	229007	0.3622
1990	286532	147282	192319	0.5566
1991	255288	148227	206119	0.4891
1992	228756	139813	179145	0.5139
1993	204009	115699	130554	0.5916
4. category of number 300				
1989	155651	51658	113417	0.4529
1990	185867	53459	140744	0.4119
1991	201572	52688	154592	0.3919
1992	197338	43657	158481	0.3423
1993	194211	43276	154543	0.3492
5. category of number 400				
1989	57648	156034	181098	0.1524
1990	66286	143894	175844	0.163
1991	64581	128862	158179	0.1822
1992	50146	120570	138758	0.1871
1993	44281	93613	105512	0.2348
6. category of number 500				
1989	85599	83391	76194	0.5491
1990	93110	65642	79216	0.5010
1991	86583	52370	68372	0.5079
1992	83321	62995	54698	0.6287
1993	63846	42544	21302	0.4853
7. category of number 600				
1989	27892	463407	464981	0.0535
1990	40739	399442	404381	0.0813
1991	38329	376002	378581	0.0862
1992	32433	324187	322558	0.0955
1993	25774	274945	271859	0.0959

8. category of number 700				
1989	292751	276752	90677	0.8407
1990	282416	261869	64141	0.8821
1991	313549	274902	61115	0.8961
1992	240850	214949	73217	0.8393
1993	216538	199981	76281	0.8168
9. category of number 800				
1989	1227740	289636	940860	0.3799
1990	1346754	295300	1057698	0.3558
1991	1515221	300303	1218354	0.3289
1992	1224054	266171	960095	0.3557
1993	1162815	283731	879084	0.3922
10. category of number 900				
1989	162934	86444	168810	0.3230
1990	165430	87926	152392	0.3985
1991	183146	84642	173298	0.3528
1992	152981	72089	145538	0.3533
1993	170834	61109	156279	0.3262

Table 3. Commodities Classified in Each Category

1. category of number 0
livestock (horses, bovine animals, swine, live sheep, live goat, fowls, ducks, geese), fishes (gold fish, carp, herrings), milk and cream, cheese, horse hair, coral, flowers, foliage, vegetables, beans, fruits,

2. category of number 100
grains (wheat, barley, rice, etc.) seed, gums, oil, margarine, preserved salmon, fish cake, sugar, cocoa, cookies,

3. category of number 200
vegetables, prepared or preserved, miso, mineral water, liquor, tobacco, salt, minerals,

4. category of number 300
medicines, fertilisers, dyes, paints, oils, dentifries, soap, fireworks, photographic color film,

5. category of number 400
rubber, tyres, animal skins, animal leather, furskins, wood, logs, plywood, ichenware of wood, paper

6. category of number 500
silk, fabrics, wovenfabrics, synthetic filament, artificial filament,

7. category of number 600
clothes, ties, gloves, blankets, tents, footwear, hat, building blocks and bricks of cement, ceramics,

8. category of number 700
glass, jewelry, iron and steel, wires, tubes, copper-nickel alloys, Aluminium, zinc,

9. category of number 800
tools, most manufacturing goods (machines)

10. category of number 900
lenses, spectacles, cinematographic cameras, microscopes, rangefinders, artificial teeth, apparatus based on the use of X-ray, watermeters, wrist watches, clocks, musical instruments, revolvers and pistols, dolls

Table 4 Payoff Matrix

		A Firm in Country 2		
		0 plant	1 plant	2 plants
A Firm in Country 1	0 plant	$[0,\ 0]$	$\lambda \geq 2$: $[0,\ \alpha(n_2)-1]$ $\lambda < 2$: $\left[0-,\ \left(2-\lambda+\frac{\lambda^2}{4}\right)\alpha(n_2)-1\right]$	$[0,\ 2(\alpha(n_2)-1)]$
	1 plant	$\lambda \geq 2$: $[\alpha(n_1)-1,\ 0]$ $\lambda < 2$: $\left[\left(2-\lambda+\frac{\lambda^2}{4}\right)\alpha(n_1),\ 0\right]$	$\lambda \geq \delta_2$: $[\alpha(n_1)-1,\ \alpha(n_2)-1]$ $\delta_2 > \lambda \geq \delta_1$: $\left[\alpha(n_1)+\left(1-\frac{\lambda}{\delta_2}\right)^{2}\alpha(n_1+n_2)-1,\right.$ $\left.1+\frac{n_1\lambda^2}{2}\alpha(n_1+n_2)-1\right]$ $\lambda < \delta_1$: $\left[\left(2-\lambda+\frac{1}{4}\left(2n_2^2+2n_2+1\right)\lambda^2\right)\alpha(n_1+n_2)-1,\right.$ $\left.\left(2-\lambda+\frac{1}{4}(2n_1^2+2n_1+1)\lambda^2\right)\alpha(n_1+n_2)-1\right]$	$\lambda \geq \delta_2$: $[\alpha(n_1+n_2)-1,\ \alpha(n_2)+\alpha(n_1+n_2)-2]$ $\lambda < \delta_2$: $\left[\left(1+\left(1\frac{\lambda}{\delta_2}\right)^2\right)\alpha(n_1+n_2)-1,\right.$ $\left.\left(1+\left(1+\frac{n_1\lambda}{2}\right)^2\right)\alpha(n_1+n_2)-2\right]$
	2 plant	$[2(\alpha(n_1)-1),\ 0]$	$\lambda \geq \delta_1$ $[\alpha(n_1)+\alpha(n_1+n_2)-2,\ \alpha(n_1+n_2)-1]$ $\lambda < \delta_1$: $\left[\left(1+\left(1+\frac{n_2\lambda}{2}\right)^2\right)\alpha(n_1+n_2)-2,\right.$ $\left.\left(1+\left(1\frac{\lambda}{\delta_1}\right)^2\right)\alpha(n_1+n_2)-1\right]$	$[2(\alpha(n_1+n_2)-1),\ 2(\alpha(n_1+n_2)-1)]$

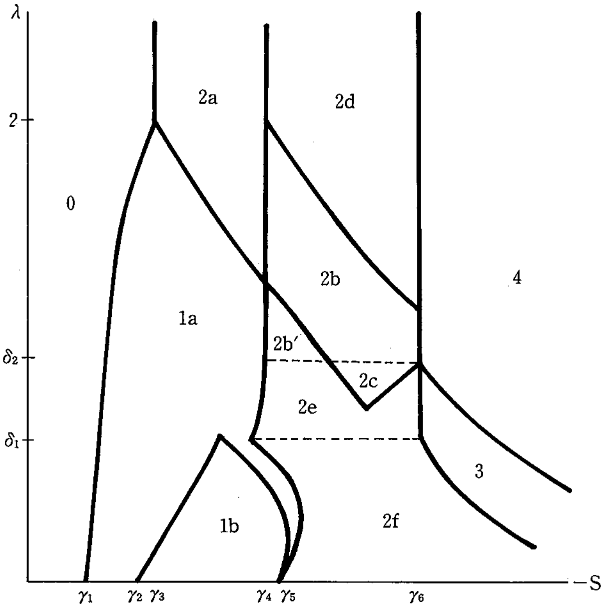

Figure 1 Specification of Parameter Regions Major Inter-regional Boundaries

0/1a : $2\left[1-\sqrt{\frac{1}{\alpha(n_2)}-1}\right]$: 1a/1b : $\lambda=2\left[1-\sqrt{\frac{1}{\alpha(n_1)}-1}\right]$,

$\lambda=2\left[1-\sqrt{\frac{1}{\alpha(n_1)}-1}\right]$, $\lambda=\frac{2}{2n_1^2+2n_1+1}\left\{1\pm\sqrt{1-(2n_1^2+2n_1+1)\left(2-\frac{1}{\alpha(n_1+n_2)}\right)}\right\}$

2a/2f : $\lambda=\frac{2}{2n_2^2+2n_2+1}\left[1\pm\sqrt{1-(2n_2^2+2n_2+1)\left(2\frac{1}{\alpha(n_1+n_2)}\right)}\right]$;

1a/2e: $\lambda=\delta_2\left[1-\frac{1}{2}\sqrt{3-\frac{1}{\alpha(n_1+n_2)}(\alpha(n_1)-1)}\right]$; 2b/2b′, 2e/2c : $2\left[1-\sqrt{1-\frac{1}{\alpha(n_2)}}\right]$;

2c/2e: $\delta_2\left[1-\sqrt{\frac{1}{\alpha(n_1+n_2)}-1}\right]$; 2b/2d : $\lambda=2\left[1-\sqrt{1-\frac{1}{\alpha(n_1)}}\right]$;

2f/3 : $\lambda=\delta_1\left[1-\sqrt{1-\frac{1}{\alpha(n_1+n_2)}}\right]$; 3/4 : $\lambda=\delta_2\left[1-\sqrt{1-\frac{1}{\alpha(n_1+n_2)}}\right]$;

$\gamma_1=\frac{k(n_2)}{2}$, $\gamma_2=\frac{k(n_1)}{2}$, $\gamma_3=k(n_2)$, $\gamma_4=k(n_1)$, $\gamma_5=\frac{k(n_1+n_2)}{2}$, $\gamma_6=k(n_1+n_2)$