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PROCESS OF PRODUCTION AND INTRA-INDUSTRY TRADE IN MANUFACTURES

YOKO SAZANAMI AND NOBORU HAMAGUCHI

I

Kennedy Round tariff cuts and abolition of other trade barriers in the 1960's contributed greatly to the expansion of trade among industrial countries. Proportion of trade between industrial countries in total world trade increased from 55.8% in 1960 to 64.8% in 1970. Much of this trade expansion reflected increase in mutual exchange of commodities produced in the same industry.

Importance of intra-industry trade among industrial countries has been stressed by Balassa [2], Grubel [8], Adler [1] and others. Traditional international trade theory has dealt only with the problem of inter-industry trade such as countries exchanging leather goods to textiles. However in the 1960's, there was a new development in world trade. A country exchanged goods that are produced in the same industry, but differed in type, style or use. The new type of trade was more pronounced in trade between EEC or CACM* member countries than between non-members.

Formation of common market and progress in trade liberalization evidently expanded the market size, eased the access to market information and spreaded the technological knowledge. Thus firms tended to specialize in particular type of products or process of production. Many firms chose suitable location for production within the liberalized region and specialized in particular production process or type of products. As a result of such behavior of the firms, countries tend to export and import products of the same industry. Grubel [8] found that there is a close relationship between formation of EEC and intra-industry trade. While intra-industry trade increased in all the EEC member countries, it increased more rapidly in trade among member countries. In EEC member countries, intra-industry trade as a percentage of total rose from 53% in 1959 to 65% in 1967 for trade between member countries. But it rose only from 44% in 1959 to 53% in 1967 for trade with other trading partners.

Number of economists have tried to give theoretical explanations to intra-industry tade. Linder [14] stressed the importance of quality of products demanded in different countries. High income country will demand high quality products thus they will hold comparative advantage in such products. They will export high quality products in exchange of low quality products that are produced in the same industry. There will be more trade between countries with similar income level. Linder's hypothesis considers domestic demand, particularly domestic market size as an important factor determining cost advantage.

* Central American Common Market.

Drèze also developed a model that stressed the importance of demestic market size. He found that small country like Belguim is unable to hold cost advantage in differentiated products that differ in design, style and use. They will tend to specialize in standardized products. On the other hand, large country like West Germany will specialize in differenciated products that are more highly fabricated and belong to latter stage of production process.

One of the reasons for the increase in intra-industry trade between industrial countries may be that countries tend to specialize in production process rather than product. Thus they exchange products that are produced in the same industry but at different level of fabrication. For example, small countries export standardized product at earlier stages of production process, while import differentiated products at latter stages of production process from large countries.

In the present study we have developed a model that relates intra-industry trade with production process rather than with product that are taken up in conventional analysis. If Drèze's hypothesis holds, Japan with GNP level similar to that of West Germany will specialize in differentiated products at latter stage of production process. We first compare the commodity structure of trade at different level of production process in West Germany and in Japan. We analyse whether Drèze's hypothesis holds for Japan. And then we proceed to see at which level of production process, intra-industry trade is most pronounced. Whether intra-industry trade is particularly seen in differentiated high processed goods or also common in intermediate and low processed goods.

II

Drèze, in his study [6], divided process of production into six stages as follows; 1) primary raw materials, 2) processed raw materials, 3) semi-manufactured, 4) primary processed manufactured, 5) secondary processed manufactured and 6) finished manufactured. He grouped 380 commodities into 28 groups according to primary raw materials used in each commodities and then subdivided each group into six stages. He found that intra-EEC export share of West Germany increases as stages of production process proceeds from 1) primary raw materials to 6) finished manufactured. Whereas intra-EEC export shares of Netherlands decline as stages of production proceeds with exception in stage 4 reflecting large steel exports. Drèze attributes this difference in trade pattern of West Germany and Netherlands to the size of domestic market. The cases where small country exporting products at latter stages of production are limited to products of large multinational firms selling at international market.

Drèze's study presents an interesting relationship between export pattern and production process that was not explicitly taken up in conventional analysis. However it is not quite clear why and how he grouped commodities and subdivided production processes into six stages. It also excludes the import side of trade structure that seems important to us. Why will some countries import raw ma-

terials, semi-manufactured or finished manufactue.

In our present study we used two approaches, both by application of input-output technique tried to analyse the relationships between production process and trade. In our first approach, we define manufacturing production as a sequence of processes where an output of one industry is used as an input in other industry. As a result of such sequences raw materials reache a final stage of finished product. Chenery-Watanabe [5] and Simpson-Tsukui [18] found in their study that by re-arranging input coeffecients in input-output table one can form triangular matrix. Such triangular matrix indicates that output from industries at lower part of the matrix will be used as input in industries at upper part of the matrix. Therefore process of production can be viewed as a process that starts from lower part and reaches to an upper part of triangular matrix.

Ozaki-Ishida [15] rearranged 1965 Japanese input-output table into triangular matrix. They grouped 450 × 350 industrial sectors into seven sub-matrix.

1) [MM]—Intermediate Input
2) [RM]—Raw material Input
3) [E]—Energy Input
4) [Aux]—Auxiliary Materials
5) [R]—Repair
6) [S]—Service
7) [V]—Value Added

[MM] is the largest and the most important sector in manufacturing. Thus it is subdivided into 18 submatrix according to raw material inputs.

We used 1970 triangular matrix of Japan that are similar to the one in 1965 and related trade data to calculate following three indices.

(1) $E_j/\sum_j^n E_j$ (export ratio) E_j ... exports of j industry

(2) $M_j/\sum_j^n M_j$ (import ratio) M_j ... imports of j industry

(3) $(E_j - M_j)/(E_j + M_j) \times 100$ (intra-industry trade index)

The results are given in Figs. 1, 2 and Table I. Industries in Figs. 1 and 2 are ranked according to level of production process as indicated in triangular matrix. Industries at upper rank produce highly fabricated goods whereas industries at lower rank produce intermediate goods and raw materials. Figs. 1 and 2 will show the relationship between structure of trade and production process in Japan. Whether Japan specializes in more fabricated goods at near the final stage of production process or at lower stage of production process. Intra-industry trade index indicates level of intra-industry trade in j industry. Instead of taking the absolute difference between exports and imports as Balassa and others did, we took the actual difference between the two. Our intra-industry trade index will range between $-100 \sim +100$, minus being import industry and plus being export industry.

As indicated in Fig. 1, Japanese exports are concentrated in highly processed goods. Ship (7.3%) motor vihicle (7.8%) household electrical appliance (4.6%)

TABLE I. INDUSTRIES WITH INTRA-INDUSTRY TRADE INDEX −50~0~+50 IN JAPAN
(Industries are grouped according to Thiangular Matrix)

0211	Nursery products and conservation and uncultivated forest materials gathered		rubber footwear)		septicized materials
0300	Hunting	2440	Made-up textile goods (except wearing apparel)	3310	Structural clay products
0410	Marine fishery products	2510	Wood milling	3320	Glass and glass products
0420	Whale	2720	Paper articles	3390	Other non-metallic mineral products
2012	Meat preserved	2800	Printing and publishing	3414	Steel ingot
2030	Vegetable and fruit preserved	2910	Leather and fur products (except wearing apparel)	3429	Other basic non-ferrous metal products
2040	Sea food preserved	3111	Basic inorganic industrial chemicals	3601	Prime mover
2050	Grain mill products	3112	Basic organic industrial chemicals	3602	Machine tool and metal working machinery
2060	Bread and confectionery products	3113	Synthetic dyestuff	3603	Industrial machinery
2091	Other food prepared	3114	Explosive compound	3604	General industrial machinery and equipment
2092	Prepared feeds for animal and poultry	3118	Chemical manure	3703	Other weak electrical appliances
2140	Soft drinks	3119	Other basic industrial chemicals	3910	Scientific, measuring and medical instruments (including sanitary goods)
2302	Cotton spinning	3130	Paint, varnish and lacquer		
2303	Wool spinning	3192	Other chemical products		
2311	Silk and rayon weaving	3291	Miscellaneous coal products	3990	Miscellaneous industrial products
2314	Woollen weaving	3292	Miscellaneous anti-		
2315	Hemp weaving				
2390	Other fiber products				
2410	Footwear (except				

rolled steel (7.4%) are the major export items. When industries are ranked from high processed goods in triangular matrix, the exports from the first to forty-second industry accounts for 66% of total exports in 1970.

In contrast to exports that are concentrated in highly processed goods, Japanese imports are concentrated in raw material industries that are ranked at the bottom of Fig. 2. Iron ore (6.5%) copper ore (5.5%) woods (7.4%) coal (5.4%) and crude oil (11.8%) are the major import items. In Table I, we listed the industries whose intra-industry trade index ranged between −50 to +50. We assumed that there is a substantial amount of intra-industry trade when index range between −50~+50. Intra-industry trade was observed not only among industries that produce highly processed products but also in industries that produce intermediate goods.

In the second approach we assumed that process of production is a sequence of increase in value added ratio. Since value of final product consists of value added in intermediate product used in production, we can assume that proportion of value added in intermediate production process in final product increases as product gets more fabricated. For example value added in final product "bread" includes value added of direct input such as "wheat flour," as well as value added

TABLE 2A. INDUSTRIES WITH INTRA-INDUSTRY TRADE INDEX $-50 \sim 0 \sim +50$ IN JAPAN
(Industries are grouped according to Induced Value Added Ratio)

0111	Grain	2910	Leather and fur products (except wearing apparel)	3602	Machine tool and metalworking machinery
2030	Vegetable and fruit preserved	3112	Basic organic industrial chemicals	3603	Industrial machinery
2040	Sea food preserved	3113	Synthetic dyestuff	3604	General industrial machinery and equipment
2050	Grain mill products	3114	Explosive compound	3605	Office machinery
2060	Bread and confectionery products	3118	Chemical manure	3703	Other weak electrical appliances
2092	Prepared feeds for animal and poultry	3119	Other basic industrial chemicals	3890	Other transport equipments
2140	Soft drinks	3130	Paint, varnish and lacquer	3910	Scientific, measuring and medical instruments (including sanitary goods)
2302	Cotton spinning	3192	Other chemical products		
2303	Wool spinning	3291	Miscellaneous coal products		
2314	Woollen weaving	3414	Steel ingot		
2315	Hemp weaving				
2510	Wood milling				
2520	Wooden products				
2800	Printing and publishing				

of indirect input such as "transportation and retail." We estimated total value added required to produce one unit of output and called such amount as induced value added ratio.

Our system can be stated as follows;

$$[I - A]^{-1} F = X \tag{1}$$

where X is total output vector

A is input coefficient matrix

F is final demand vector.

Total induced output required to produce an unit of output in j sector can be estimated by,

$$x_j^* = [i][I - A]^{-1} A_j \tag{2}$$

where A_j is jth raw vector of input coefficient matrix A .

$[i]$ is $[1, 1 \ldots 1]$ column vector of 1 ,

then x_j^* is induced output.

Equation (2) can take more general form,

$$X^* = [i][I - A]^{-1} A \tag{3}$$

Induced value added corresponding to induced output in (3) can be estimated by

$$V^* = [i][\hat{v}][I - A]^{-1} A \tag{4}$$

where $[\hat{v}]$ is a diagonal matrix of direct value added ratio,

TABLE 2B. INDUSTRIES WITH INTRA-INDUSTRY TRADE INDEX $-50 \sim 0 \sim +50$ IN WEST GERMANY (Industries are grouped according to Induced Value Added Radio)

0211	Nursery products and conservation and uncultivated forest materials gathered	2910	Leather and fur products (except wearing apparel)	3415	Hot-rolled steel
0410	Marine fishery products	2930	Leather products (except wearing apparel)	3417	Cold-finished and plated steel
1101	Coal	3111	Basic inorganic industrial chemicals	3418	Iron and steel castings and forgings
1400	Stone and quarrying	3112	Basic organic industrial chemicals	3422	Copper rollings
2020	Dairy products	3114	Explosive compound	3423	Aluminium rollings
2050	Grain mill products	3115	Rayon material	3429	Other basic non-ferrous metal products
2060	Bread and confectionery products	3116	Synthetic fiber material	3501	Structural metal products
2070	Sugar	3117	Plastic	3605	Office machinery
2092	Prepared feeds for animal and poultry	3119	Other basic industrial chemicals	3606	Household machinery
2110	Liquor and alcoholic drinks	3191	Medicine	3607	General machine parts
2200	Tobacco	3192	Other chemical products	3701	Strong electrical machinery
2305	Rayon spinning	3210	Petroleum refinery products (including grease and lubricating oil)	3702	Household electrical appliances
2306	Synthetic fiber spinning	3292	Miscellaneous antisepticized materials	3703	Other weak electrical appliances
2312	Cotton and spun rayon weaving	3310	Structural clay products	3810	Ship and its repairing
2313	Synthetic fiber weaving	3320	Glass and glass products	3850	Motorcycle and bicycle
2315	Hemp weaving	3330	Pottery, china and earthenware	3860	Aircraft
2320	Knit	3340	Cement	3890	Other transport equipments
2330	Rope and fish net	3390	Other non-metallic mineral products	3920	Photographic and optical instruments (including photographic sensitive materials)
2390	Other fiber products	3412	Iron scrap	3930	Watch and clock
2410	Footwear (except rubber footwear)	3414	Steel ingot	3990	Miscellaneous industrial products
2440	Made-up textile goods (except wearing apparel)			8300	Business services
2520	Wooden products			8400	Recreation services
2600	Furniture and fixture				
2720	Paper articles				
2800	Printing and publishing				

$$[\hat{v}] = \begin{bmatrix} v_1 & & 0 \\ & \ddots & \\ 0 & & v_n \end{bmatrix}.$$

In Fig. 3 and 4, we rank the industries according to induced value added ratio assuming that high value added ratio corresponds to fabricated high processed goods. Industries with low value added ratio are assumed to produce intermediate goods and goods at early stage of fabrication. We used 1970 trade data for Japan and West Germany and calculated $E_j/\sum_j^n E_j$ (export ratio), $M_j/\sum_j^n M_j$ (import

ratio) and $(E_j-M_j)/(E_j+M_j)\times 100$ (intra-industry trade index) for each industry.

In both countries, high export ratio was concentrated in industries with high induced value added ratio. Thus we may conclude that Japan and West Germany, both countries having large domestic market export high processed goods. However there is a marked difference in distribution of import ratio in two countries. While high import ratios in Japan are concentrated in low processed intermediate and raw materials, there is no observed difference between import ratio of high processed goods and low processed goods in West Germany. As a result of such difference in import ratio of Japan and West Germany, intra-industry trade index falls between $-50\sim+50$ in 31 industries in case of the former against 67 industries in case of the latter.

Table 2 lists industries where intra-industry trade index fall between $-50\sim+50$. 67 industries in West Germany include various type of industries. They include consumer goods industries-bread and confectionary, dairy products, intermediate goods industries-chemical fiber, cement, and capital goods industries-office machinery, ships and vessels. 31 industries in Japan include such industries as food and textile where imports are increasing rapidly reflecting recent rise in wages and fall in price competitiveness, machinery industries where export started to expand reflecting technological advance in the 1960's. In both countries intra-industry trade was not limited to differentiated final products that style or quality difference seem important. There was substantial intra-industry trade transactions in standardized intermediate goods.

It became obvious from Table 2A and 2B that there is more intra-industry transactions in West Germany than in Japan. Such difference reflected the difference in import ratios in two countries. Import ratios ware generally higher in various types of industries in West Germany compared to those in Japan.

III

Conclusions

1) We found that Japan with domestic market size approximately similar to West Germany tends to specialize and export high processed products than low processed intermediate products. If we assume that high processed products correspond to differentiated commodities and low processed products to standardized commodities, Japanese trade structure can be characterized by exports of differentiated commodities.

2) Intra-industry trade is often related to product differentiation. Namely that country will export and import products that belong to the same industry but differ in style, design or quality. However our study shows that intra-industry trade is not limited to differentiated products but also observed in intermediate standardized products.

3) As for intra-industry trade index, inter-country difference between West Germany and Japan was much greater than inter-commodity difference. In West

Germany, intra-industry trade indexes of 67 industries in total of 160 industries ranged betwen $-50\sim+50$. There were only 31 industries that ranged between $-50\sim+50$ in case of Japan. Japanese industries in Table 2 were either industries that were facing increase in imports as their competitive positions were weakening, or experiencing increase in exports as their competitive postitions were strengthening.

4) Difference in intra-industry trade pattern between West Germany and Japan may be due to formation of EEC and trade liberalization policy undertaken by West Germany. In West Germany, lowering of import duties and lifting of other trade barriers date back to mid-1950's. However in case of Japan, major objectives of trade policy till 1970's were to expand exports and curb imports. Especially imports of manufactured goods were discouraged to provide necessary employment opportunities in labor intensive consumer goods industry and to assure domestic market for so-called "infant-industries." After the rapid liberalization policy in 1971 and 1972, there is a gradual increase in manufactured imports.

5) In case of West Germany, early liberalization policy and mutaual tariff reduction of EEC may have led to specialization in particular processes and type of products. Whether intra-industry trade in West Germany is more pronounce in trade with EEC member countries or also observed in trade with other developed countries is yet to be analysed. But as Balassa has pointed out, trade liberalization seems to be very important factor in intra-industry trade.

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APPENDIX I. AGGRIGATED SECTOR CLASSIFICATION (160×160 Sector)

Code	Name of Sector	Code	Name of Sector	Code	Name of Sector
0111	Grain		products	2070	Sugar
0112	Other field crop and vegetable except for industrial process	0420	Whale	2091	Other food prepared
		0430	Inland water fishery products	2092	Prepared feeds for animal and poultry
0113	Fruit	1101	Coal	2110	Liquor and alcoholic drinks
0114	Field crop for non-fiber industrial process	1102	Lignite	2140	Soft drinks
		1210	Iron ore	2200	Tobacco
		1220	Non-ferrous metal ore	2301	Silk reeling and waste silk spinning
0115	Field crop for fiber industrial process	1301	Crude petroleum	2302	Cotton spinning
		1302	Natural gas	2303	Wool spinning
0116	Livestock breeding except for fiber	1400	Stone quarrying	2304	Hemp spinning
		1910	Salt quarrying	2305	Rayon spinning
0117	Livestock breeding for fiber	1990	Other non-metal ore mining and quarrying	2306	Synthetic fiber spinning
0118	Sericulture	2011	Carcass and meat prepared	2311	Silk and rayon weaving
0120	Agricultural servies	2012	Meat preserved	2312	Cotton and spun rayon weaving
0211	Nursery products and conservation and uncultivated forest materials gathered	2020	Dairy products	2313	Synthetic fiber weaving
		2030	Vegetable and fruit preserved	2314	Woollen weaving
0212	Charcoal and firewood	2040	Sea food preserved	2315	Hemp weaving
0220	Log	2050	Grain mill products		
0300	Hunting	2060	Bread and confectionery products		
0410	Marine fishery				

Appendex I. Continued

Code	Name of Sector
2316	Yarn and fabric dyeing and finishing (entrusted processing only)
2320	Knit
2330	Rope and fish net
2390	Other fiber products
2410	Footwear (except rubber footwear)
2430	Wearing apparel (except footwear)
2440	Made-up textile goods (except wearing apparel)
2510	Wood milling
2520	Wooden products
2600	Furniture and fixture
2711	Pulp
2712	Paper
2720	Paper articles
2800	Printing and publishing
2910	Leather and fur products (except wearing apparel)
2930	Leather products (except wearing apparel)
3000	Rubber products
3111	Basic inorganic industrial chemicals
3112	Basic organic industrial chemicals
3113	Synthetic dyestuff
3114	Explosive compound
3115	Rayon material
3116	Synthetic fiber material
3117	Plastic
3118	Chemical manure
3119	Other basic industrial chemicals
3120	Vegetable and animal oil and fat
3130	Paint, varnish and lacquer
3191	Medicine
3192	Other chemical products
3210	Petroleum refinery products (including grease and lubricating oil)
3291	Miscellaneous coal products
3292	Miscellaneous anti-septicized materials
3310	Structural clay products
3320	Glass and glass products
3330	Pottery, china and earthenware
3340	Cement
3390	Other non-metallic mineral products
3411	Pig iron
3412	Iron scrap
3413	Ferro alloy
3414	Steel ingot
3415	Hot-rolled steel
3416	Steel pipe and tube
3417	Cold-finished and plated steel
3418	Iron and steel castings and forgings
3421	Non-ferrous metal materials
3422	Copper rollings
3423	Aluminium rollings
3429	Other basic non-ferrous metal products
3501	Structural metal products
3502	Other metal products
3601	Prime mover
3602	Machine tool and metalworking machinery
3603	Industrial machinery
3604	General industrial machinery and equipment
3605	Office machinery
3606	Household machinery
3607	General machine parts
3701	Strong electrical machinery
3702	Household electrical appliances
3703	Other weak electrical appliances
3810	Ship and its repairing
3820	Railroad equipment
3830	Motor vehicle
3840	Motor vehicle repairing
3850	Motorcycle and bicycle
3860	Aircraft
3890	Other transport equipments
3910	Scientific, measuring and medical instruments (including sanitary goods)
3920	Photographic and optical instruments (including photographic sensitive materials)
3930	Watch and clock
3990	Miscellaneous industrial products
4001	New residential building construction
4002	New non-residential building construction
4003	Building repairing
4004	Public utility construction
4009	Other construction
5110	Electric power supply (including privately generated power)
5120	Gas supply and distribution
5200	Water supply and sanitary services
6110	Wholesale trade
6120	Retail trade

Appendex I. Continued

Code	Name of Sector	Code	Name of Sector	Code	Name of Sector
6200	Financial business		facility services		services
6300	Insurance business	7150	Ocean transport	8300	Business services
6401	Real estate agency	7160	Coastal and inland	8400	Recreation services
6402	House rents		water transport	8501	Drinking and eating
6403	Real estate rents	7170	Air transport		places
7110	National railway	7190	Other transport	8509	Other personal
	transport		services		services
7121	Local railway and	7200	Storage facility	8600	Office supplies
	tramway transport		services	8700	Packing materials
7122	Road passenger	7300	Communication	8800	Research institutes
	transport	8100	Government service		(governmental)
7141	Road freight	8210	Education service	9000	Activities not
	transport	8220	Health service		adequately described
7142	Road transport	8290	Other community		

Fig. 1. Export Ratio (1/10,000) by Process of Production in Japan
(by Triangular matrix)

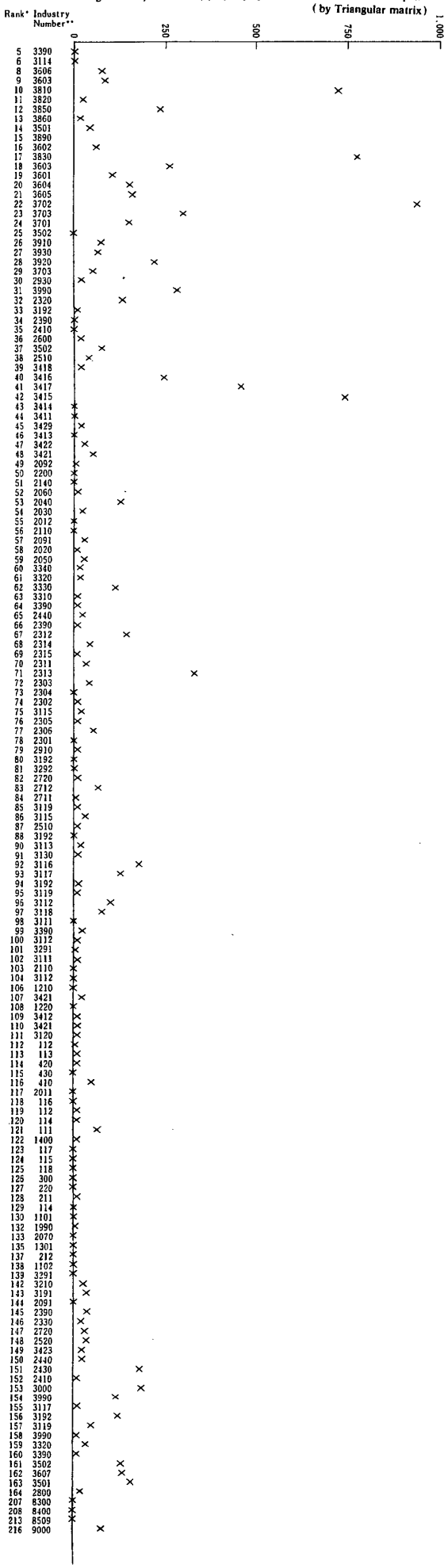
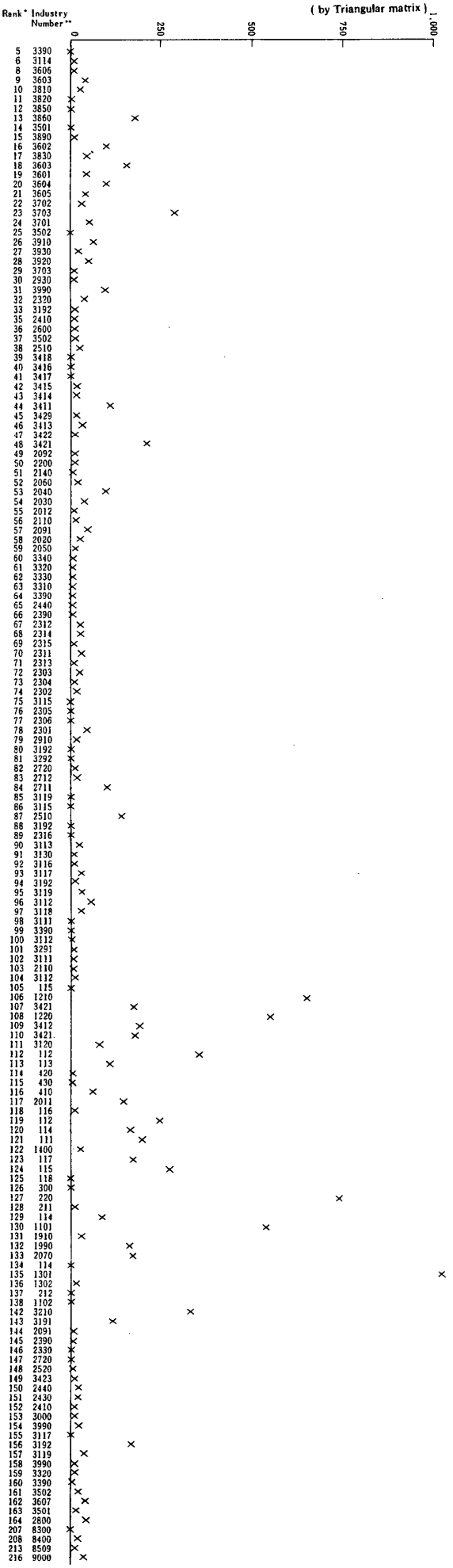


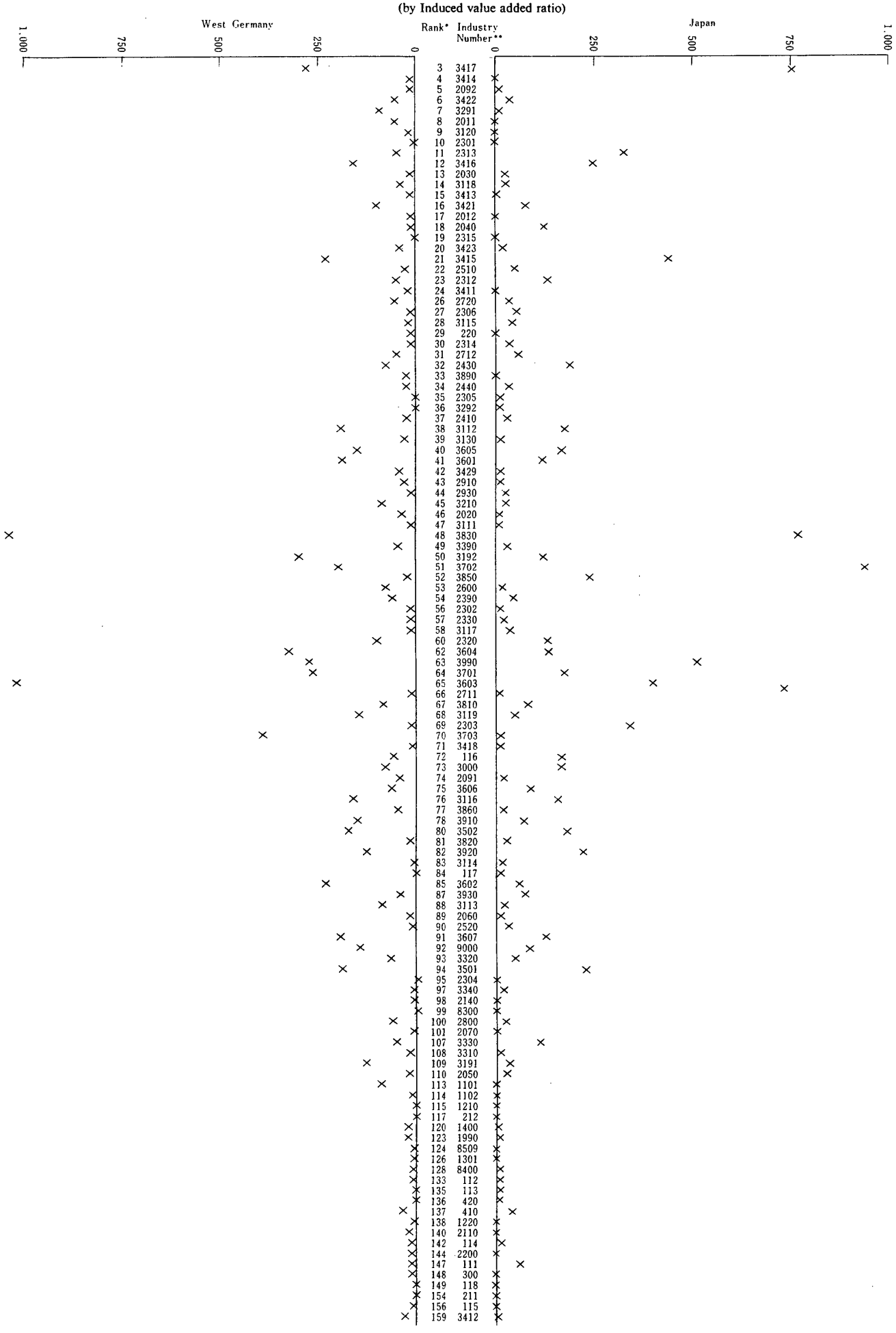
Fig. 2. Import Ratio (1/10,000) by Process of Production in Japan
(by Triangular matrix)



* Industries are ranked according to the order in triangular matrix so that higher rank will indicate highly fabricated goods while low rank will indicate intermediate good's and raw materials. Missing number shows industry with no trade transaction.

** See Appendix I.

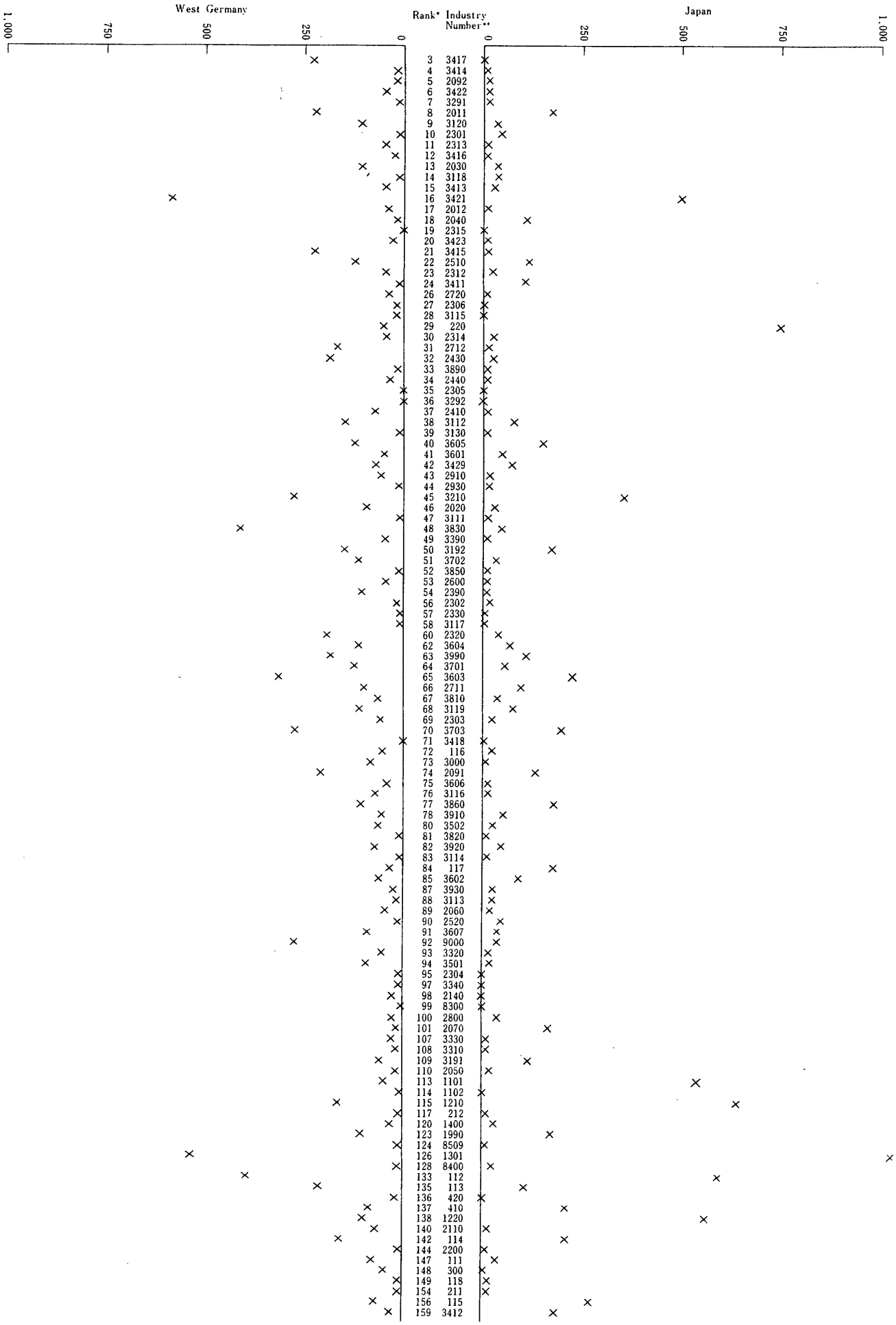
Fig. 3. Export Ratio (1/10,000) by Process of Production in JAPAN and in West Germany
(by Induced value added ratio)



* Industries are ranked according to the level of induced value added ratio, assuming that high ratio corresponds to highly fabricated goods while low ratio corresponds to intermediate goods and raw materials. Missing number shows industry with no trade transaction.

** see Appendix I.

Fig. 4. Import Ratio (1/10,000) by Process of Production in JAPAN and in West Germany
(by Induced value added ratio)



* Industries are ranked according to the level of induced value added ratio, assuming that high ratio corresponds to highly fabricated goods while low ratio carreponds to intermediate goods and raw materials, Missing number shows industry with no trade transaction.

** see Appendix I.