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A COMPARISON OF INDUSTRIAL AND TRADE STRUCTURES OF KOREA, JAPAN, AND THE U.S.: HOW AND WHY ARE THEY DIFFERENT?

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I. INTRODUCTION

In the late 19th century, Japan embarked on a path of late industrialization, following the precedent of early industrialized Western countries like the U.S. Even though the Japanese industrial base had to be rebuilt after World War II, Japan resumed its rapid economic development in the 1950s under the slogan of "catching-up with the West" by relying on an outward-oriented growth strategy. Since the early 1960s, another group of Asian economies, the four "dragons" of Korea, Taiwan, Singapore and Hong Kong, followed the lead of Japan in their own efforts to industrialize by adopting similar strategies of outward-oriented economic growth. These four Asian economies' experiences were again followed by several Southeast Asian countries such as Malaysia, Indonesia and Thailand in the 1970s. During the 1980s, China also joined this group of late-late industrializing countries.[1]

Even though their economic growth rates took off as Rostow (1956) described in the 1950s, 60s, 70s, and 80s respectively, growth was unbalanced, as Hirschman (1958) predicted. Instead of developing various industries at the same time, their industrialization pattern was characterized by the continuous emergence of new industries over time. This has continuously transformed the composition of industrial production in these economies as Chenery (1986) explained. Furthermore, as the engine of growth of these Asian economies was export growth in manufacturing industry, the trade pattern of these economies also changed over time as their industrial structures changed. It is generally believed that their

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[1] For a more detailed and comprehensive analysis of these countries, refer to World Bank [1993].

industrial and trade structures were dominated first by labor-intensive products, then capital-intensive products, followed by skill-intensive products, and finally knowledge-intensive products as their economies grew over time. Therefore, their industrial and trade structures are expected to show a certain degree of similarity with a certain time lag between more developed and less developed economies.

In this paper, we compare the industrial and trade structures of the U.S., Japan, and Korea's manufacturing industries. Each country was selected to represent early industrialized countries, late industrialized countries, and late-late industrialized countries, respectively. For each of the comparisons, the U.S. was viewed as the reference country, whose industrial and trade structures are the most matured and stabilized. In the following section, the industrial structures of these three countries, measured by value-added data, are compared and analyzed. In section three, the trade structures of these three countries are compared in two different ways: Inter-industry trade patterns of the three countries, measured by trade specialization indices, are first examined: Then, Intra-industry trade patterns of the three countries, measured by Grubel-Lloyd indices, are compared. The final section summarizes our results. In sections two and three, the industrial and trade structures of the three countries were compared by using the method of Spearman's rank correlation coefficients, and a regression was run in order to explain the discovered differences of intra-industry trade patterns between the three countries.

Ⅱ. A COMPARISON OF INDUSTRIAL STRUCTURES

While the neoclassical growth models emphasize the accumulation of capital in an aggregate output framework, another group of models studied the distribution of resources among different sectors and the pattern of industrialization along with economic growth. These studies include Chenery (1986), which confirms that a country's industrial structure should go through a certain degree of transformation as its economy develops. In particular, such structural changes are most easily observed in the early stages of economic development when the economy grows at an accelerating pace. Chenery and Taylor (1968) found that so-called early industries such as textiles, food, leather emerge when the income per capita is low, and as the income per capita increases, late industries such as consumer durable goods emerge, so that the pattern of industrialization across countries should show certain similarities.[2] More recently, Stokey (1988) had a model where a new good is continuously introduced to an economy as the stock of hu-

[2] The relative importance of the textile industry in the Japanese industrial and trade structures is studied in Park and Anderson [1991]. They found that the textile industry emerges in the initial stage of Japanese economic development, and continuously increases its share of total GNP until the late 1930s, and then decreases.

man capital in that economy increases. All of these models suggest that the composition of industrial productions change over time, and this structural change is more substantial in the early stage of economic development than in the more mature stage.

In this section, we examine these claims by comparing the industrial structures of Korea, Japan, and the U.S. To do this, manufacturing sector's value-added data for the period of 1967 to 1990 (classified by the United Nations' ISIC 3-digit level) for each country are used to represent each country's industrial production structure. First of all, to determine how much structural change has occured in each country between 1967 and 1990, the 1990 ranks of each country's manufacturing sectors' value-added data are compared to 1967 ranks by using Spearman's Rank Correlation Coefficient (R_s) method.[3] The following is the result of this comparison for each country:

[Table 1] R_s between 1967 data and 1990 data of each country (t-statistics)

country	Korea	Japan	U.S.
R_s	0.560218 (4.00)	0.868303 (10.36)	0.890114 (11.55)

Note: Numbers in parenthesis are t-statistics, and all estimations are significant at 0.1% level.

In the above table, the low value of R_s for Korea means that Korea experienced more structural changes during the period 1967 to 1990 than the other two countries. This finding coincides with the claim by Chenery (1986) that countries at an earlier stage of economic development, like Korea, will experience more structural transformation than the more developed countries like Japan and the U.S. The value of R_s for the U.S. was very close to 1, meaning that the U.S. industrial structure has not changed much between 1967 and 1990. For the same period, Japanese industrial structure showed slightly more change than the U.S., but it was also quite stable.

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[3] Spearman's Rank Correlation Coefficient (R_s) between two different sets of industrial value-added data can be computed as the following:

$$R_s = 1 - \left[\frac{\sigma \cdot \sum_{i=1}^{n} d_i^2}{n \cdot (n^2 - 1)} \right]$$

where n is the number of manufacturing industries in 1967 and 1990, which is 37, and d_i is the difference between the rank of ith industry in 1967 and the rank of ith industry in 1990. The closer R_s is to 1, the more positively correlated the two sets of data are. We have used rank correlation instead of simple correlation, as we concerned more about comparing the industrial and trade structures between two countries rather than comparing the magnitudes of industrial productions and trade volumes between two countries.

Second of all, to examine the difference of industrial structures among the three countries, the rank order of Korean manufacturing industries' value-added data are compared to those of Japan, and the U.S. for each year. Likewise, the rank order of Japanese manufacturing industries' value-added data are compared to that of the U.S. for each year. The results of this comparison are presented below.

[Table 2] Comparison of Korea-Japan, Korea-U.S., and Japan-U.S. Industrial Structures

Selected Years	R_s between two countries (t-statistics)		
	Korea & Japan	Korea & U.S.	Japan and U.S.
1967	0.541252 (3.81)	0.525486 (3.65)	0.842461 (9.25)
1971	0.577051 (4.18)	0.563656 (4.04)	0.880868 (11.01)
1976	0.671171 (5.36)	0.563893 (4.04)	0.884898 (11.24)
1981	0.699502 (5.79)	0.608464 (4.54)	0.905880 (12.65)
1986	0.703687 (5.94)	0.615932 (4.69)	0.924987 (14.60)
1990	0.779845 (7.47)	0.711785 (6.08)	0.873947 (10.79)

Note: Numbers in parenthesis are t-statistics, and all estimations are significant at 0.1% level.

From Table 2, several points can be made. First of all, not only are the Japanese and the U.S. industrial structures stable over time as it was shown in Table 1, but also they are very similar to each other with R_s close to 0.9 for most of the years since the early 1970s. In other words, this means that an industry, whose value-added share of GNP is high in Japan, also has a high value-added share of the U.S. GNP, and vice-versa. On the other hand, the industrial structure of Korea in 1967 was significantly different from that of Japan the U.S. Even though they were still positively correlated, the value of R_s in 1967 between Korea and Japan, and between Korea and the U.S. are merely 0.54 and 0.53 each, which do not assure that those industries, which have high shares in Korea, also have high shares in Japan, or in the U.S. However, as the Korean economy sustained rapid development after 1967 accompanied by significant structural changes, the industrial structure of Korea becomes more and more similar to the referent economies. Furthermore, even though Korea continuously assimilated its industrial structure to that of more advanced countries, its industrial structure resembles Japan's, more than to the U.S.'s, which is considered as the standard for a mature economy, as it grows over time. While the value of R_s between Korea and Japan is almost identical to the value of R_s between Korea and the U.S. in 1967, the two values diverge after the mid-1970s, implying that the industrial structure of Korea shows more similarity to that of Japan than to

that of the U.S. since then.

Finally, based on the above finding that the Korean development experience resembles Japan's to a greater extent than that of the U.S., let us now compare the 1990's industrial structure of Korea to the Japanese industrial structure data from 1967 to 1990 so that we can find out at what point the Japanese industrial structure shows the greatest similarities to Korea's industrial structure in 1990. This will enable us to measure the time lag between Korean and Japanese industrial structures. The ranks of the Korean manufacturing industries' value-added data for 1990 are compared to the ranks of Japanese manufacturing industries' value-added data for several selected years, and R_s are computed based on these comparisons in Table 3.

[Table 3] R_s between Korea (1990) and Japan (selected years)

year	1967	1971	1976	1981	1986	1990
R_s	0.845899	0.851588	0.873637	0.853485	0.792975	0.779845

Note : All estimations are significant at 0.1% significance level.

As can be seen in the above table, the industrial structure of Korea in 1990 resembles the industrial structure of Japan in 1976 the most. Generally, the industrial structures of Japan in the late 1970s showed the highest correlations with the industrial structure of Korea in 1990. This enables us to conclude that there exists approximately a 15 year time lag between the two countries in terms of the composition of the manufacturing industries' value-added production. However, as the industrial structure of Korea for the past three decades changed more rapidly than those of Japan, this 15 year time difference between Korea and Japan does not mean that, for example, Korea's industrial structure of 1986 resembles most to the 1971 industrial structure of Japan. As the industrial structure of Korea has been rapidly upgraded and gets more resembled to that of Japan as time goes by as it is seen in Table 2, it would be more likely that the 1986 industrial structure of Korea had more than 15 years time difference from that of Japan. Also, following the same logic, it would be more likely that the 1995 industrial structure of Korea had less than 15 years time difference from that of Japan, considering the fast catching up of Korea with Japan in terms of its industrial structure. Furthermore, as we follow the same logic, the 15 year time difference between Korea and Japan as of 1990 in terms of their industrial structures does not mean that Korea's industrial structure will be identical to that of Japan 15 years after 1990.

We have examined the industrial structures of Korea, Japan and the U.S. for the period of 1967 to 1990 in this section. Both the Japanese and the U.S. manufacturing industries' composition of value-added production does not show

much changes over time (especially, the U.S.). At the same time, they show a great deal of similarity to each other despite the suspicion that Japan adopted a different set of industrial policies from the U.S. The industrial structure of Korea, which went through more substantial structural changes during the same period, continuously resembles that of Japan and the U.S., with the resemblance between Korea and Japan stronger than the resemblance between Korea and the U.S. Finally, it was concluded that the Korean manufacturing industries' structure in 1990 is roughly 15 years behind that of Japan, but this time gap is presumed to be narrowed as the industrial structure of Korea is rapidly upgraded. In the following section, we will examine the trade structures of these three countries by comparing inter-industry trade patterns, and also by comparing intra-industry trade patterns between the three.

Ⅲ. A COMPARISON OF TRADE STRUCTURES

3.1 Inter-Industry Trade Patterns

Traditional trade theories tell us that the inter-industry trade structure, which is the pattern of trade between industries, can be determined according to the law of comparative advantage. A country will specialize in the production of a good, where it has a comparative advantage over the other country, and thus exports that good, while it imports a good, where it has a comparative disadvantage. Whether a certain industry will have a comparative advantage or not in a certain country will be determined by the required factor intensity of that industry and the factor endowments of that country. Furthermore, the comparative advantages of a certain country can change over time, which will in turn change the range of goods this country will export and also the range of goods it will import. For example, Krugman (1979b) showed that the range of goods a developing country exports to a developed country will change as technology transfer from the developed country to the developing country occurs. Stokey (1991) also showed that the composition of export goods in a developing country will change as the stock of human capital in that country changes. Various empirical tests were performed to verify whether a country's inter-industry trade pattern coincide with the law of comparative advantage. In particular, Hong (1987) showed that the evolution of Korea's trade pattern coincides with the Heckscher-Ohlin theory of trade over time. A similar study was done by Schive (1987) regarding the Taiwan's trade pattern, and Yamazawa (1987) regarding Japan.

The main purpose of this section lies not in the verification of the explanatory power of traditional trade theories regarding the inter-industry trade patterns of countries, rather it is the comparison of inter-industry trade patterns between countries. We seek to determine how much a country's inter-industry trade structure resembles that of the other. Lee (1986) compared the trade patterns of Kor-

ea, Taiwan and Japan by using the data of these three countries trade with OECD countries. Even though the work of Lee (1986) relates to the main purpose of this section, it falls below our expectations in the sense that it covers only the period 1963 to 1977, and thus leaves out the more recent years' comparison of these countries' trade structures. Furthermore, Lee (1986) used the index of revealed comparative advantage, which shows the relative competitiveness of export industries only, and thus cannot explain the net-export trade structure of a country. To overcome these limitations, we will try to compare the trade structure of Korea to that of Japan throughout the period 1962 to 1991, by using the index of trade specialization ($S_i^j(t)$) based on the manufacturing industries' trade data for Korea and Japan with the U.S. We chose Korean and Japanese trade data with the U.S. because they can reflect the international competitiveness of those two countries' manufacturing industries best, in the sense that the U.S. market is the most open, and transparent market to penetrate from a foreign manufacturing sector's point of view. Furthermore, compared to the data for trade with other countries, the trade data for Korea and Japan with the U.S. showed a more stable trend over time, partly because of the above reason and also because of the fact that the U.S. is still the biggest export market in the world.

The index of trade specialization ($S_i^j(t)$) can be defined as follows:

$$(1) \quad S_i^j(t) = \{[E_i^j(t) - M_i^j(t)] / [E_i^j(t) + M_i^j(t)]\} \times 100$$

where $E_i^j(t)$ is the export value of industry i from country j to the U.S. at time t, and $M_i^j(t)$ is the import value of industry i from country j to the U.S. at time t: "j" can be either K (Korea), or J (Japan): "i" varies from SITC 512 (organic chemicals) to SITC 899 (manufactured articles): "t" assumes values between 1962 and 1991.

According to the magnitude of this index, each manufacturing industry in Korea and Japan was ranked, and the ranks of the two countries are compared to compute the rank correlation coefficient (R) between them. In Table 4, we have each year's rank correlation coefficient between Korean and Japanese manufacturing industries' trade specialization indices.

From Table 4, it can be seen that the trade structure of Korea, measured by the trade specialization indices of manufacturing industries' trade with the U.S., is positively correlated to that of Japan with the correlation coefficients taking significantly positive values. Furthermore, the rank correlation coefficients between the two countries' inter-industry trade structures are relatively stable over time with a lower bound of 0.34025 (1975) and a upper bound of 0.66271 (1964). However, unlike the comparison of industrial production structures between the two countries as we have seen in the previous section, the inter-industry trade

[Table 4] Comparison of Korean and Japanese Inter-Industry Trade Structure (Rank Correlation between the Trade Specialization Indices of Korea and Japan)

5 Year Average	R	Selected Years	R
1962−65	0.67099	1962	0.56754
1966−70	0.59125	1964	0.66271
1971−75	0.53181	1970	0.50869
1976−80	0.46307	1975	0.34025
1981−85	0.58335	1980	0.40174
1986−90	0.53765	1985	0.58772
1991	0.41234	1991	0.41234

Note: All estimations are significant at 0.1 % level.

[Table 5] Rank Correlation Coefficients (R) between Korean (1990s) and Japanese (various periods) Trade Specialization Indices

Between K (1990s) and J (various periods)	Rank Correlation
1962−65 average	0.66563
1966−70 average	0.79988
1971−75 average	0.72933
1976−80 average	0.69487
1981−85 average	0.66379
1986−90 average	0.53765
1990−91 average	0.47098

Note: All estimations are significant at 0.1% level.

structures of the two countries do not show any trend toward increasing assimilation between them over time.

Since we found that the inter-industry trade structure of Korea is positively correlated to that of Japan year by year, now let us examine which year of Japan's inter-industry trade structure shows the most resemblance to the inter-industry trade structure of Korea in 1990s. In the previous section, similar test were performed to measure the time lag between the industrial structure of Korea and that of Japan, and it was found that the industrial structure of Korea in 1990 resembles most the industrial structures of Japan in the late 1970s. Now, to measure the differences between the inter-industry trade structures of Korea in 1990s (1990-91) and those of Japan in various periods, the ranks of average trade specialization indices for Korean manufacturing industries in 1990s (1990-91) are compared to the ranks of average trade specialization indices for Japanese manufacturing industries in different periods, and the rank correlation coefficients (R)

between them are calculated. The results of this work are presented in Table 5.

As it is shown in Table 5, the inter-industry trade structure of Korea in the 1990s (1990-91), measured by the trade specialization indices for Korean manufacturing goods traded with the U.S. resembles the inter-industry trade structure of Japan in the late 1960s the most. In other words, in terms of the net-export trade structure of Korea today, Korea lags behind Japan by approximately 20 years. To be more specific, the inter-industry trade structure of Korea in 1991 correlates most with that of Japan in 1968. This finding contrasts with the previous section's finding that the industrial production structure of Korea, measured according to the value-added of Korea's manufacturing industries, lags approximately 15 years behind that of Japan. Therefore, Korea's inter-industry trade structure lags behind that of Japan by five years larger than the industrial production structure of Korea lags behind that of Japan. This fact can be explained by Tables 2 and 4. In both tables, the industrial and inter-industry trade structures of Korea are positively correlated to those of Japan. However, in Table 2, it is shown that the degree of resemblance between both countries' industrial structures increases steadily over time, implying that Korea is catching up with Japan in terms of industrial structure as time goes by. On the other hand, Table 4 does not show any such convergence of the two countries' inter-industry trade structures over time, thus leaving the time lag between the two countries' inter-industry trade structures unchanged. This difference made the inter-industry trade structure of Korea lag behind that of Japan by 20 years, while the industrial structure of Korea lags behind that of Japan by 15 years. From this finding, we can conclude that Korea has upgraded its industrial structure faster than its inter-industry trade structure over the past three decades. This finding coincides with the findings of Krueger(1977) that the structural changes of industry precede the structural changes of trade.

3.2 Intra-Industry Trade Patterns

Even though Ricardo's law of comparative advantage, augmented by Heckscher-Ohlin, can explain the trade pattern of a country between industries, it fails to explain what is called "intra-industry trade" patterns between countries. Intra-industry trade, which can be roughly defined as two-way trade (imports and exports) of similar products inside a certain industry between countries, are now accounting for a considerable amount of industrialized countries' trade flows. While traditional trade theory cannot explain the occurrence of trade between two identically endowed economies, intra-industry trade theories try to explain the sources of trade between two similar economies. Krugman (1979a) showed that when there exist economies of scale and imperfect competition, two economies, which are identical to each other in tastes and technology, can engage in trade, and provide a greater variety of goods to consumers. Lancaster (1980)

also found that intra-industry trade can occur between similar economies when the market is characterized by monopolistic competition and when there exist economies of scale and differentiated products within an industry. It is also generally believed that intra-industry trade increases as the economy develops and trade barriers fall. Furthermore, it is most likely to occur between similarly developed industrial economies within manufacturing industries. Greenaway and Milner (1986, pp: 107-142) also introduces several empirical studies regarding intra-industry trade. Besides the already stated features of intra-industry trade, it shows that the degree of intra-industry trade increases when there are more competition and more foreign direct investment. Furthermore, it also shows that intra-industry trade is more likely to occur in a technology-intensive industry, where the R&D share is high, than in other industries because a faster product cycle and more vertical differentiation can be created in a technology-intensive industry than in other industries.

Bearing the above hypotheses about intra-industry trade in mind, let us now examine the degree of intra-industry trade for Korea, Japan, and the U.S. In measuring the degree of intra-industry trade, the Grubel-Lloyd Index $B_i^j(t)$ is used:

$$(2) \quad B_i^j(t) = 1 - \{ \mid X_i^j(t) - M_i^j(t) \mid / [X_i^j(t) + M_i^j(t)] \}$$

where $X_i^j(t)$ is country j's export value of industry i at time t, and $M_i^j(t)$ is country j's import value of industry i at time t: "j" can be either K (Korea), J (Japan), or U (U.S.): "i" varies from SITC 512 (organic chemicals) to SITC 899 (manufactured articles): "t" assumes values between 1962 and 1991.

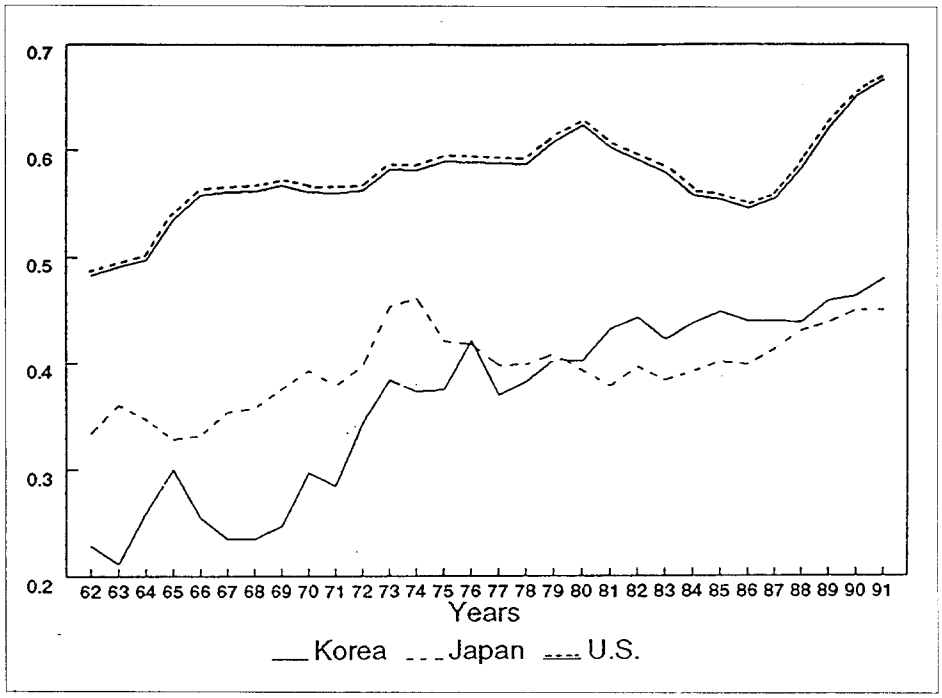
First of all, to see the general trend in intra-industry trade, manufacturing industries' average $B_j(t)$ for the three countries during the period of 1962 to 1991 is calculated, using the United Nations' SITC 3-digit data on 102 manufacturing industries' exports and imports data. This is depicted in Figure 1.

Figure 1 shows that the degree of intra-industry trade in the U.S. and Japan are relatively stable over the last three decades, even though there is a slightly upward trend in the U.S.[4] Furthermore, it is also clear that the degree of

[4] The 10 year average of B_j for each country is the following:

Years	B^K	B^J	B^U
1960s(1962-70) average	0.2534	0.3536	0.5350
1970s(1971-80) average	0.3738	0.4122	0.5872
1980s(1981-90) average	0.4416	0.4079	0.5838
1991	0.4789	0.4496	0.6658

[Figure 1] Annual Intra-Industry Trade Index for the Manufacturing Industry



intra-industry trade with regards to Japan was considerably lower than that of the U.S. during the entire period despite the fact that Japan was one of the fastest growing economies during that period. On the contrary, the degree of Korea's intra-industry trade steadily increased over the past three decades as its economy continues developing, and it finally surpassed that of Japan since 1980 even though it was still below the level of the U.S. intra-industry trade. From this observation, we can conclude that the average of manufacturing industries' intra-industry indices for Korea, and the U.S. coincide with the hypothesis that the degree of intra-industry trade increases as an economy develops, and a more developed economy is likely to have more intra-industry trade than a less developed economy. However, in terms of overall manufacturing industries' intra-industry trade index, Japan stands out as an exceptional case as was discussed in Lincoln (1990) as well.

To examine the trend in intra-industry trade among different industries, the manufacturing industry has been divided into four large groups of industries according to their SITC values : chemicals (SITC 5), basic manufactures (SITC 6), machinery and transport equipment (SITC 7), and miscellaneous manufactured goods (SITC 8). The average intra-industry trade indices of these four groups of manufacturing industries in each country in the 1960s (1962-70), 1970s (1971-80),

and 1980s (1981-90) are presented in Table 6.

[Table 6] Intra-Industry Trade in Each Commodity Group for Each Country

Country	Years	SITC 5	SITC 6	SITC 7	SITC 8
Korea	1960s	0.0952	0.3117	0.1465	0.3184
	1970s	0.2688	0.3886	0.4280	0.3667
	1980s	0.4112	0.4450	0.4602	0.4405
	1991	0.4427	0.5049	0.4190	0.5017
Japan	1960s	0.5463	0.2490	0.4378	0.3838
	1970s	0.5691	0.3518	0.3248	0.5249
	1980s	0.6158	0.3877	0.2356	0.4501
	1991	0.5673	0.4517	0.3465	0.4425
U.S.	1960s	0.5266	0.5522	0.5129	0.5171
	1970s	0.6217	0.5716	0.6415	0.5452
	1980s	0.7155	0.5312	0.7158	0.4795
	1991	0.7141	0.6477	0.7691	0.5690

From the above table, we can observe that in Korea, the degree of intra-industry trade increases in every manufacturing industry. Especially, it shows very rapid increases in chemicals (SITC 5) and machinery and transport equipment (SITC 7). This coincides with the theoretical hypothesis of intra-industry trade that intra-industry trade is more likely to occur in an industry, which is technology-intensive, and where there are many differentiated products, and there are economies of scale effects with a market structure of monopolistic competition. The degree of intra-industry trade in Korea steadily increases over time so that Korea has surpassed Japan in every industry except chemicals since the 1980s.[5] In the case of the U.S., the degree of intra-industry trade in SITC 6 and 8 industries does not show any significant change over time, while there are modest upward trends in industries 5 and 7, which also coincide with the hypothesis.[6] Even though the degree of intra-industry trade in the U.S. is relatively stable for

[5] The top 5 industries which showed the largest increase of intra-industry trade in Korea between 1960s (1962-70) and 1980s(1981-90) are the followings: SITC 686 (zinc, 80 times increased), SITC 531 (symthetic organic dyestuffs, 66 times increased), SITC 554 (soals, cleansing polishing preparations, 60 times increased), SITC 731 (railway vehicle, 32 times increased), SITC 631 (veneers, plywood board, 28 times increased).

[6] The top 5 industries which showed the largest increase of intra-industry trade in the U.S. are the followings: SITC 621 (materials of rubber, 9 times increased), SITC 685 (lead, 5 times increased), SITC 731 (railway vehicles, 5 times increased), SITC 533 (pigments, paints, varnishes, 5 times increased), SITC 554 (soaps, cleansing and polishing preparations, 4 times increased).

each industry, it still leads the other two countries by substantial magnitudes. In the case of Japan, however, rather peculiar phenomena can be observed. First of all, there exists a stable, but modest upward trend in the degree of intra-industry trade in SITC 5, which corresponds to the U.S. case. The level of intra-industry trade of SITC 6 also increases steadily over time in Japan. This can be explained by the fact that most SITC 6 products are intermediate goods, such as leather, rubber, wood, and non-metal mineral manufactures. These are items Japan must import to use as inputs, which are then reprocessed into final goods.[7] What is most peculiar is the degree of intra-industry trade in SITC 7 products, which are machinery and transport equipment. According to the theoretical hypothesis, these are the industries which are supposed to show an increasing trend in intra-industry trade as an economy develops. However, in the case of Japan, SITC 7 shows a distinctively downward trend over time. While the degree of intra-industry trade of SITC 7 of the U.S. shows a clear upward trend, that of Japan, which was initially lower than that of the U.S. since the early 1960s, continues to widen its gap from the U.S. case, and it has even fallen below that of Korea since 1974. The downward trend in intra-industry trade in SITC 7 is due to the lack of import growth compared to increasing export growth in this industry. This is a peculiar phenomenon of Japan, which is quite different from the U.S. case, and also different from the Korean case, which can only be explained by relying on the existence of managed trade policies of Japan in this industry.

Now, let us compare the rank of each industry's intra-industry trade index of Korea to that of Japan, and also to that of the U.S. This is to see whether an industry in which the intra-industry trade level is high in Japan and the U.S., also showed a high level of intra-industry trade in Korea. To examine this, each manufacturing industry in Korea was ranked according to the value of its intra-industry trade index, and these ranks were compared to those of Japan and to those of the U.S. Similarly, the intra-industry trade index ranks of Japan were compared to those of the U.S. as well, and the ranks correlation coefficients between the two countries for each year and for a period of years have been computed in Table 7.

Even though it is difficult to find any obvious trend from Table 7, a couple of observations can be made: First of all, even though the coefficients are not large (and sometimes, insignificant), there exists a positive (and significant during most of the periods) correlation between the intra-industry structure of Korea and that of the U.S. over the entire period. Second of all, the rank correlation coefficients between Japanese intra-industry structure and U.S. intra-industry

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[7] The top of 5 industries which showed the largest increase of intra-industry trade in Japan are the followings: SITC 674 (universals, plates, and sheets of iron and steel, 22 times increased), SITC 666 (pottery, 20 times increased), SITC 652 (cotton fabrics, woven, 9 times increased), SITC 651 (textile yarn and thread, 7 times increased), SITC 532 (dyeing and tanning extracts, 6 times increased).

[Table 7] Each Year's and Each Period's Rank Correlation Coefficients between Two Countries' Intra-Industry Trade Indices

Year	R between K & J	R between K & U	R between J & U
62−65 average	−0.31824***	0.29980***	−0.06867
66−70 average	−0.11986	0.27087***	−0.03150
71−75 average	−0.13199	0.17257*	0.16124
76−80 average	−0.12645	0.11627	0.09518
81−85 average	−0.02093	0.15610	0.21189**
86−90 average	0.20917**	0.26462***	0.25102**
1986	0.05962	0.20812**	0.19774**
1987	0.18713*	0.27810***	0.20897**
1988	0.27980***	0.29191***	0.22343**
1989	0.28819***	0.25011**	0.25571***
1990	0.30017***	0.07071	0.18229*
1991	0.28957***	0.14560	0.12488

Note: Estimates with "*" are significant at 10% level, those with "**" are significant at 5% level, and those with "***" are significant at 1% level.

structure show that the intra-industry structure of Japan also shows a positive correlation with that of the U.S. since the 1980s, even though there were some fluctuations before the '80s. What is rather clear from the above table is that the intra-industry trade structure of Korea begins to resemble that of Japan from the early 1980s, with the ranks correlation coefficients between the two countries taking more and more significantly positive values over time since then. In other words, since the early 1980s, those goods, whose intra-industry trade levels are high in Japan, also have high intra-industry trade levels in Korea. However, what prevents the intra-industry trade structure of Korea from resembling that of Japan further is the continuous downward trend in intra-industry trade of the SITC 7 industry in Japan as is explained above.

Based on the above descriptive analysis of the trends and structures of intra-industry trade levels of the three countries, we can conclude that the U.S. and Korea (particularly, Korea) follow the hypothesis of intra-industry trade theories more faithfully, while Japan stands out as an exception. When we examined the level of intra-industry trade across four different groups of industries, we observed that the peculiarity of Japanese intra-industry trade behavior arises mostly from SITC 7 (machinery and transport equipment) industry. Furthermore, by comparing the structures of intra-industry trades among these three countries, we found that Korea's intra-industry structure resembles that of Japan's over time to a limited extent.

Having this descriptive analysis in hand, let us now perform a regression ana-

lysis to examine how the theoretical hypothesis of intra-industry trade fits the case of Korea's intra-industry trade. To perform this work, 84 different Korean manufacturing industries' trade data with 33 countries in 1978 and in 1987 are examined. We have the intra-industry trade index of Korea's manufacturing industry i at time t with country j (denoted as $B_i^{K,j}(t)$) as a dependent variable. For the explanatory variables, we have the following country-specific and industry-specific variables, which affect the degree of intra-industry trade between countries, and also across industries in Table 8.

[Table 8] Explanatory Variables of the Regression Model

Variables	Country-Specific Variables	
	Expected Sign	Contents
$LAYP_j(t)$	(+)	average of Korea's per-capita GNP and country j's per-capita GNP in time t
$DYP_j(t)$	(−)	difference between Korea's per-capita GNP and country j's per-capita GNP
$LAY_j(t)$	(+)	average of Korea' GDP and country j's GDP
$DY_j(t)$	(−)	difference between Korea's GDP and country j's GDP
$Dist_j(t)$	(−)	distance between Korea and country j
$TB_j(t)$	(−)	level of trade barriers between Korea and country j
$Dum_j(t)$	(+)	dummy for the East Asian NIEs (Taiwan, Hong Kong, Singapore)
Variables	Industry-Specific Variables	
	Expected Sign	Contents
PD_i	(+)	degree of product differentiation in industry i
RD_i	(+)	share of R&D out of total sales in industry i
ES_i	(+)	measurement for economies of scale in industry i
FDI_i	(+)	foreign direct investment in industry i

Note : For the further explanation of variables stated above, refer to Greenway & Milner (1986), and Kim (1992).

After running an Ordinary Least Squares (OLS) regression based on the trade data of 84 different Korean manufacturing industries with 33 different countries in 1978 and in 1987, we have a coefficient for each explanatory variable as is shown in Table 9.

[Table 9] Estimated Coefficients for Explanatory Variables in 1978 and in 1987

Variables	1978	1987
Constant	−0.075 (1.96)	−0.448 (10.71)
LAYP	0.051 (4.43)	0.056 (4.75)
DYP	−0.016 (0.43)	−0.110 (2.70)
LAY	0.046 (5.25)	0.106 (12.04)
DY	0.016 (0.56)	−0.147 (5.05)
TB	−0.027 (0.65)	−0.066 (1.54)
Dist	−0.007 (6.79)	−0.005 (4.67)
Dum	0.080 (4.09)	0.160 (7.61)
PD	0.004 (0.50)	0.072 (8.56)
RD	0.002 (1.30)	0.003 (1.31)
ES	0.002 (2.02)	−7.32E5 (0.06)
FDI	−0.002 (0.31)	−0.019 (2.70)
n	2114	2551
F-statistics	23.62	44.56
R^2	0.093	0.156

Note: numbers in parenthesis are t-statistics.

From the above regression analysis, it can be seen that every coefficient (except for ES and FDI) assumes the sign that was expected based upon our theoretical hypothesis. Furthermore, the significance of the coefficients also improved greatly in 1987 compared to 1978. According to the t-statistics, given in parenthesis, only LAYP, LAY, Dist, Dum, and ES have coefficients which are significant at 5 % level in 1978. However, in 1987, all the estimations (except for TB, RD, ES) are significant at 5 % level with the values of the F-statistics and R^2 greatly improved as well. Therefore, we can conclude that the magnitudes of intra-industry trade in Korea coincide with the hypothesis suggested by the theories of intra-industry trade both in 1978 and in 1987. Moreover, in 1987, the explanatory power of the theoretical hypothesis improved their significance greatly.

Ⅳ. CONCLUSION

In this paper, we have examined the industrial and trade structures of Korea, Japan, and the U.S. for the past three decades. Our main purpose was to examine whether a country's industrial and trade structures coincide with the theoreitical hypothesis, and also to compare each one's structure to the other's. In each comparison, the U.S. was viewed as a reference country so that the structures of Korea and Japan are compared to those of the U.S. to see how much those two countries are behind the reference country in terms of their economic structures.

Furthermore, as there exists a time lag between the economic development of Japan and Korea, these two countries' economic structures are compared to each other in each section. As these three countries have different natural resource endowments, we excluded industries whose structures can be affected by such endowments, and examined manufacturing industries only.

The area where those three countries showed the greatest similarities was the industrial structure, measured by value-added in production. In terms of industrial production structure, both Japan and the U.S. showed few changes throughout the entire period with each one's structure resembling the other's a great deal. It was Korea whose industrial structure changed the most. However, the industrial structure of Korea is rapidly catching up with that of Japan and the U. S., and it was calculated that the industrial structure of Korea in 1990 lags behind Japan by approximately 15 years.

Trade structures were compared in two different ways. First, the trade structures of Korea and Japan were compared to each other according to their inter-industry trade structures, measured by trade specialization indices. Contrary to the industrial structures' comparison, the inter-industry trade structures of the two countries did not show any clear trend of increasing resemblance over time, with approximately a 20 year lag between the two countries' inter-industry trade structures. Finally, the intra-industry trade structures of the three countries were examined according to the theoretical hypothesis, and compared to each other. It was found that both Korea and the U.S. showed an increasing trend of intra-industry trade over time as their economies grow (a rapid increase in Korea, and stable but modest increase in the U.S.). However, the degree of intra-industry trade in Japan did not change much over the entire period, and even decreased significantly after the mid-1970s. This peculiarity of Japan originated mostly from its machinery and transport equipment industry's trade data. Considering the fact that this industry is the one that is supposed to show a great deal of intra-industry trade according to the theoretical hypothesis, and also considering the empirical fact that both Korea and the U.S. have increasing intra-industry trade in this area over the same period convinces us to conclude that the peculiarity of Japanese machinery and transport equipment industry is due to the existence of industrial policies of Japan in this industry. Finally, using the trade data of Korea in 1978 and in 1987, we regressed the intra-industry trade indices of Korea's manufacturing industries over the explanatory variables suggested by our theoretical hypothesis, and obtained estimations that largely coincide with our expectations. For the future studies, it would be desirable to perform a similar study between Korea and Taiwan, as Taiwan has achieved a similar level of economic development to Korea, but it is presumed to have gone through a different pattern from Korea.

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