Changes in Industrial Interdependency between Japan and Korea since 1985

Working Paper 02-18

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## —An Application of International Input-Output Analysis

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KOREA INSTITUTE FOR INTERNATIONAL ECONOMIC POLICY

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Price USD 2

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**December 2002**

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KIEP Working Paper 02-18
Published December 30, 2002 in Korea by KIEP

## Executive Summary

Based on an analysis of the International Input-Output Table Japan-Korea (1985, 1990) and the Asian International Input-Output Table (1995), this paper focuses on changes in the industrial interdependence between Korea and Japan after the Plaza Accord, an agreement which triggered a drastic appreciation of the yen. Considering the industrial structures of the two countries and the structure of the trade between them, special attention was paid to the manufacturing sectors, which were analyzed on the basis of a more detailed industrial classification than the other sectors. In particular, we measured the international technological specialization (ITS) index between Korea and Japan, which provided a foundation for studying the structure of Koreas heavy dependence on Japan-made intermediate inputs. The ITS index shows the amount of intermediate goods certain industries in two countries import from each other, and serves as a good indicator of a country's dependency on imports for intermediate inputs.

The empirical results showed that Korea still depends quite heavily on imported intermediate inputs from Japan, particularly in the machinery industry. The results also showed clearly that Japan is gradually becoming more dependent on Korean-made intermediate inputs. This implies that the technology gap between Korea and Japan has gradually narrowed throughout the sample period.

HongBae Lee, a senior researcher at the Korea Institute of International Economic Policy (KIEP), received his Ph.D. in economics from SOKA University in Japan. His main fields of interest are economic and industrial structure and cooperation in Japan and Korea, trade issues between Japan and Korea, and Input-Output Table Analysis. His major publication are "Pending Problems and Countermeasures in Trade between Japan and Korea (1998)," "Study on the Impact of Korea's Open Market Policy against Japan (2000)," and "Current Status and Cooperation Possibilities in the IT industry between Japan and Korea (2001)." Recently, he has been conducting research on changes in industrial structure and interdependency within Northeast Asia.

# Contents

# Tables

# Changes in Industrial Interdependency between Japan and Korea since 1985

## —An Application of International Input-Output Analysis

HongBae Lee

# I. Introduction

Since the normalization of diplomatic relations in 1965, the industrial linkage between Japan and Korea has gradually deepened. However, after the Asian economic crisis in 1997, the two countries came to recognize the need to create a new economic partnership in the ever-changing global economic environment. Their efforts were symbolized, for example, by the Korea-Japan Bilateral Investment Treaty (KJBIT), which went into effect in December 2002. The Korea-Japan Free Trade Agreement (KJFTA), which is currently under a feasibility evaluation, would be another milestone toward strengthening the bilateral economic relations.

Although BITs and FTAs are necessary for consolidating a new economic partnership, it is still unclear what the benefits and other effects of those agreements will be. Therefore, many studies have attempted to compute and evaluate the effects of the KJBIT and KJFTA. However, such studies have not been successful because they squeeze out the effects by considering the economy as a whole.

To more accurately evaluate the effects of the KJBIT and KJFTA,

it is necessary to conduct a detailed study on the bilateral industrial interrelationship between the Japan and Korea. Such a study can play a crucial role in successful conclusion of the FTA negotiations.

In the field of international industrial linkage, a few, but not many, empirical studies have been carried out mainly on Japan. Sano (1996), Jung and Bang (2001) and Kim (1989) analyzed the industrial structures of Korea and Japan. However, the scope of their studies were confined to a general industrial linkage analysis, such as comparison of the gross output, value-added and international trade structures. Lee and Fujikawa (1997) focused on the change in both countries production structures. However, again, their research was limited to a comparison using separate input-output tables for both countries.

This paper focuses on identifying and analyzing the technological gap between Korea and Japan, as well as conducting a general industrial linkage analysis, using International Input-Output Tables released by the Institute of Developing Economies. In this regard, this paper can be distinguished from past studies.

The rest of the paper is organized as follows.

First of all, an international industrial linkage model is needed to obtain an overview of the bilateral industrial interdependency. Chapter I provides a detailed explanation of the statistical data and method used for the international industrial linkage model. Chapter II observes the interdependency of the two countries intermediate and final products industries, using a basic international industrial linkage model. The chapter provides an analysis of forward and backward linkages, a supply-side analysis, which shows the interrelationship in the production structures with a particular focus on

intermediate imports from each partner economy. In addition, an analysis of production induction and decomposition of production by final demand, a demand-side analysis which clarifies production induced by each partner economy, is also provided. Chapter III measures and analyzes international technology specialization (ITS) as the ratio of intermediated input imported from each country's counterpart economy by using a modified version of the international industrial linkage model. For further analysis, ITS is then broken down into three major factors the production technique factor, intermediate input coefficient factor, and production structure factor. Finally, Chapter IV summarizes the empirical results of this study and reviews the major findings.

# II. Statistical Background for Empirical Analysis

This paper is statistically based on data from the Japan-Korea International Input-Output Table 1985 and 1990, and Asian International Input-Output Table 1995.[1] Regarding the data for 1995, the Institute of Developing Economies (IDE), Japan, tabulated the 1995 Asian International Input-Output Table which covered eight major Asian countries plus Japan and the United States. But, it did not separately prepare a Japan-Korea table for 1995. Thus, the 1995 Japan-Korea table used in this research was created with data extracted from the 1995 Asian Table.

In this paper, all industries are classified into 18 endogenous sectors with relatively higher attention paid to the manufacturing sectors, in order to draw a detailed picture of recent changes in the industrial structure and interdependency in the manufacturing industry between Japan and Korea. The period covered is from 1985, when the Plaza Agreement was established, to 1995.[2]

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1) For details, see the "Analytical Tables for Asian International Input-Output Table (I)" AIO Series No.21, March, 1991.

2) One point to note about the time-series analysis given here is that, with regards to the Asian International Input-Output Table 1995, business consumption is dispersed within the endogenous sector while in the Japan-Korea Table 1985 and 1990, business consumption is included in the endogenous sector. Thus, business consumption in 1985 and 1990 is included in the service sector. In the same context, when the final demand and the value-added sector of both the Asian International

The international input-output table connects the input-output tables of several countries to illustrate not only the production and distribution of a single nation but also transactions among different nations. Therefore, the international table enables us to identify the demand structure and flow of goods and interdependency among nations, while also allowing an international comparison of industrial structures according to a unified classification. Moreover, the importance of the international table is growing, considering the deepening interdependency and accelerating international specialization due to a rise in trade and economic cooperation among nations in the rapidly changing global economy.

To address these needs, the international input-output table between Japan and Korea was published four times: in 1970, 1975, 1985, and 1990. Also, the Asian International Input-Output Table, which includes the Asian countries and the U.S., was published in 1975, 1985, 1990, and 1995.[3] The international input-output table for 1995 may

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Input-Output Table 1995 and the Japan-Korea Table are compared, there is one extra sector in the Japan-Korea Table for which no adjustments have been made. As to service transactions, data is shown in the trade part of the Japan-Korea Table thanks to the abundant statistical data of Korea. However, it is assumed that there are no international service transactions in the Asian International Input-Output Table due to the unavailability of the service trade data of each country.

3) The International Input-Output Table Japan-Korea was prepared jointly by the Bank of Korea (BOK) and the Institute of Developing Economies (IDE). The Asian International Input-Output Table was tabulated by government organizations and national universities of each country including the BOK and IDE. The ten countries covered in the Asian

seem like an outdated source for data. However, completing the table requires an enormous amount of data and research. The input-output table for only Japan and Korea is tabulated and announced every four or five years. When the table is extended to the supra-national level, identifying the usage of imported goods in the various industries, it takes even more time to compile.

From here on, it is assumed that the country from which producers obtain certain goods and the amount of those goods needed to produce a specific product is predetermined. For instance, in the case of clothing made in Korea, the quantity of cotton required to produce one suit is fixed. Because goods among nations are differentiated, changes in suppliers will be deterred, even if there are fluctuations in the exchange rate. Thus, if the structure of inputs is fixed to some extent, statistical data will be meaningful despite some passage of time.

<Appendix 2> lists the industry classification of Japan-Korea Tables (18 endogenous sectors) used for this study. Our classification is based on a detailed classification (78 or 274 sectors) of the IDE adopted in the Asian International Input-Output Table 1995 and International Input-Output Table Japan-Korea 1985, 1990. For input and output, five-letter codes have been assigned to each entry, with the first two letters indicating countries and latter three digits indicating industrial sectors or items. Three-digit sector codes are identified below (refer to <Table 1>).

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International Input-Output Table were, China, Japan, Korea, Taiwan, the U.S. and five Southeast Asian countries (Thailand, Singapore, Malaysia, Indonesia, and the Philippines).

**<Table 1> Sector Classification of Japan-Korea Table (18 Endogenous Sectors)**

| Code | Intermediate Sectors | Code | Final Demand |
|---|---|---|---|
| 001 | Agriculture, forestry and fishery | 001 | Business consumption |
| 002 | Crude petroleum and natural gas | 002 | Government consumption |
| 003 | Other mining | 003 | Gross private fixed capital formation |
| 004 | Food, beverage and tobacco | 004 | Gross government fixed capital formation |
| 005 | Textile products | 005 | Changes in stock |
| 006 | Other light industry | 900 | Total final demand |
| 007 | Chemical products | | Notice that in 1985 table, 003 |
| 008 | Ceramic industry · cement products | | indicates gross fixed capital |
| 009 | Metal products | | formation, 004 indicates changes in stock. |
| 010 | Ordinary machinery | | 【Value Added】 |
| 011 | Electronics and electronic products | 001 | Wages and salaries |
| 012 | Transportation machinery | 002 | Operating surplus |
| 013 | Precision machines | 003 | Depreciation of fixed capital |
| 014 | Other manufacturing products | 004 | Indirect Taxes |
| 015 | Electricity, gas and water supply | 005 | Less Subsidies |
| 016 | Construction | 900 | Total Value Added |
| 017 | Commerce · transportation | | Notice that in 1985 table, 004 |
| 018 | Services | | indicates Indirect Taxes plus Subsidies. |
| 900 | Total Intermediate Sectors | | |

Note: AJ Endogenous Sector of Japan, AK Endogenous Sector of Korea, BF International Freight & Insurance Imposed on Imports from Japan and Korea, CW Imports from Rest of the World, DT Import duties & Import Sales Tax, VV Value added, XX Total Input (=Total Output), FJ Final Demand of Japan, FK Final Demand of Korea, FX Final Demand of Japan & Korea, GJ Gross Demand of Japan, GK Gross Demand of Korea, LK Exports to Rest of the World. X denotes code for each country · region as follows. C: China, N: Taiwan, H: Hong Kong, T: Thailand, S: Singapore, M: Malaysia, P: Philippines, I: Indonesia, E: England, F: France, G: West Germany, L: East Germany, U: United States of America, W: Rest of the World, X: Total, QX Statistical discrepancies.

# III. Changes in Industrial Linkage between Japan and Korea

In this chapter, changes in the industrial structure and interdependency between Japan and Korea will be analyzed using aggregated Japan-Korea tables, the International Input-Output Tables Japan-Korea 1985 and 1990, and the 1995 Japan-Korea table extracted from the 1995 Asian International Input-Output Table. The focus is placed on how much Korea and Japan depend on their counterparts for intermediate inputs, and how much production was induced as a result of this intermediate input demand in both countries. A simple analytical model was devised to obtain a conprehensive view of forward and backward linkages as well as production induction.

## 1. Analytical Framework

This chapter analyzes the International Input-Output Table between Japan and Korea based on the Asian International Input-Output Table 1995 and the International Input-Output Table Japan-Korea 1985, 1990 through sector consolidation.

The International Input-Output Model originates from the material balance equation that assumes that the total demand for intermediate products, consumption, investment and export meets the total supply from domestic production and imports.

The following equation is formed using the input coefficient in the International Input-Output Model.

$$\begin{bmatrix} A^{JJ} & A^{JK} \\ A^{KJ} & A^{KK} \end{bmatrix} \begin{bmatrix} X^{J} \\ X^{K} \end{bmatrix} + \begin{bmatrix} F^{JJ} + F^{JK} \\ F^{KJ} + F^{KK} \end{bmatrix} = \begin{bmatrix} X^{J} \\ X^{K} \end{bmatrix}$$

This equation can be arranged to solve for X, as below.

$$\begin{bmatrix} X^{J} \\ X^{K} \end{bmatrix} = \begin{bmatrix} I - A^{JJ} & -A^{JK} \\ -A^{KJ} & I - A^{KK} \end{bmatrix}^{-1} \begin{bmatrix} F^{JJ} + F^{JK} \\ F^{KJ} + F^{KK} \end{bmatrix}$$

The inverse matrix on the right hand side is known as the Leontief Inverse Matrix. If we denote this inverse matrix by B, it can be rewritten as,

$$\begin{bmatrix} X^{J} \\ X^{K} \end{bmatrix} = \begin{bmatrix} B^{JJ} & B^{JK} \\ B^{KJ} & B^{KK} \end{bmatrix} \begin{bmatrix} F^{JJ} + F^{JK} \\ F^{KJ} + F^{KK} \end{bmatrix} \qquad \text{---------①}$$

When we designate the elements of the Leontief Inverse B as b, the backward linkage effects of Japan and Korea, which indicate direct and indirect influence occurring from a one unit increase of final demand in certain sectors, can be expressed as follows.

$$BL^{J} = \sum_{i} (b_{ij}^{JJ} + b_{ij}^{KJ})$$
$$BL^{K} = \sum_{i} (b_{ij}^{JK} + b_{ij}^{KK})$$

where KJ represents the influence of Japan on Korea while JK represents the influence of Korea on Japan. In other words, KJ measures the amount of intermediate goods Japan imports from Korea, and JK measures the amount Korea imports from Japan. The induced pro-

duction ratio to counterpart is the ratio of the counterpart's production induced through backward linkage from the home country to the counterpart's total production.

Forward linkage measures of Japan and Korea, designed to quantify the extent of influence from one unit increase of final demand in every sector, can be defined as follows.

$$FL^{J} = \sum_{j} (b_{ij}^{JJ} + b_{ij}^{JK})$$
$$FL^{K} = \sum_{j} (b_{ij}^{KJ} + b_{ij}^{KK})$$

The production induced from the final demand can be calculated from formula ① and dependency can be expressed in the proportion of production induced by the final demand of each country to the total production (that is, production induced by the final demand of all the countries).

## 2. Results of Empirical Analysis

*A. Forward and Backward Linkage Effects*

In the above Chapter, we analytically formulated the forward and backward linkage effects in Korea and Japan. This Chapter, will calculate the forward and backward linkage effects empirically and review the characteristics and chanages over time.

Forward and backward linkage effects can be interpreted to show the relative scale of characteristics and changes in interdependency in relation to the overall average using an induced production ratio. Also, forward and backward linkage effects are often called power of

dispersion index and sensitivity of dispersion index, respectively.

<Table 2> depicts the backward linkage effects of Japan and Korea on each other. The backward linkage effects shown in this table are quite similar to those of the single nation input-output analysis. But the difference is that the feedback effect from the other country's production is included in the figures shown in <Table 2>.

The backward linkage effect on the counterpart is an index showing the effects of a unit of demand increase in a specific domestic industry on the entire industrial production of the counterpart.

Korea reveals high backward linkage effects in metal products, transportation machinery, food, beverages and tobacco, and ordinary machinery. Among those, the backward linkage effect of metal products has been consistently high, but now is slowly decreasing. Backward linkage effects of transportation machinery, ordinary machinery, electronics and electronic products and other manufacturing products have also showed a slight decline.

Japan reveals high backward linkage effects in transportation machinery, metal products, ordinary machinery, electronics and electronic products and textile products. Among those, the backward linkage effect of transportation machinery was high until it began to decline in 1995. Declines have also been evident in the areas of ordinary machinery, electronics and electronic products and textile products. Comparing Japan and Korea's backward linkage effects in 1995, we find that figures are high for both countries in the areas of transportation machinery, metal products, other manufacturing products and ordinary machinery, although the ranking is quite different. Additioal sectors showing backward linkage effects are the food, beverages and tobacco sector in Korea and electronics and electronic products in Japan.

## <Table 2> Changes in Backward Linkage Effects of Japan and Korea

| | Korea | | | Japan | | |
|---|---|---|---|---|---|---|
| | 1985 | 1990 | 1995 | 1985 | 1990 | 1995 |
| Home | | | | | | |
| 001 | 1.5654 | 1.5815 | 1.5544 | 1.8821 | 1.7751 | 1.7597 |
| 002 | 1.0000 | 1.0000 | 1.0000 | 1.6044 | 1.5301 | 1.5617 |
| 003 | 1.6466 | 1.5685 | 1.5034 | 2.0733 | 1.9684 | 1.9657 |
| 004 | 2.1122 | 2.1371 | 2.0081 | 2.1925 | 2.1249 | 2.0452 |
| 005 | 2.1930 | 2.1629 | 1.8801 | 2.2640 | 2.1290 | 2.0513 |
| 006 | 1.9456 | 1.9049 | 1.8372 | 2.1797 | 2.0609 | 2.0079 |
| 007 | 1.6209 | 1.7496 | 1.6669 | 1.8992 | 1.9102 | 1.8853 |
| 008 | 1.9787 | 1.8925 | 1.9367 | 2.1460 | 2.0456 | 1.9957 |
| 009 | 2.3082 | 2.2602 | 2.1440 | 2.5613 | 2.3104 | 2.2007 |
| 010 | 2.0222 | 2.0568 | 1.9670 | 2.3242 | 2.2377 | 2.1804 |
| 011 | 1.8190 | 1.9245 | 1.7121 | 2.3438 | 2.2256 | 2.1465 |
| 012 | 2.0154 | 2.1218 | 2.0594 | 2.6371 | 2.6671 | 2.6263 |
| 013 | 1.8005 | 1.9251 | 1.8011 | 2.1662 | 2.1198 | 2.0017 |
| 014 | 2.1384 | 2.0611 | 1.8334 | 2.1516 | 2.1364 | 2.1034 |
| 015 | 1.5200 | 1.5522 | 1.6155 | 1.6193 | 1.6068 | 1.6934 |
| 016 | 2.0695 | 1.9554 | 2.0043 | 2.2109 | 2.0571 | 2.0121 |
| 017 | 1.5706 | 1.5447 | 1.5048 | 1.6962 | 1.6415 | 1.5471 |
| 018 | 1.6290 | 1.6751 | 1.5007 | 1.6375 | 1.6231 | 1.5347 |
| Counterpart | | | | | | |
| 001 | 0.0243 | 0.0244 | 0.0162 | 0.0056 | 0.0044 | 0.0025 |
| 002 | 0.0000 | 0.0000 | 0.0000 | 0.0009 | 0.0017 | 0.0012 |
| 003 | 0.0437 | 0.0295 | 0.0199 | 0.0021 | 0.0036 | 0.0022 |
| 004 | 0.0290 | 0.0298 | 0.0230 | 0.0061 | 0.0066 | 0.0042 |
| 005 | 0.1530 | 0.1247 | 0.0728 | 0.0192 | 0.0158 | 0.0129 |
| 006 | 0.0678 | 0.0583 | 0.0398 | 0.0021 | 0.0029 | 0.0020 |
| 007 | 0.1025 | 0.1061 | 0.0959 | 0.0046 | 0.0057 | 0.0064 |
| 008 | 0.0676 | 0.0527 | 0.0566 | 0.0055 | 0.0058 | 0.0033 |
| 009 | 0.2395 | 0.1240 | 0.0959 | 0.0085 | 0.0152 | 0.0138 |
| 010 | 0.2771 | 0.2038 | 0.1476 | 0.0039 | 0.0070 | 0.0063 |
| 011 | 0.3586 | 0.3032 | 0.2323 | 0.0063 | 0.0101 | 0.0171 |
| 012 | 0.2983 | 0.1994 | 0.1681 | 0.0038 | 0.0059 | 0.0055 |
| 013 | 0.3678 | 0.2777 | 0.1364 | 0.0043 | 0.0069 | 0.0103 |
| 014 | 0.1332 | 0.1042 | 0.0669 | 0.0056 | 0.0073 | 0.0090 |
| 015 | 0.0379 | 0.0399 | 0.0305 | 0.0012 | 0.0026 | 0.0016 |
| 016 | 0.0980 | 0.0593 | 0.0530 | 0.0038 | 0.0058 | 0.0041 |
| 017 | 0.0502 | 0.0368 | 0.0164 | 0.0024 | 0.0036 | 0.0010 |
| 018 | 0.0443 | 0.0290 | 0.0177 | 0.0016 | 0.0021 | 0.0013 |

Turning to backward linkage effects on counterparts, which expresses the impact of Japanese and Korean industries on their counterparts, Korea indicates high backward linkage effects on Japan in electronics and electronic products, transportation machinery, ordinary machinery, precision machines and metal products. However, Korea's backward linkage effects on Japan in all sectors, including those just mentioned, have decreased since 1985.

For electronics and electronic products, ordinary machinery, precision machines and other manufacturing products, Korea reflected low backward linkage effects within the nation, but high effects on Japan. An important observation in this regard is that Korea depended heavily on inputs from Japan for production in these sectors in the past, but this dependence has now declined. Japan expresses high backward linkage effects on Korea in electronics and electronic products, metal products, textile products, precision machines and ordinary machinery. Japan's backward linkage effects on Korea have traditionally been highest in textile products, but this sector is continually falling, though it still maintains third place among the various sectors. Recently, Japan's backward linkage effects on Korea in metal products, ordinary machinery and transportation machinery have also shown a decrease.

Demand for electronics and electronic products, transportation machinery, ordinary machinery, precision machines and metal products in Korea seems to induce more production in Japan while demand for electronics and electronic products, metal products, textile products, precision machines and ordinary machinery in Japan stimulates production in Korea.

## <Table 3> Changes in Forward Linkage Effects of Japan and Korea

| | Korea | | | Japan | | |
|---|---|---|---|---|---|---|
| | 1985 | 1990 | 1995 | 1985 | 1990 | 1995 |
| Home | | | | | | |
| 001 | 1.8789 | 1.8297 | 0.3612 | 1.8286 | 1.6687 | 1.4690 |
| 002 | 1.0000 | 1.0000 | 1.0063 | 1.0181 | 1.0075 | 1.0064 |
| 003 | 1.3162 | 1.2803 | 1.1083 | 1.1652 | 1.1435 | 1.1088 |
| 004 | 1.4462 | 1.5028 | 1.2886 | 1.5055 | 1.4545 | 1.3709 |
| 005 | 1.9695 | 1.9258 | 1.4420 | 1.6102 | 1.5776 | 1.4519 |
| 006 | 1.8981 | 1.8439 | 2.0814 | 2.2515 | 2.1841 | 2.1122 |
| 007 | 3.9092 | 3.0833 | 2.9583 | 3.8771 | 3.2219 | 3.0788 |
| 008 | 1.5309 | 1.4985 | 1.3307 | 1.4126 | 1.3493 | 1.3346 |
| 009 | 3.2677 | 3.2331 | 2.9028 | 3.4962 | 3.1820 | 2.9177 |
| 010 | 1.5277 | 1.6056 | 1.4860 | 1.7767 | 1.7711 | 1.4905 |
| 011 | 1.4941 | 1.6773 | 1.9562 | 1.9297 | 2.0395 | 1.9672 |
| 012 | 1.2123 | 1.4616 | 2.0743 | 1.7782 | 1.8907 | 2.1008 |
| 013 | 1.0967 | 1.1059 | 1.1237 | 1.1891 | 1.1880 | 1.1245 |
| 014 | 1.0371 | 1.0451 | 1.1503 | 1.1138 | 1.1426 | 1.1533 |
| 015 | 1.7736 | 1.6732 | 1.7780 | 1.8546 | 1.6382 | 1.7943 |
| 016 | 1.1937 | 1.2604 | 1.2938 | 1.2250 | 1.2641 | 1.3028 |
| 017 | 2.4108 | 2.4686 | 3.5066 | 3.4300 | 3.4143 | 3.6302 |
| 018 | 2.9924 | 3.5788 | 4.7267 | 5.1271 | 5.0324 | 4.9050 |
| Counterpart | | | | | | |
| 001 | 0.0164 | 0.0098 | 1.0956 | 0.0073 | 0.0058 | 0.0045 |
| 002 | 0.0008 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 003 | 0.0151 | 0.0084 | 0.0020 | 0.0019 | 0.0017 | 0.0010 |
| 004 | 0.0163 | 0.0118 | 0.1313 | 0.0020 | 0.0038 | 0.0028 |
| 005 | 0.0896 | 0.0616 | 0.0151 | 0.0140 | 0.0140 | 0.0089 |
| 006 | 0.0579 | 0.0514 | 0.0217 | 0.0018 | 0.0025 | 0.0021 |
| 007 | 0.4101 | 0.3356 | 0.1213 | 0.0192 | 0.0173 | 0.0185 |
| 008 | 0.0513 | 0.0297 | 0.0053 | 0.0030 | 0.0029 | 0.0020 |
| 009 | 0.5206 | 0.2940 | 0.0394 | 0.0136 | 0.0247 | 0.0236 |
| 010 | 0.1719 | 0.1485 | 0.0130 | 0.0007 | 0.0020 | 0.0017 |
| 011 | 0.2691 | 0.2767 | 0.0263 | 0.0049 | 0.0088 | 0.0213 |
| 012 | 0.0655 | 0.0377 | 0.0081 | 0.0004 | 0.0011 | 0.0008 |
| 013 | 0.1238 | 0.0947 | 0.0034 | 0.0006 | 0.0011 | 0.0013 |
| 014 | 0.0109 | 0.0083 | 0.0019 | 0.0008 | 0.0007 | 0.0006 |
| 015 | 0.0589 | 0.0336 | 0.0118 | 0.0022 | 0.0020 | 0.0018 |
| 016 | 0.0125 | 0.0116 | 0.0050 | 0.0004 | 0.0007 | 0.0004 |
| 017 | 0.2410 | 0.1785 | 0.0403 | 0.0082 | 0.0124 | 0.0061 |
| 018 | 0.2615 | 0.2107 | 0.1149 | 0.0062 | 0.0117 | 0.0073 |

Now we will turn to forward linkage effects, which are summarized in <Table 3>. Forward linkage effects are similar to backward linkage effects. Forward linkage effects within a nation refers to the feedback effect on the nation from the counterpart's production. On the other hand, forward linkage effects from the counterpart is an index showing how much impact a uniform increase (typically, one unit of increase) in all the counterpart's industries has on the production of a specific domestic industry.

Regarding the forward linkage effects within a nation, both Japan and Korea show high values in services, commerce and transportation, metal products and chemical products. In Korea, forward linkage effects increased significantly in services, commerce and transportation, but slightly decreased in metal products and chemical products. And in Japan, the forward linkage effects in services, metal products and chemical products are continuously declining.

Examining the manufacturing sector in more detail, both countries revealed high forward linkage effects in chemical products and metal products within their nations. In order of decreasing forward linkage effects, these items are transportation machinery, electronics and electronic products, ordinary machinery and textile products.

<Table 3> describes a distinctive feature of Korea. Until 1985 forward linkage effects on agriculture, forestry and fishery were relatively high while in 1995 they declined to their lowest levels. The same analysis can be applied to Japan. However, Japan showed a modest decrease in this sector, as it also did in ordinary machinery.

In Japan, other light industries had high forward linkage effects until 1985, but declined to levels similar to transportation machinery in 1995. It is notable that in 1995 the industries with high forward

linkage effects were unusually similar for both Japan and Korea within their nations.

Forward linkage effects on counterparts indicate how much one nation's industrial production influences the other nations' industrial production. In the case of Korea, high rankings are found in the same industries as those of the forward kinkage effects within the nation, though the industries of services, commerce and transportation occupied a much lower position. In the manufacturing industry, both Japan and Korea showed high values for forward linkage effects on the counterpart in chemical products, electronics and electronic products, while Japanese metal products recorded the highest forward linkage effects (0.0236) from Korea. And at the same time, the forward linkage effects from Japan on Korean metal products decreased drastically (from 0.5206 in 1985 to 0.0394 in 1995).

One point differentiating the two countries is that the forward linkage effects from Japan on Korean textile products are higher than the effects from Korea on Japanese products. Although the effects dropped sharply in 1995, Korean textile products still take fifth place in terms of forward linkage effects from Japan. Meanwhile, forward linkage effects from Japan on Korean chemical products, metal products, and ordinary machinery are declining remarkably.

### *B. Induced Production Ratio and Interdependency of Production on the Counterpart's Final Demand*

Forward and backward linkage effects are used to measure and compare the effects of Japanese and Korean industries within their nations and on their counterparts in a simple and precise manner. However, considering the difference between the two countries in

terms of economic size, it is difficult to estimate how much production domestic demand creates on the counterpart with the above mentioned linkage effects.[4)]

Therefore, <Table 4> displays the induced production ratio on the counterpart. This ratio indicates the production induced in the counterpart when a single unit of demand is generated in the domestic industry.

The production induced in Japan by Korean industries proves to be much higher than production induced in Korea by Japanese industries. This outcome can be explained not only by the difference in the economic size of the two countries, but also by Korea's high dependence on imports from Japan. However, the influence of Korean demand on Japanese production greatly weakened over time, while the impact of Japanese demand on Korea's production rose gradually. If we divide the former by the latter, the ratio indicates a constant decline from 29 in 1985 to 17 in 1990 and finally to 16 in 1995. This tells us that Korean industries are slowly becoming less dependent on Japanese industries.

<Table 4> Demand from most Korean industries seems to reduce the induced production ratio of Japan especially in precision machines, metal products, transportation machinery, ordinary machinery and electronics and electronic products. In contrast, demand from most Japanese industries seem to raise the production-inducing ratio of Korea particularly in electronics and electronic products, precision machines and other manufacturing products.

In addition, metal products, ordinary machinery and trans-

4) Note: Such a measure could be calculated using the hypothetical extraction method, but that may be beyond the scope of this study.

portation machinery showed high growth from 1985 to 1990 while indicating a slight decrease in 1995. Although the two economies are different in size, the fact that their vectors run in opposite directions tells us that Japan and Korea are in a complementary relationship.

One unexpected finding was that the demand on Japanese textile products tends to consistently reduce the production inducing ratio of Korea.

**<Table 4> Induced Production Ratio to Counterpart**

(Unit: percent)

| | Korea→Japan | | | Japan→Korea | | |
|---|---|---|---|---|---|---|
| | 1985 | 1990 | 1995 | 1985 | 1990 | 1995 |
| 001 | 1.53 | 1.52 | 1.03 | 0.29 | 0.25 | 0.14 |
| 002 | 0.00 | 0.00 | 0.00 | 0.06 | 0.11 | 0.08 |
| 003 | 2.59 | 1.85 | 1.31 | 0.10 | 0.18 | 0.11 |
| 004 | 1.35 | 1.38 | 1.13 | 0.28 | 0.31 | 0.21 |
| 005 | 6.52 | 5.45 | 3.73 | 0.84 | 0.74 | 0.63 |
| 006 | 3.37 | 2.97 | 2.12 | 0.09 | 0.14 | 0.10 |
| 007 | 5.95 | 5.72 | 5.44 | 0.24 | 0.30 | 0.34 |
| 008 | 3.31 | 2.71 | 2.84 | 0.26 | 0.28 | 0.16 |
| 009 | 9.40 | 5.20 | 4.28 | 0.33 | 0.65 | 0.62 |
| 010 | 12.05 | 9.02 | 6.98 | 0.17 | 0.31 | 0.29 |
| 011 | 16.47 | 13.61 | 11.95 | 0.27 | 0.45 | 0.79 |
| 012 | 12.89 | 8.59 | 7.55 | 0.14 | 0.22 | 0.21 |
| 013 | 16.96 | 12.61 | 7.04 | 0.20 | 0.32 | 0.51 |
| 014 | 5.86 | 4.81 | 3.52 | 0.26 | 0.34 | 0.43 |
| 015 | 2.43 | 2.50 | 1.85 | 0.07 | 0.16 | 0.09 |
| 016 | 4.52 | 2.94 | 2.58 | 0.17 | 0.28 | 0.20 |
| 017 | 3.10 | 2.33 | 1.08 | 0.14 | 0.22 | 0.07 |
| 018 | 2.65 | 1.70 | 1.17 | 0.10 | 0.13 | 0.08 |
| Average | 6.77 | 5.17 | 4.70 | 0.23 | 0.31 | 0.30 |

In this section we will examine how much domestic and external final demands contributed to the industrial production of Japan and

Korea. <Table 5> shows the contribution ratio of Korea, Japan and the rest of the world to the domestic industrial production of Korea and Japan, respectively.

As shown in the Table, Japan's production relies more on domestic final demand than that of Korea. In 1995, Japan's final demand induced 89.2% of the domestic production, whereas Korea's final demand induced only 75.5% of the domestic production. A comparison of data for 1995 reveals that Korea depended heavily on Japan's final demand. The Table shows that 2.5% of Korea's domestic production was attributable to Japan's final demand, while only 0.5% of Japan's domestic production was sttributable to Korea's final demand. In other words, while pursuing an export expansion policy during the period of rapid growth by building a full-set production structure like Japan, Korea inadvertently increased its dependency on foreign countries. The dependency of Korea's production on Japan's final demand rose from 3.4% in 1985 to 4.3% in 1990. However, Korea's dependency on Japan again lowered in 1995 to 2.5%. This may be due to the maturity of the Korean economy, that is, a higher dependency on the home market, and the emergence of new export markets, such as mainland China, which lead to greater production dependency on the rest of the world. In contrast, the dependency of Japan's production on Korea's final demand was quite low, but constantly increasing. This reinforces our earlier observation through intertemporal changes in backward and forward linkage effects that Korea benefited from the industrial activities of Japan.

**<Table 5> Dependency of National Production on Final Demand**

(Unit: percent)

| | Final Demand | | | | | | Export to the Rest of the World | | |
|---|---|---|---|---|---|---|---|---|---|
| | Korea | | | Japan | | | | | |
| | 1985 | 1990 | 1995 | 1985 | 1990 | 1995 | 1985 | 1990 | 1995 |
| Korea | 72.6 | 75.6 | 75.5 | 3.4 | 4.3 | 2.5 | 24.1 | 20.1 | 22.0 |
| Japan | 0.4 | 0.5 | 0.5 | 84.2 | 88.0 | 89.2 | 15.4 | 11.5 | 10.3 |

<Table 6> depicts external and internal dependency by industry. Except for electronics and electronic products, almost all the industries in Korea lowered their dependency of production on Japan's final demand, especially in chemical products, ordinary machinery, transportation machinery, precision machines and other manufacturing products.

Korea seems to rely more heavily on exports to the rest of the world for its production in textile products, chemical products, electronics and electronic products, ordinary machinery and transportation machinery.

In the case of Japan, dependency of production on domestic final demand is generally strong except in the case of ordinary machinery and precision machines. However, in other industries, excluding chemical products, textile products and transportation machinery, Japan's dependency on Korea's final demand tends to be greater.

## <Table 6> Dependency on Final Demand by Sector

| | Final Demand | | | | | | Exports to the Rest of the World | | |
|---|---|---|---|---|---|---|---|---|---|
| | Korea | | | Japan | | | | | |
| | 1985 | 1990 | 1995 | 1985 | 1990 | 1995 | 1985 | 1990 | 1995 |
| Korea | | | | | | | | | |
| 001 | 92.6 | 91.7 | 89.9 | 3.8 | 4.1 | 3.4 | 3.7 | 4.3 | 6.7 |
| 002 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 003 | 69.7 | 74.8 | 81.9 | 6.1 | 6.9 | 3.3 | 24.2 | 18.3 | 14.8 |
| 004 | 95.2 | 92.5 | 88.1 | 1.3 | 3.2 | 2.6 | 3.4 | 4.2 | 9.4 |
| 005 | 27.9 | 27.4 | 38.1 | 8.6 | 13.6 | 8.5 | 63.5 | 16.5 | 53.4 |
| 006 | 76.7 | 79.8 | 80.7 | 3.1 | 3.7 | 1.9 | 20.2 | 16.5 | 17.4 |
| 007 | 59.8 | 66.4 | 62.0 | 6.0 | 5.9 | 4.1 | 34.2 | 27.7 | 33.9 |
| 008 | 80.1 | 81.8 | 83.3 | 4.2 | 4.8 | 2.6 | 15.7 | 13.4 | 14.1 |
| 009 | 43.4 | 59.9 | 64.8 | 4.7 | 7.1 | 5.2 | 51.9 | 32.9 | 30.0 |
| 010 | 77.0 | 79.0 | 75.8 | 1.5 | 2.8 | 1.7 | 21.5 | 18.2 | 22.5 |
| 011 | 43.7 | 46.9 | 37.6 | 3.9 | 4.1 | 5.8 | 52.4 | 48.9 | 56.6 |
| 012 | 54.9 | 78.7 | 66.6 | 0.5 | 0.9 | 0.3 | 44.6 | 20.4 | 33.1 |
| 013 | 55.8 | 54.3 | 64.6 | 7.4 | 9.5 | 3.6 | 36.8 | 36.2 | 31.9 |
| 014 | 39.5 | 43.7 | 49.0 | 5.1 | 9.4 | 7.9 | 55.4 | 46.9 | 43.2 |
| 015 | 72.5 | 77.2 | 80.2 | 3.3 | 4.1 | 2.1 | 24.2 | 18.7 | 17.4 |
| 016 | 97.2 | 98.4 | 98.9 | 0.2 | 0.3 | 0.1 | 2.5 | 1.3 | 1.0 |
| 017 | 70.5 | 72.6 | 73.9 | 3.7 | 5.7 | 1.5 | 25.9 | 21.7 | 24.6 |
| 018 | 89.4 | 88.8 | 89.6 | 1.4 | 2.1 | 0.7 | 9.2 | 9.0 | 9.7 |
| Japan | | | | | | | | | |
| 001 | 0.1 | 0.1 | 0.1 | 96.1 | 97.1 | 97.9 | 3.8 | 2.8 | 2.0 |
| 002 | 0.6 | 0.6 | 1.3 | 81.1 | 87.8 | 85.9 | 18.3 | 11.6 | 12.8 |
| 003 | 0.6 | 0.5 | 0.5 | 88.8 | 92.8 | 93.1 | 10.6 | 6.7 | 6.4 |
| 004 | 0.1 | 0.1 | 0.1 | 97.1 | 97.5 | 98.4 | 2.9 | 2.4 | 1.5 |
| 005 | 0.4 | 0.4 | 0.4 | 85.4 | 89.1 | 89.9 | 14.2 | 10.5 | 9.8 |
| 006 | 0.3 | 0.4 | 0.4 | 89.4 | 91.4 | 92.2 | 10.3 | 8.3 | 7.5 |
| 007 | 0.8 | 1.1 | 0.1 | 78.6 | 80.5 | 80.9 | 20.6 | 18.4 | 18.0 |
| 008 | 0.5 | 0.5 | 0.6 | 84.7 | 88.8 | 89.1 | 14.9 | 10.7 | 10.3 |
| 009 | 0.9 | 1.1 | 1.4 | 66.5 | 77.7 | 77.7 | 32.5 | 21.2 | 21.0 |
| 010 | 1.4 | 1.9 | 2.7 | 68.3 | 73.0 | 72.7 | 30.3 | 25.2 | 24.6 |
| 011 | 0.9 | 1.1 | 1.3 | 60.9 | 66.2 | 64.3 | 38.2 | 32.7 | 34.3 |
| 012 | 0.3 | 0.3 | 0.3 | 51.1 | 64.7 | 67.6 | 48.6 | 35.0 | 32.1 |
| 013 | 1.5 | 1.6 | 2.1 | 60.3 | 73.2 | 65.6 | 38.2 | 25.2 | 32.3 |
| 014 | 0.3 | 0.5 | 0.4 | 81.1 | 84.5 | 86.5 | 18.6 | 15.1 | 13.1 |
| 015 | 0.4 | 0.4 | 0.4 | 86.8 | 90.6 | 92.3 | 12.8 | 9.0 | 7.4 |
| 016 | 0.0 | 0.0 | 0.0 | 99.0 | 99.3 | 99.2 | 1.0 | 0.7 | 0.7 |
| 017 | 0.3 | 0.3 | 0.4 | 87.4 | 90.8 | 90.3 | 12.3 | 8.9 | 9.3 |
| 018 | 0.2 | 0.2 | 0.1 | 93.1 | 94.9 | 96.2 | 6.7 | 5.0 | 3.7 |

# IV. Changes and Comparison of International Technological Specialization between Japan and Korea

In this section, we will measure the international technological specialization level and analyze factors underlying the technological discrepancy between the two countries by using the Japan-Korea Tables.

The 「international technological specialization」(ITS)[5] index indicates the degree of technological dependency between two regions or nations based on transactions of intermediate products between them on a scale of 0 to 1. We can present a simple example to illustrate the concept. Suppose the auto industry in Korea. The number of tires required to produce one car is fixed from the beginning. However, those tires could be either domestic or foreign-made. The ratio of Japanese tires to total tires required can be calculated *ex post* using trade statistics, input-output tables, etc. The percentage of other raw materials imported from Japan can also be estimated in the same way. This percentage index expresses Korea's technological depend-

5) Japan's Ministry of International Trade and Industry (MITI) for the first time conducted an analysis on international technological specialization in Japan, United States and EU, focused on the technology gap between them. For details, see Ministry of Economy Trade and Industry (ed.). (1999) "International Input-Output Table for Japan, United States, EU and Asia 1990." Tsusho Tokei Kyokai and Takahashi Mutsuharu (2000) "Changes of Independency and Economic Structure between the U.S. and Japan since 1985," Institute of Developing Economies.

ency on Japan. The upper limit of the index is '1,' which indicates maximum external dependency, or total "international technological specialization," while the lower limit is '0,' indicating no external dependency, or no "international technological specialization." A detailed model applied for the analysis of international technological specialization and its factor decomposition between Japan and Korea is explained below.

### 1. Analytical Framework

Total input structure including inputs from Korea can be written as below.

$$A^{JK} + A^{KK} + A^{WK}$$

If we denote individual elements of A's, input matrixes, as $a_{ij}^{JK}$, $a_{ij}^{KK}$, $a_{ij}^{WK}$ and $a_{ij}^{K}$, and the ratio of intermediate products imported from Japan to total inputs of Korea as $b_{ij}^{JK}$, we have the following relation.

$$b_{ij}^{JK} = a_{ij}^{JK} / a_{ij}^{K}$$

And if we denote the component ratio of Korea's intermediate product input by industry as $w_{ij}^{K}$, this can be defined as

$$w_{ij}^{K} = a_{ij}^{K} / \sum_{i} a_{ij}^{K}$$

Within Korea's intermediate product input structure, the amount of intermediate products imported from Japan (δ) can be calculated by taking a weighted average of $b_{ij}^{JK}$ with weight vector $w_{ij}^{K}$. Thus, δ can be expressed as

$$d_j^{JK} = \sum_i b_{ij}^{JK} \cdot w_{ij}^{K}$$

This indicates the proportion of imported intermediate products to the input structure of each industry. And from calculating the weighted average of this ratio over the entire industries, we can derive the international technological specialization of Korea as a whole vis-a-vis Japan.

Therefore, when we denote the international technological specialization of Korea on Japanese intermediate products by $l^{JK}$, $l^{JK}$ can be derived from the weighted average of $d_j^{JK}$ with weight vector $f_j^{K}$ as a scalar and can be defined as follows.

$$l^{JK} = \sum_j d_{ij}^{JK} \cdot f_j^{K}$$

where the component ratio of Korea's industrial output can be expressed as

$$f_{ij}^{K} = X_j^{K} \Big/ \sum_j X_j^{K}$$

Thus, with the above formulas in hand, we can rewrite the international technological specialization of Korea on Japanese intermediate products $l^{JK}$ as follows.

$$l^{JK} = \sum_j \left( \sum_i a_{ij}^{JK} \bullet \frac{1}{\sum_i a_{ij}^{K}} \bullet f_j^{K} \right)$$

The right hand side of this equation is composed of three components, structure of intermediate products imported from Japan, input structure of Korea and industrial structure of Korea, respectively.

According to this rewritten formula, the discrepancy in international technological specialization on intermediate products between Japan and Korea can be divided into the following three components.

$$\Delta l = l^{JK} - l^{KJ}$$
$$= \sum_j \left( \Delta \frac{1}{\sum_i a_{ij}} \bullet \frac{\sum_i a_{ij}^{JK} \cdot f_j^{K} + \sum_i a_{ij}^{KJ} \cdot f_j^{J}}{2} \right)$$

Manufacturing technology component (difference in input structure): This component focuses on the total intermeidiate input coefficient, regardless of the country of origin. When the domestic proportion of industrial intermediate inputs is lower than that of the counterpart, the domestic specialization index becomes positive.

$$+ \sum_j \left[ \left\{ \left( \frac{1}{\sum_i a_{ij}^{K}} + \frac{1}{\sum_i a_{ij}^{J}} \right) \Big/ 2 \right\} \bullet \Delta \sum_i a_{ij} \bullet \left( \frac{f_j^{K} + f_j^{J}}{2} \right) \right]$$

National intermediate input coefficient component (difference in input structure of intermediate products from counterpart): This component focuses on the intermediate input from the counterparts: In

the case of Korea, it focuses on the intermediate input imported from Japan, and in the case of Japan, it focuses on intermediate input imported from Korea. When the domestic proportion of the industrial intermediate input from counterpart is higher than that of the counterpart, the domestic industrial specialization index becomes positive.

$$+\sum_j \left[ \left\{ \left( \frac{1}{\sum_i a_{ij}^K} + \frac{1}{\sum_i a_{ij}^J} \right) \Big/ 2 \right\} \bullet \frac{\sum_i a_{ij}^{JK} + \sum_i a_{ij}^{KJ}}{2} \bullet \Delta f_j \right]$$

Production structure component (difference in industrial structure): This component focuses on the output structure. When industrial structure is higher in the home country than in the counterpart, the domestic industrial specialization index becomes positive.

## 2. Results of Empirical Analysis

### *A. ITS Index Decomposition and Analysis of Technological Differences between Japan and Korea*

Computation of the ITS indicates that indexes for Korea are higher than Japan's, indicating that Korea's technological dependency on Japan remained relatively high. For the three sample years of 1985, 1990, and 1995, the indexes for both countries reveal a downward trend, while the difference between the two nations shrank only slowly (refer to <Table 7>).

**<Table 7> International Technological Specialization (ITS) between Japan and Korea and Its Factor Decomposition**

| | International Technological Specialization | | | Difference and Its Factor | | |
|---|---|---|---|---|---|---|
| | Korea | Japan | Difference (Korea-Japan) | Manufacturing Technological | Intermediate Input Coefficient | Production Structure |
| 1985 | 0.0400 | 0.0018 | 0.0382 | 0.2209 | -0.1803 | -0.0024 |
| 1990 | 0.0348 | 0.0025 | 0.0323 | 0.0497 | -0.0180 | 0.0006 |
| 1995 | 0.0314 | 0.0020 | 0.0295 | -0.7428 | 0.7687 | 0.0035 |

For a detailed analysis of the international technological specialization and factor decomposition between Japan and Korea,[6] we can decompose the gap in the specialization indexes of Japan and Korea,

6) Technically speaking, the decomposition of the technology gap between two countries (the difference in international technology specialization indexes) into production technique, intermediate input coefficient and production structure portions may be carried out first by extracting the pertaining parts of the Leontief multiplier (inverse) matrix. The extracted parts, that is two vectors, may then be processed according to the decompostion formula demonstrated in the top of this page. Here, the elements of the vectors extracted from the multiplier matrix are conceptually analogous to the input coefficients in international input-output analysis. Thus, we can regard this manipulation as identifying the details about the input structures of intermediate goods. For details about the extraction from the Leontief matrix, see Nakamura, Y. (1993) "A Multiplier Analysis of Industrial Linkages between Japan, the United States and Developing Asia." in Takao Sano and Chiharu Tamamura, ed., *International Industrial Linkages and Economic Interdependency in Asia-Pacific Region*, Tokyo:Institute of Developing Economies.

using the decomposing formula above. The result of the decomposition is summarized in <Table 7>. The first factor is 'manufacturing technology' which can be found by comparing the input ratio of raw materials. The second factor is the 'national intermediate product input coefficient' representing the portion of imported inputs to the total intermediate inputs. And the third and last factor is the 'production structure' which indicates a disparity in output composition between the two nations.

In 1985 and 1990, the disparity in international technological specialization between Japan and Korea was mainly caused by the manufacturing technology factor, while in 1995 the contribution of the national intermediate product input coefficient factor rose remarkably. This suggeests that the manufacturing technology gap between Japan and Korea, in terms of intermediate input coefficient from the world, has narrowed while Korea's dependency on Japan in intermediate products has increased. The role of the production structure appeared to be small but growing, although the impact still seems insignificant.

The sudden change in the contribution of the manufacturing technology and intermediate input coefficients in 1995 might be due to the consolidated classification of the Japan-Korea Table 1995 which was based on the assumption that no service transactions occurred in that year as mentioned in the second part of chapter II.

*B. ITS Index Decomposition and Sector-wise Analysis of Technological Differences by Industry between Japan and Korea*

According to the sector classification of the Japan-Korea Tables, decomposition of sector-wise ITS was also carried out, and the results for the three sample years are summarized in <Table 8>. A compar-

ison of the international technological specialization indexes of Japan and Korea by industry tells us that Korea's dependence on Japan is high in the following seven sectors: electronics and electronic products, metal products, chemical products, transportation machinery, textile products, ordinary machinery and services.

On the other hand, the indexes show that Japan's technological dependence on Korea was higher in electronics and electronic products, metal products, chemical products and services, all of which overlap with the industries in which Korea heavy depends on Japan listed above. However, Korea indicated higher international technological specialization in all the four sectors compared to Japan (refer to <Table 8>).

In the case of Korea, ITS indexes by industry were examined as follows.

First, regarding manufacturing technology, in addition to the sectors of electronics and electronic products, chemical products, ordinary machinery and metal products, the textile products and services sectors also played a substantial role in pushing up the ITS index. However, in 1995 the contribution of all these sectors to the index declined particularly in electronics and electronic products, whose ITS indexes turned negative. The phenomenon detected for 1995 indicates that the technological gap between Japan and Korea is diminishing.[7]

Second, concerning the national intermediate input coefficient, most sectors showed negative results except in the case of transportation machinery, commerce and transportation in 1985 and 1990. But in 1995, the contribution of electronics and electronic products

7) Korea's sector-wise ITS index increase if Korea's intermeidate input coefficient (from the world) is lower than that of Japan.

and services as well as transportation machinery boosted the index considerably. This tells us that Korea's increased exports in electronics and electronic products including semiconductors induced an increase in the import of intermediate products from Japan in those industries.[8)]

Third, with regards to production structure, we find that textile products in 1985 and 1990 and chemical products, electronics and electronic products in 1995 made positive contributions.[9)]

In conclusion, the disparity in international technological specialization between Japan and Korea is primarily caused by differences in the manufacturing technology for ordinary machinery and chemical products and by the national intermediate input coefficients in services, electronics and electronic products and transportation machinery.

An analysis of the international technological specialization indexes of Korea and Japan reveals that Korea relies much more on inputs from Japan than the other way around. Nevertheless, Korea's dependency on Japan continuously decreased for the period 1985 to 1995. It is also notable that Japan's dependency on Korea grew, though slowly, over the same period.

8) Korea's sector-wise ITS index increases if Korea's depencency on intermediate input imported from Japan is higher than the corresponding figure for Japan.

9) This portion reflects the difference in output structure between Korea and Japan.

## <Table 8> International Technological Specialization (ITS) by Industry between Japan and Korea and Its Factor Decomposition

| (1985) | International Technological Specialization | | | Difference and Its Factor | | |
|---|---|---|---|---|---|---|
| | Korea | Japan | Difference (Korea-Japan) | Manufacturing Technological | Intermediate Input Coefficient | Production Structure |
| 001 | 0.0008 | 0.0001 | 0.0006 | -0.0011 | 0.0014 | 0.0003 |
| 002 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 003 | 0.0000 | 0.0000 | 0.0000 | -0.0001 | 0.0001 | 0.0000 |
| 004 | 0.0003 | 0.0001 | 0.0002 | 0.0030 | -0.0029 | 0.0001 |
| 005 | 0.0037 | 0.0002 | 0.0035 | 0.0279 | -0.0260 | 0.0016 |
| 006 | 0.0005 | 0.0000 | 0.0005 | 0.0031 | -0.0026 | -0.0001 |
| 007 | 0.0056 | 0.0002 | 0.0054 | 0.0655 | -0.0612 | 0.0011 |
| 008 | 0.0004 | 0.0000 | 0.0003 | 0.0049 | -0.0046 | 0.0001 |
| 009 | 0.0042 | 0.0002 | 0.0040 | 0.0447 | -0.0407 | 0.0000 |
| 010 | 0.0026 | 0.0000 | 0.0025 | 0.0257 | -0.0219 | -0.0013 |
| 011 | 0.0075 | 0.0002 | 0.0074 | 0.1011 | -0.0926 | -0.0011 |
| 012 | 0.0038 | 0.0000 | 0.0038 | -0.0321 | 0.0370 | -0.0011 |
| 013 | 0.0008 | 0.0000 | 0.0008 | 0.0050 | -0.0038 | -0.0004 |
| 014 | 0.0003 | 0.0000 | 0.0003 | 0.0042 | -0.0039 | 0.0000 |
| 015 | 0.0003 | 0.0000 | 0.0003 | -0.0006 | 0.0008 | 0.0000 |
| 016 | 0.0016 | 0.0001 | 0.0015 | 0.1004 | -0.0989 | 0.0000 |
| 017 | 0.0037 | 0.0003 | 0.0034 | -0.1616 | 0.1656 | -0.0006 |
| 018 | 0.0039 | 0.0003 | 0.0036 | 0.0310 | -0.0263 | -0.0010 |
| Total | 0.0400 | 0.0018 | 0.0382 | 0.2209 | -0.1803 | -0.0024 |

| (1990) | International Technological Specialization | | | Difference and Its Factor | | |
|---|---|---|---|---|---|---|
| | Korea | Japan | Difference (Korea-Japan) | Manufacturing Technological | Intermediate Input Coefficient | Production Structure |
| 001 | 0.0006 | 0.0001 | 0.0006 | -0.0013 | 0.0016 | 0.0002 |
| 002 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 004 | 0.0003 | 0.0001 | 0.0002 | 0.0019 | -0.0018 | 0.0001 |
| 005 | 0.0032 | 0.0001 | 0.0030 | 0.0128 | -0.0112 | 0.0014 |
| 006 | 0.0006 | 0.0000 | 0.0005 | 0.0027 | -0.0021 | -0.0001 |
| 007 | 0.0041 | 0.0002 | 0.0039 | 0.0176 | -0.0143 | 0.0006 |
| 008 | 0.0004 | 0.0000 | 0.0003 | 0.0179 | -0.0177 | 0.0001 |
| 009 | 0.0025 | 0.0003 | 0.0021 | 0.0138 | -0.0119 | 0.0003 |
| 010 | 0.0030 | 0.0001 | 0.0029 | 0.0331 | -0.0297 | -0.0005 |
| 011 | 0.0089 | 0.0003 | 0.0087 | 0.0523 | -0.0439 | 0.0003 |
| 012 | 0.0038 | 0.0000 | 0.0038 | -0.0182 | 0.0221 | -0.0001 |
| 013 | 0.0006 | 0.0000 | 0.0006 | 0.0026 | -0.0015 | -0.0005 |
| 014 | 0.0003 | 0.0000 | 0.0003 | -0.0098 | 0.0100 | 0.0000 |
| 015 | 0.0004 | 0.0000 | 0.0004 | 0.0031 | -0.0027 | 0.0000 |
| 016 | 0.0012 | 0.0002 | 0.0010 | -0.0214 | 0.0224 | 0.0000 |
| 017 | 0.0031 | 0.0006 | 0.0025 | -0.0717 | 0.0749 | -0.0007 |
| 018 | 0.0019 | 0.0004 | 0.0015 | 0.0143 | -0.0123 | -0.0004 |
| Total | 0.0348 | 0.0025 | 0.0323 | 0.0497 | -0.0180 | 0.0006 |

| (1995) | International Technological Specialization | | | Difference and Its Factor | | |
|---|---|---|---|---|---|---|
| | Korea | Japan | Difference (Korea-Japan) | Manufacturing Technological | Intermediate Input Coefficient | Production Structure |
| 001 | 0.0002 | 0.0000 | 0.0001 | -0.0004 | 0.0004 | 0.0001 |
| 002 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 004 | 0.0003 | 0.0001 | 0.0002 | 0.0019 | -0.0018 | 0.0000 |
| 005 | 0.0012 | 0.0001 | 0.0011 | 0.0075 | -0.0069 | 0.0005 |
| 006 | 0.0004 | 0.0000 | 0.0004 | 0.0036 | -0.0031 | 0.0000 |
| 007 | 0.0049 | 0.0002 | 0.0046 | 0.0251 | -0.0216 | 0.0011 |
| 008 | 0.0005 | 0.0000 | 0.0005 | 0.0037 | -0.0033 | 0.0001 |
| 009 | 0.0024 | 0.0003 | 0.0021 | 0.0130 | -0.0115 | 0.0006 |
| 010 | 0.0026 | 0.0001 | 0.0025 | 0.0506 | -0.0482 | 0.0002 |
| 011 | 0.0107 | 0.0006 | 0.0101 | -0.2359 | 0.2447 | 0.0013 |
| 012 | 0.0040 | 0.0000 | 0.0039 | -0.0243 | 0.0280 | 0.0002 |
| 013 | 0.0004 | 0.0000 | 0.0004 | -0.0089 | 0.0092 | 0.0000 |
| 014 | 0.0001 | 0.0000 | 0.0001 | -0.0015 | 0.0016 | 0.0000 |
| 015 | 0.0002 | 0.0000 | 0.0002 | 0.0011 | -0.0009 | 0.0000 |
| 016 | 0.0013 | 0.0001 | 0.0012 | 0.0162 | -0.0150 | 0.0000 |
| 017 | 0.0004 | 0.0001 | 0.0004 | 0.0017 | -0.0012 | -0.0001 |
| 018 | 0.0018 | 0.0002 | 0.0015 | -0.5964 | 0.5983 | -0.0004 |
| Total | 0.0314 | 0.0020 | 0.0295 | -0.7428 | 0.7687 | 0.0035 |

# V. Concluding Remarks

An analysis of the International Input-Output Table Japan-Korea for 1985, 1990, and 1995 provide several major findings, which can be summarized as follows.

① Considering the size of both economies, Japan's influence on Korean industries was greater than the other way around. However, if we turn to the changes over time, Korea's influence on Japanese industries increased slowly, while Japan's influence on Korean industries decreased rather sharply.

② The industrial structure of Korea experienced a drastic change during the ten years of the sample period. The proportion of the primary industry dropped while that of the tertiary industry increased in both Korea and Japan. In the case of Korea, the agriculture, forestry and fishery industries showed a remarkable contraction, while a substantial expansion was observed in the service sector. The portion of the economy occupied by the services sector also grew significantly in Japan. In the manufacturing industry, Korea witnessed significant growth in its metal products, electronics and electronic products, ordinary machinery and transportation machinery.

③ Korea's backward linkage effects on Japan was high in electronics and electronic products, ordinary machinery, transportation machinery, other manufacturing products, precision machines and metal products, with electronics and electronic products ranking the highest. On the other hand, Japan extended high backward linkage effects on Korea in electronics and electronic products, textile products, metal products, ordinary machinery, precision machines, trans-

portation machinery and other manufacturing products. The backward linkage effects on Korean textile products declined sharply, but textiles still maintained the third place ranking in 1995. In recent years, the backward linkage effects on Korea in electronics and electronic products, metal products and precision machines revealed a significant increase, but effects on ordinary machinery and transportation machinery rather declined.

④ Regarding forward linkage effects from its counterpart, in both Japan and Korea, deeper impacts were measured in chemical products, metal products and electronics and electronic products, with Korea's forward linkage effects on Japanese metal products ranking the highest. Intertemporal observation of the indexes indicates that the forward linkage effects from Japan on Korean metal products decreased drastically. Also, the forward linkage effects from Japan on Korean textile products was higher than Korea's effects on Japanese textile products. Although the effects dropped sharply in 1995, textiles still took fifth place. Forward linkage effects from Japan on Korean chemical products, metal products, and ordinary machinery also declined remarkably.

⑤ Korean industries were found to have induced much more production for Japan than the other way around. Demand from most Korean industries seemed to reduce Japan's induced production ratio, especially in precision machines, metal products, transportation machinery, ordinary machinery and electronics and electronic products. In contrast, demand from most Japanese industries seemed to raise Korea's induced production ratio particularly in electronics and electronic products, precision machines, metal products, ordinary machinery, transportation machinery and other manufacturing products.

⑥ Japan's industrial production relies more on domestic final demand compared to Korea. In the case of Korea, there was no noticeable change in the dependency of production on domestic final demand after a slight increase in the period of 1985-90. Examining the dependency of production on the counterpart's final demand, Korea depended more on Japan's final demand than the other way around. However, the ratio of dependency on Japan's final demand decreased while Japan's dependency on Korea's final demand slowly increased.

⑦ Korea lowered its dependency of production on Japan's final demand in such fields as chemical products, ordinary machinery, transportation machinery, precision machines and other manufacturing products. However, Japan increased its dependency of production on Korea's final demand in most industries except chemical products, textile products and transportation machinery.

⑧ A comparison of international technological specialization (ITS) between Japan and Korea shows that Korea's international technological specialization index was much higher than that of Japan, meaning Korea's technological dependency on Japan was deepening. However, the index level showed a modest decline. Factor decomposition of the technological gap between the two countries tells us that in 1985 and 1990, the discrepancy in manufacturing technology was the main factor, while in 1995 the contribution of the national intermediate input coefficient was remarkable. Examination by industry indicates that Korea's technological dependence on Japan was high in electronics and electronic products, metal products, chemical products, transportation machinery, textile products, and ordinary machinery mainly due to the factors of manufacturing technology and intermediate input coefficient.

Finally, both Japan and Korea have maintained similar industrial and organizational structures, resulting from their adherence to an export-oriented economic growth model. They also share the common tasks of securing stable export markets and attracting foreign investment amid deepening global regionalism. Additionally, cultural and social similarities between the two countries consolidated the economic relationship. Therefore, complementarity and competitiveness between the two have deepened.

Recently, Korea and Japan have been moving together towards a new and expanded partnership. For example, the new Korea-Japan Bilateral Investment Treaty (KJBIT) came into effect in December 2002. Also, the two countries have actively discussed the issue of import deregulation, in line with the future bilateral Free Trade Agreement (FTA). Cooperation between the two countries is essential not only for their survival in the global economy, but also to actively taking advantage of the ever-changing world trade environment. It is also important to build political trust and promote mutual understanding by sharing economic interests. Therefore, strengthening industrial interdependency, along with the removal of trade barriers though competition, would enable Japan and Korea to establish a productive partnership.

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# Appendix

## Sector Classification and International Input-Output Table of Japan and Korea (18 Endogenous Sectors)

### 1) Japan-Korea Table based on Asian International Input-Output Table 1995

| | ASIAN I-O | (18 Endogenous Sector) | |
|---|---|---|---|
| Agriculture, forestry and fishery | 001, 002, 003, 004, 005 | ------- | 001 |
| Crude petroleum and natural gas | 006 | ------- | 002 |
| Other mining | 007 | ------- | 003 |
| Food, beverage and tobacco | 008 | ------- | 004 |
| Textile products | 009 | ------- | 005 |
| Other light industry | 010, 011 | ------- | 006 |
| Chemical products | 012, 013, 014(050A) | ------- | 007 |
| Ceramic industry · cement products | 015 | ------- | 008 |
| Metal products | 016 | ------- | 009 |
| Ordinary machinery | 017(045A, 045B, 045C, 045E) | ------- | 010 |
| Electronics and electronic products | 017(045D, 046A, 046B) | ------- | 011 |
| Transportation machinery | 018 | ------- | 012 |
| Precision machines | 019(049) | ------- | 013 |
| Other manufacturing products | 019(050B) | ------- | 014 |
| Electricity, gas and water supply | 020 | ------- | 015 |
| Construction | 021 | ------- | 016 |
| Commerce · transportation | 022 | ------- | 017 |
| Services | 023, 024 | ------- | 018 |

Note: Codes in the brackets are basic classification of 78 sectors.

## 2) Japan-Korea Table based on International Input-Output Table of 1985 and 1990

| | K-J I-O Uniform Classification (Basic classification of 274 sectors) | | (18 Endogenous Sector) |
|---|---|---|---|
| Agriculture, forestry and fishery | 001~028 | ------- | 001 |
| Crude petroleum and natural gas | 036A, B | ------- | 002 |
| Other mining | 029~035 | ------- | 003 |
| Food, beverage and tobacco | 037~061 | ------- | 004 |
| Textile products | 062~078 | ------- | 005 |
| Other light industry | 079~092 | ------- | 006 |
| Chemical products | 093~126 | ------- | 007 |
| Ceramic industry · cement products | 127~136 | ------- | 008 |
| Metal products | 137~157 | ------- | 009 |
| Ordinary machinery | 158A~173 | ------- | 010 |
| Electronics and electronic product | 174~188 | ------- | 011 |
| Transportation machinery | 189~200 | ------- | 012 |
| Precision machines | 201~204 | ------- | 013 |
| Other manufacturing products | 205~209 | ------- | 014 |
| Electricity, gas and water supply | 210~216 | ------- | 015 |
| Construction | 217~225 | ------- | 016 |
| Commerce · transportation | 226~239 | ------- | 017 |
| Services | 240~274 | ------- | 018 |

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ISBN 89-322-4127-9
89-322-4026-4(세트)