

Changes in Industrial Interdependency between Japan and Korea

- An Application of International Input-Output Analysis -

Kwangsoo YANG*

Hong Bae LEE**

Key Words: International Input-Output Model, Trade Interdependency, Import Structure of Intermediate Goods, Backward Linkage Effect, Forward Linkage Effect

. 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.

* Professor, University of Nagasaki, Japan

** Asistant Professor, Dong-Eui University, Korea

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 inter-relationship between Japan and Korea. Such a study can play a crucial role in the 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 in Japan. Sano (1996), Jung and Bang (2001) and Kim (1989) analyzed the industrial structures of Korea and Japan. However, the scope of their studies was 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 the production structures both countries. 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. Section I provides a detailed explanation of the statistical data and method used for the inter-

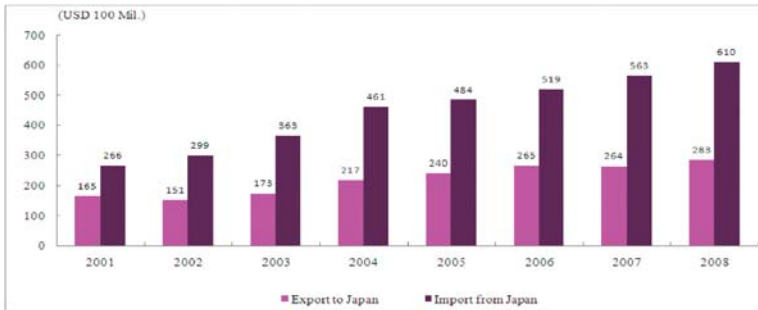
national industrial linkage model. Section II analyzes the current trade situation between Japan and Korea. Section III observes the interdependency of the two countries intermediate and final products industries, using a basic international industrial linkage model. The section provides an analysis 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. Finally, section IV summarizes the empirical results of this study and reviews the major findings.

. Current Trade Situation between Korea and Japan

After the foreign exchange crisis, the temporarily daunting trade between Korea and Japan has continuously increased since 2001.¹ In 2008 , Korea's export to Japan was USD 28.3 billion and import from Japan was USD 61.0 billion. The import volume was more than twice the export volume. Since 1965 , when trade statistics between Korea and Japan began, Korea's trade balance in relation to Japan has been continuously recording a deficit. Especially, in 2008 , Korea's trade balance deficit with Japan was recorded as USD 32.7 billion, and this was the first time it went over USD 30.0 billion.

However, Japan's portion of Korea's trade volume has been decreasing in Korea's total volume of trade in the world. The export portion was 19.4 % in 1990 and since then, it continued to decrease to 6.7% in 2008 . During the same years, the import portion also decreased from 26.6% to 7.1 %.

<Figure 1> The Amount of Trade between Korea and Japan



Source: Kotis.

The trade between Korea and Japan is in a very similar form in terms of the two countries' industries, items, and processing stages. In industries, the industrial products' heavy chemical industry is given a great deal of weight. In items, the electric machines and steel industries are important

<Table 1> Korea's Industries, Items, and Processing Stages' Trade with Japan
(Unit: USD 100 Mil.)

Industries			Items*				Processing Stages		
	Export	Import	Export		Import			Export	Import
Primary Industry	21	13	Electricity (85)	65	Nuclear Reactors (84)	110	Raw Materials	136	289
Industrial Products	262	596	Nuclear Reactors (84)	30	Steel (72)	108	Capital Goods	110	283
Light Industry	20	43	Fuel (27)	39	Electricity (85)	107	Consumer Products	36	38
Heavy Chemical Industry	242	553	Steel (72)	29	Plastics (39)	37			

Note: Items are in HSK's 2 unit basis for the top 4 items, and the parentheses are HSK codes.

Source: Kotis.

and in processing stages, raw materials are relatively more important.²

Based on the technological level, a great deal of weight is given to middle technological products in trade between the two countries. From middle technological products, Korea mostly exports middle and low technological products and imports middle and high technological products. In 2007, the middle and high technological product's trade balance deficit with Japan was USD 19.4 billion and this took up 64.7% of Korea's total trade balance deficit with Japan (USD 29.9 billion).

<Table 2> Korea's Trade with Japan based on the Level of Technology
(Unit: USD 100 Mil.)

		2000	2002	2004	2006	2007
High Technology ¹⁾	Export	72	50	70	63	74
	Import	103	94	122	102	107
Middle and High Technology ²⁾	Export	25	25	41	83	71
	Import	142	125	216	256	265
Middle and Low Technology ³⁾	Export	69	49	77	95	95
	Import	59	68	110	145	173
Low Technology ⁴⁾	Export	19	13	14	11	10
	Import	8	7	7	7	8

Note: This is based on OECD's classification.

- 1) High technology: Airplanes, office/computation/accounting machines, pharmaceutical/medical compounds, visual/audio/communication equipment
- 2) Middle and high technology: General machines/equipment, home electric machines, precision instruments, automobiles, other transportation equipment, chemicals/chemical products
- 3) Middle and low technology: Rubber/plastics, coke/oil refined products, non-ferrous metals, primary metals, construction metals, electric machines/electric converters
- 4) Low technology: Vessel construction/repair, foodstuffs/tobacco, textiles/clothing/leather products, lumber/paper products, printing/publishing/copying, furniture

Source: Institute for International Trade . 2008 . 『The Current Status of Unfavorable Trade Conditions with Japan and Related Measures』 .

. 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 and 2000.³ Regarding the data for 1995 and 2000 , the Institute of Developing Economies (IDE) , Japan, tabulated the 1995 and 2000 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 and 2000 . Thus, the 1995 and 2000 Japan-Korea table used in this research was created with data extracted from the 1995 and 2000 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 2000 (refer to <Table 3>) .

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 , 1995 and 2000.⁴ The international input-output table for 2000 may 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.

<Table 3> Sector Classification of Japan-Korea Table (18 Endogenous Sectors)

Code	Intermediate Sectors	Code	Final Demand
	Agriculture, forestry and fishery		Business consumption
001	Crude petroleum and natural gas	001	Government consumption
002	Other mining	002	Gross private fixed capital formation
003	Food, beverage and tobacco	003	Gross government fixed capital formation
004	Textile products	004	Changes in stock
005	Other light industry	005	Total final demand
006	Chemical products	900	Notice that in the 1985 table ,
007			

008	Ceramic industry cement		003 indicates gross fixed capital formation , 004 indicates changes in stock .
009	products		
010	Metal products		
011	Ordinary machinery		
012	Electronics and electronic	001	【Value Added】
013	products	002	Wages and salaries
014	Transportation machinery	003	Operating surplus
015	Precision machines	004	Depreciation of fixed capital
016	Other manufacturing products	005	Indirect taxes
017	Electricity, gas and water	900	Less subsidies
018	supply		Total value added
	Construction		Notice that in the 1985 table ,
	Commerce transportation		004 indicates Indirect Taxes
	Services		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.

. Changes in Industrial Linkage between Japan and Korea

In this section, 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 and 2000 Japan-Korea table extracted from the 1995 and 2000 Asian International Input-Output Table. The focus is placed on how much Korea and Japan depends on their counterparts for intermediate in-

puts, 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 comprehensive view of forward and backward linkages as well as production induction.

1 . Analytical Framework

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 ,

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

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 cer-

tain 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 production 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 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 Section, we analytically formulated the forward and backward linkage effects in Korea and Japan. This Section, will calculate the

forward and backward linkage effects empirically and review the characteristics and changes 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 the power of dispersion index and the sensitivity of dispersion index, respectively.

<Table 4> 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 4> .

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 2000 , 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. Additional sectors showing backward linkage effects are the food, beverages and tobacco sector in Korea and electronics and electronic products in Japan .

<Table 4> Changes in Backward Linkage Effects of Japan and Korea

	Korea				Japan			
	1985	1990	1995	2000	1985	1990	1995	2000
Home								
001	1.5654	1.5815	1.5544	1.6185	1.8821	1.7751	1.7597	1.7505
002	1.0000	1.0000	1.0000	1.0000	1.6044	1.5301	1.5617	1.6294
003	1.6466	1.5685	1.5034	1.5776	2.0733	1.9684	1.9657	2.0323
004	2.1122	2.1371	2.0081	2.0995	2.1925	2.1249	2.0452	1.9713
005	2.1930	2.1629	1.8801	1.9875	2.2640	2.1290	2.0513	2.0186
006	1.9456	1.9049	1.8372	2.0286	2.1797	2.0609	2.0079	1.9911
007	1.6209	1.7496	1.6669	1.5820	1.8992	1.9102	1.8853	1.7896
008	1.9787	1.8925	1.9367	2.0076	2.1460	2.0456	1.9957	1.9629
009	2.3082	2.2602	2.1440	2.1722	2.5613	2.3104	2.2007	2.1505
010	2.0222	2.0568	1.9670	2.1205	2.3242	2.2377	2.1804	2.1305
011	1.8190	1.9245	1.7121	1.7061	2.3438	2.2256	2.1465	2.1160
012	2.0154	2.1218	2.0594	2.3440	2.6371	2.6671	2.6263	2.5978
013	1.8005	1.9251	1.8011	2.0021	2.1662	2.1198	2.0017	1.9155
014	2.1384	2.0611	1.8334	2.0484	2.1516	2.1364	2.1034	2.1367
015	1.5200	1.5522	1.6155	1.5195	1.6193	1.6068	1.6934	1.6579
016	2.0695	1.9554	2.0043	1.9873	2.2109	2.0571	2.0121	1.9653
017	1.5706	1.5447	1.5048	1.5307	1.6962	1.6415	1.5471	1.5402
018	1.6290	1.6751	1.5007	1.54463	1.6375	1.6231	1.5347	1.5390
Counterpart								
001	0.0243	0.0244	0.0162	0.0149	0.0056	0.0044	0.0025	0.0044

Changes in Industrial Interdependency between Japan and Korea

002	0.0000	0.0000	0.0000	0.0000	0.0009	0.0017	0.0012	0.0016
003	0.0437	0.0295	0.0199	0.0164	0.0021	0.0036	0.0022	0.0073
004	0.0290	0.0298	0.0230	0.0231	0.0061	0.0066	0.0042	0.0054
005	0.1530	0.1247	0.0728	0.0565	0.0192	0.0158	0.0129	0.0125
006	0.0678	0.0583	0.0398	0.0524	0.0021	0.0029	0.0020	0.0035
007	0.1025	0.1061	0.0959	0.0661	0.0046	0.0057	0.0064	0.0118
008	0.0676	0.0527	0.0566	0.0493	0.0055	0.0058	0.0033	0.0057
009	0.2395	0.1240	0.0959	0.1367	0.0085	0.0152	0.0138	0.0133
010	0.2771	0.2038	0.1476	0.1340	0.0039	0.0070	0.0063	0.0088
011	0.3586	0.3032	0.2323	0.2096	0.0063	0.0101	0.0171	0.0204
012	0.2983	0.1994	0.1681	0.1358	0.0038	0.0059	0.0055	0.0079
013	0.3678	0.2777	0.1364	0.1609	0.0043	0.0069	0.0103	0.0134
014	0.1332	0.1042	0.0669	0.0883	0.0056	0.0073	0.0090	0.0127
015	0.0379	0.0399	0.0305	0.0206	0.0012	0.0026	0.0016	0.0025
016	0.0980	0.0593	0.0530	0.0534	0.0038	0.0058	0.0041	0.0053
017	0.0502	0.0368	0.0164	0.0168	0.0024	0.0036	0.0010	0.0020
018	0.0443	0.0290	0.0177	0.0143	0.0016	0.0021	0.0013	0.0017

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 5> Changes in Forward Linkage Effects of Japan and Korea

	Korea				Japan			
	1985	1990	1995	2000	1985	1990	1995	2000
Home								
001	1.8789	1.8297	1.6352	1.6305	1.8286	1.6687	1.4690	1.3800
002	1.0000	1.0000	1.0000	1.0000	1.0181	1.0075	1.0064	1.0069
003	1.3162	1.2803	1.2238	1.1644	1.1652	1.1435	1.1088	1.1004
004	1.4462	1.5028	1.5317	1.4503	1.5055	1.4545	1.3709	1.3634
005	1.9695	1.9258	1.4070	1.4644	1.6102	1.5776	1.4519	1.3834
006	1.8981	1.8439	1.8041	1.8139	2.2515	2.1841	2.1122	2.0012
007	3.9092	3.0833	3.0117	3.4895	3.8771	3.2219	3.0788	2.7430
008	1.5309	1.4985	1.4973	1.4550	1.4126	1.3493	1.3346	1.3058
009	3.2677	3.2331	2.9775	2.9943	3.4962	3.1820	2.9177	2.7030
010	1.5277	1.6056	1.4395	1.5470	1.7767	1.7711	1.4905	1.5734
011	1.4941	1.6773	1.6672	1.7063	1.9297	2.0395	1.9672	1.9330
012	1.2123	1.4616	1.4988	1.5270	1.7782	1.8907	2.1008	2.0216

Changes in Industrial Interdependency between Japan and Korea

013	1.0967	1.1059	1.0913	1.1408	1.1891	1.1880	1.1245	1.0853
014	1.0371	1.0451	1.4084	1.4525	1.1138	1.1426	1.1533	1.6884
015	1.7736	1.6732	1.6397	1.7013	1.8546	1.6382	1.7943	1.8067
016	1.1937	1.2604	1.1980	1.1433	1.2250	1.2641	1.3028	1.3173
017	2.4108	2.4686	2.0524	2.0454	3.4300	3.4143	3.6302	3.4195
018	2.9924	3.5788	3.5218	4.1525	5.1271	5.0324	4.9050	5.0630
Counterpart								
001	0.0164	0.0098	0.0048	0.0052	0.0073	0.0058	0.0045	0.0031
002	0.0008	0.0003	0.0007	0.0003	0.0000	0.0000	0.0000	0.0000
003	0.0151	0.0084	0.0051	0.0031	0.0019	0.0017	0.0010	0.0010
004	0.0163	0.0118	0.0079	0.0076	0.0020	0.0038	0.0028	0.0028
005	0.0896	0.0616	0.0293	0.0178	0.0140	0.0140	0.0089	0.0070
006	0.0579	0.0514	0.0388	0.0383	0.0018	0.0025	0.0021	0.0029
007	0.4101	0.3356	0.2420	0.2091	0.0192	0.0173	0.0185	0.0399
008	0.0513	0.0297	0.0311	0.0246	0.0030	0.0029	0.0020	0.0024
009	0.5206	0.2940	0.2084	0.2141	0.0136	0.0247	0.0236	0.0224
010	0.1719	0.1485	0.0933	0.0932	0.0007	0.0020	0.0017	0.0030
011	0.2691	0.2767	0.2443	0.2098	0.0049	0.0088	0.0213	0.0234
012	0.0655	0.0377	0.0464	0.0309	0.0004	0.0011	0.0008	0.0015
013	0.1238	0.0947	0.0142	0.0233	0.0006	0.0011	0.0013	0.0030
014	0.0109	0.0083	0.0398	0.0413	0.0008	0.0007	0.0006	0.0051
015	0.0589	0.0336	0.0290	0.0294	0.0022	0.0020	0.0018	0.0028
016	0.0125	0.0116	0.0100	0.0097	0.0004	0.0007	0.0004	0.0004
017	0.2410	0.1785	0.1630	0.1562	0.0082	0.0124	0.0061	0.0077
018	0.2615	0.2107	0.1398	0.1353	0.0062	0.0117	0.0073	0.0122

Now we will turn to forward linkage effects, which are summarized in <Table 5> . 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 coun-

terpart'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 5> describes a distinctive feature of Korea. Until 1985 forward linkage effects on agriculture, forestry and fishery were relatively high while in 2000 they declined to their low 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 2000 . It is notable that in 2000 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 linkage 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 (0.0224) 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 0.2141 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 2000 , Korean textile products still take sixth 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 .

Therefore , <Table 6> 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 to 16 in 1995 and finally to 9 in 2000 . This tells us that Korean industries are slowly becoming less dependent on Japanese industries.

<Table 6> 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 transportation machinery showed high growth from 1985 to 2000 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 6> Induced Production Ratio to Counterpart

(Unit: percent)

	Korea Japan				Japan Korea			
	1985	1990	1995	2000	1985	1990	1995	2000
001	1.53	1.52	1.03	0.90	0.29	0.25	0.14	0.25
002	0.00	0.00	0.00	0.00	0.06	0.11	0.08	0.10

Changes in Industrial Interdependency between Japan and Korea

003	2.59	1.85	1.31	1.01	0.10	0.18	0.11	0.35
004	1.35	1.38	1.13	1.05	0.28	0.31	0.21	0.27
005	6.52	5.45	3.73	2.57	0.84	0.74	0.63	0.58
006	3.37	2.97	2.12	2.41	0.09	0.14	0.10	0.17
007	5.95	5.72	5.44	3.77	0.24	0.30	0.34	0.64
008	3.31	2.71	2.84	2.33	0.26	0.28	0.16	0.28
009	9.40	5.20	4.28	5.69	0.33	0.65	0.62	0.60
010	12.05	9.02	6.98	5.80	0.17	0.31	0.29	0.39
011	16.47	13.61	11.95	10.23	0.27	0.45	0.79	0.90
012	12.89	8.59	7.55	5.34	0.14	0.22	0.21	0.29
013	16.96	12.61	7.04	7.20	0.20	0.32	0.51	0.66
014	5.86	4.81	3.52	3.99	0.26	0.34	0.43	0.57
015	2.43	2.50	1.85	1.27	0.07	0.16	0.09	0.14
016	4.52	2.94	2.58	2.57	0.17	0.28	0.20	0.26
017	3.10	2.33	1.08	1.07	0.14	0.22	0.07	0.13
018	2.65	1.70	1.17	0.91	0.10	0.13	0.08	0.11
Average	6.77	5.17	4.70	3.23	0.23	0.31	0.30	0.37

In this section we will examine how much domestic and external final demands contributed to the industrial production of Japan and Korea . <Table 7> 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 2000 , Japan's final demand induced 78.3% of the domestic production, whereas Korea's final demand induced only 66.5% of the domestic production. A comparison of data for 2000 reveals that Korea depended heavily on Japan's final demand. The Table shows that 3.4% of Korea's domestic production was attributable to Japan's final demand, while only 1.3% of Japan's domestic production was attributable to Korea's final demand. In other words, while pursuing an export expan-

sion 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 4.0% in 1990 . However, Korea's dependency on Japan again lowered in 2000 to 3.4% . 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 7> Dependency of National Production on Final Demand

(Unit: percent)

	Final Demand								Export to the Rest of the World			
	Korea				Japan							
	1985	1990	1995	2000	1985	1990	1995	2000	1985	1990	1995	2000
Korea	72.6	75.6	75.5	69.5	3.4	4.0	3.1	3.4	24.1	20.4	21.5	27.0
Japan	0.4	0.7	1.2	1.3	84.2	80.9	81.5	78.3	15.4	18.4	17.3	20.4

. Concluding Remarks

An analysis of the International Input-Output Table Japan-Korea for 1985 , 1990 , 1995 and 2000 provides several major findings, which can be summarized as follows.

First, 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 .

Second, the industrial structure of Korea experienced a drastic change during the fifteen 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 .

Third, 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, transportation 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 .

Fourth, 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 .

Fifth, 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 .

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, complementary and competitiveness between the two have deepened.

Recently, Korea and Japan have been moving together towards a new and expanded partnership. For example, the two countries have 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 active-

ly take 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 through competition, would enable Japan and Korea to establish a productive partnership .

Notes

- ¹ In 2007 , Korea's export to Japan decreased USD 160 million compared to the previous year .
- ² On the other hand, until 2004 , Korea's consumer products' export to Japan took up more than 40% in Korea's total export but it has been continuously decreasing .
- ³ For details, see the " Analytical Tables for Asian International Input-Output Table (I) " AIO Series No.21 , March , 1991 .
- ⁴ 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 International Input-Output Table were, China, Japan, Korea, Taiwan, the U.S. and five Southeast Asian countries (Thailand, Singapore, Malaysia, Indonesia, and the Philippines) .

References

- Clements, Benedict J . 1990 . " On the Decomposition and Normalization of Interindustry Linkages . " *Economics Letters* , 33 , pp.337-340 .
- Institute of Developing Economies . 2006 . *Asian International Input-Output Table 2000* . Statistical Data Series No.90 . Tokyo: Institute of

Developing Economies.

_____. 2001. *Asian International Input-Output Table 1995*. Statistical Data Series No.82. Tokyo: Institute of Developing Economies.

_____. 1998. *Asian International Input-Output Table 1990*. Statistical Data Series No.81. Tokyo: Institute of Developing Economies.

Jung, Jong-Inn & Bang, Hong-Kee. 2001. "Comparative Analysis and Future Prospects on Trade Structure of China, Japan and Korea." The Bank of Korea.

Kim, Chong-Gui. 1989. "Analysis of Growth Factor in Korean Economy based on Constant Input-Output Table." *Monthly Research Statistics*, The Bank of Korea, pp.18-46.

Lee, Jin-Myun & Fujikawa Kiyoshi. 1997. "Analysis on Factors of Industrial Growth and of Structural Change in Production in Japanese and Korean Economy." *Policy Analysis* Vol.19, No.2, Korea Development Institute, pp.213-268.

Lee, Kyu-Inn. 2001. "Analysis of Interdependency among Asia Pacific Countries." *Quarterly National Accounts* No.3, The Bank of Korea.

Lee, Hong-Bae. 2009. "Changes in Production Technology Structure of Intermediate Products among ASEAN, Japan, China and Korea". *The Journal of Northeast Asian Economic Studies*. Vol, 22. No 2. The Northeast Asian Economic Association of Korea.

_____. 2008. "Analysis of Trade Interdependency among Korea, China, Japan and ASEAN". *The Korea-Japan Journal of Economics & Management Studies*. Vol. 40. The Korea-Japan Economics & Management Association.

Lee, Hong-Bae & Oh, Dong-Yun. 2009. "Industrial Effects of Tariff

- Removal between Korea and Japan. *International Area Studies Review* " Vol . 13 NO . 2 . The International Association of Area Studies .
_____ . 2004 . " Possibility of Realizing a Japan-Korea FTA . " *The Journal of East Asian Affairs*, Spring/Summer 2004 . The Research Institute for International Affairs .
- _____ . 2004 . The Effect of a Korea-Japan FTA on Components Industry. KIEP .
- Ministry of Economy Trade and Industry (ed .) . 1999 . " International Input-Output Table for Japan, United States, EU and Asia 1990 . " Tsusho Tokei Kyokai .
- Ministry of Economy, Trade and Industry . 2001 . " Input-Output Table of 1997 . "
- Miyazawa, Kenichi . 1975 . " A Guide to Inter-industry Analysis . " Nihon Keizai Shinbun, Inc .
- _____ . 1966 . " Internal and External Matrix Multipliers in the Input-Output Model . " *Hitotsubashi Journal of Economics* , 7 , pp.38-55 .
- _____ . 1976 . " Input-Output Analysis and the Structure of Income Distribution . " Springer-Verlag, Berlin .
- 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 .
- Sano, Takao . 1996 . " Time Series Analysis of International Input-Output Table Japan-Korea . " Institute of Developing Economies .
- The Bank of Korea . 1998 . " Trade Structure of Major East Asian Countries Including Korea and Interdependency between East Asia and

Advanced Countries based on International Input-Output Table. ”
Takahashi, Mutsuharu . 2000 . “ Changes of Independency and Economic
Structure between U.S and Japan since 1985. ” Institute of Develop-
ing Economies .

* This paper is funded by the President’s Discretionary Research Fund
(2009 ~ 2010) at the University of Nagasaki, Japan.