Who benefits from the emerging China?An International Input-Output Approach

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Abstract

This paper attempts to analyze the impact of China's emergence on the Asian countries from the aspect of China's expanding final demand by using the International Input-Output (IIO) approach from 1990 to 2005. Results show that the expanding final demand of China had a positive effect on Asian countries. Although the induced sums of Japan were larger than those for other Asian countries', Japan's share was diminishing. In contrast, the induced sums of Korea and Taiwan increased significantly, and their ratios in the total induced sums rose sharply. In comparison with the induced sums of Japan, Korea and Taiwan, the induced sums of the ASEAN5 (Indonesia, the Philippines, Malaysia, Thailand and Singapore) were relatively small, however, the share of the ASEAN5 did increase slightly. Moreover, comparing the induced sums of each country based on the final demand of the U.S. and that of China, we find that the induced sums of each country based on U.S. final demand were much larger than those for China. Although China had not become a global economic locomotive that could replace the U.S. in enabling economic growth in Asian countries during the period under study, China was clearly becoming an important market for other Asian countries-especially Korea, Taiwan and the ASEAN5- as a destination for these countries' export of final goods and these countries benefited from this change.

1．Introduction

In recent years, China's economic performance has attracted much international attention. The country's economy has grown at an average rate of over 10 percent during the past few decades since the onset of China's opening-up policy and market-oriented structural reforms in the late 1970s[1]. China's increasing presence in the global scene is due to its rapidly expanding trade. China's imports and exports have grown faster than world trade, resulting in its share of world trade increasing from less than 1 percent in the

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1 See details in INSITITUTE FOR INTERNATIONAL TRADE AND INVESTMENT (ITI) (http://www.iti.or.jp/stat/4-003.pdf)

late 1990s to 6 percent today, China is now the world's fourth largest trader. The effects of China's expanding external trade are likely to be felt especially intensely by Asian countries. Geographical proximity, shared borders and the existence of extensive networks of overseas Chinese are among the reasons to expect large amounts of trade between China and the rest of Asia. Indeed, the economic linkages among countries in Asian have deepened significantly, supported by the rapid expansion of intra-regional trade.

Many economic studies have examined economic linkages in East Asia. For instance, by using the International Input-output (IIO) framework, in a study of three sectors from 1985 to 2000, Fujikawa, Shimoda and Watanabe (2006) found that most East Asian countries had a decreasing home production rate, and that a large amount of these countries' value-added had not remained within the East Asian region. They therefore, concluded that it would still be premature to regard the East Asia region as an independent economic community. However, they overlooked the indirect effects, and basically concentrated only on the value-added effects.

On the other hand, after examining 19 sectors from 1985 to 2000, Hasebe and Shrestha (2006) insisted that the average of self-dependence in the region had declined, but that the average of dependence on regional partners had increased and regional interdependence had deepened although the extent of dependence was small. Unfortunately, they only focused on the indirect effects and a portion of the direct effects. To solve the problem of misspecification in the conventional IIO analysis, in a study of 63 sectors from 1990 to 2000, Shrestha (2008) defined an extended IIO framework and insisted that East Asia's economic impacts through export and industrial productions on the regional economies had increased, particularly regarding imported intermediate deliveries between 1990 and 2000. In contrast, the relative share of exports' contribution to the domestic economies diminished. However, for applying an assumed export column, he left the actual trade structure out of consideration.

Furthermore, the research group of the Institute of Developing Economies (IDE) has reported many studies concerning the emergence of the Chinese economy and re-organization of the Asian industrial structure in their publications, for instance, Yokohashi, Tokoyama and Shimoda (2007)[2].

Owing to its special role in intraregional trade, China is also frequently discussed in economic studies using trade data. For instance, Eichengreen, Rhee and Tong (2007) analyzed the impact of China's growth on the exports of other Asian countries, distinguishing China's demand for imports from its penetration of export markets from 1990 to 2003. They claimed that the effect of Chinese growth was negative for low-income Asian countries that exported mainly consumer goods and felt the brunt of Chinese competition in third markets but not for high-income Asian countries that exported mainly capital goods

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2   Yokohashi, Tokoyama and Shimoda (2007) analyzed the triangular trade structure of China, the U.S. and East Asia, and found that the production of China's electronic industry due to the final demand of the U.S., in particular for private consumption, greatly increased. To support this production, China's imports from East Asia, mainly for the electronic industry, expanded rapidly from 1995 to 2000. They concluded that it is likely that the rebuilding of the division of labor in the production process or the reorganization of the electronic industry advanced in this region, which was attributed to the U.S. demand.

and benefited from China's voracious appetite for imported machinery and equipment. Greenaway, Mahabir and Milner (2008) extended their earlier work by using disaggregate trade data to explore the differential impact of China's exports as well as that of its imports on product categories, which were classified by technology intensity and stages of production over the period 1992-2006, they found that displacement due to China's export surge occurred more in medium- and high-tech sectors and high income countries were more adversely affected, and that China offered export growth opportunities to its neighbors in parts and components, automotive products and high-tech sectors.

However, no studies have examined the impact that China's expanding imports of final goods has had on other Asian countries at a more detailed industry-lever, though, taking into account both direct and indirect effects. Therefore, this paper attempts to analyze the impact of China's expanding final demand on its neighbors, by using the IIO approach. We have found that all of China's neighbors[3] have benefited from China's expanding demand for final goods, and that the induced sums of Japan were the greatest.

Each country's share in the total induced sums shows a different trend-Japan's share goes downward, whereas those of Taiwan, Korea and the ASEAN5 rise. While the economy-wide analysis gives a broad picture for each country, we also examine our results at the industry-level, for there may be different results in different sectors. We find that in most industries the shares of Taiwan and Korea increased sharply, whereas the share of the ASEAN5 showed a slight upward trend. Moreover, in some industries, Japan's share was quite high and still rose sharply, such as in the heavy electric machinery industry, ordinary and specialized machinery, precision machines, metal products, and glass and glass products industry. This differed considerably from the macro-level results, and suggests that the international division of labor has been advancing in East Asia.

So far export-oriented growth strategies have been widely adopted by Asian countries, and the export performance of each of these countries depends heavily on income growth in industrialized countries. As the emergence of China continues, will China displace the industrialized countries as a major market for exports of final goods from other Asian countries? The answer from our analysis comparing the U.S. and China is "not yet". However, the different trends for the share of each country in total induced sums based on the final demand of the U.S. and China suggest that China is becoming an extremely important market for Asian countries, especially for Korea, Taiwan and the ASEAN5, as these countries increasingly export their final goods to China and benefit from these exports.

The remainder of this paper is organized as follows. Section 2 presents the analytical framework and the data sets used in this study. Section 3 discusses the calculation results of the analysis. Section 4 concludes the paper.

2. Method and Data

We adopt the International Input-Output (IIO) model for our analysis as it is designed to reflect direct and indirect interaction effects between production sectors as well

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3   Here, "China's neighbors" refers to Japan, Korea, Taiwan and the ASEAN5.

as between countries. Moreover, the IIO table, which is the basis of the IIO framework, provides information about the transaction of intermediate goods and final goods across each production sector and each endogenous country. Furthermore, it also provides information about the import of intermediate input goods from the exogenous countries to each production sector of each endogenous country.

Figure 1 is a layout of a typical IIO table with two endogenous countries (A and B), one exogenous country (C), two production sectors (sector 1 and sector 2), an export column, a total output column, a value added row and a total input row. The shaded part shows the intermediate input composition associated with each industry in each country. For instance, Z_{12}^{AB} represents the transaction of intermediate goods from sector 1 of country A to sector 2 of country B.

Figure 1: A Typical International Input-Output Table

		Intermediate Input				Final Demand		Export	Total Output
		Country A		Country B		Country A	Country B		
		Sector 1	Sector 2	Sector 1	Sector 2				
Country A	Sector 1	Z_{11}^{AA}	Z_{12}^{AA}	Z_{11}^{AB}	Z_{12}^{AB}	F_1^{AA}	F_1^{AB}	E_1^{A}	X_1^{A}
Country A	Sector 2	Z_{21}^{AA}	Z_{22}^{AA}	Z_{21}^{AB}	Z_{22}^{AB}	F_2^{AA}	F_2^{AB}	E_2^{A}	X_2^{A}
Country B	Sector 1	Z_{11}^{BA}	Z_{12}^{BA}	Z_{11}^{BB}	Z_{12}^{BB}	F_1^{BA}	F_1^{BB}	E_1^{A}	X_1^{B}
Country B	Sector 2	Z_{21}^{BA}	Z_{22}^{BA}	Z_{21}^{BB}	Z_{22}^{BB}	F_2^{BA}	F_2^{BB}	E_2^{A}	X_2^{B}
Country C	Sector 1	Z_{11}^{CA}	Z_{12}^{CA}	Z_{11}^{CB}	Z_{12}^{CB}	F_1^{CA}	F_1^{CB}		
Country C	Sector 2	Z_{21}^{CA}	Z_{22}^{CA}	Z_{21}^{CB}	Z_{22}^{CB}	F_2^{CA}	F_2^{CB}		
Value-Added		V_1^{A}	V_2^{A}	V_1^{B}	V_2^{B}				
Total Input		X_1^{A}	X_2^{A}	X_1^{B}	X_2^{B}				

Note. Refer to Shresta, N. (2008), P13.

The most popular approach in IIO analysis is the Leontief method, which uses the requirement matrix B[4]. By multiplying the requirement matrix B with final demand F (consisting of private consumption, government consumption, gross fixed capital formation and changes in stocks) of a particular country, we can calculate the impact of that particular country on an endogenous country in terms of the size effect. Unfortunately, this IIO analytical framework does not properly address the exogenous country effect and the value-added input effect. Therefore, we adopt the total input requirement (TIR) matrix as a substitute for the Leontief inverse matrix. The TIR matrix was defined by Shrestha (2008) to measure the impact of the expanding final demand of China on Asian countries. The TIR matrix (denote by *D*) is drawn out as follows.

The total input coefficient matrix (*A*) is defined as

$$A = \begin{bmatrix} Ad \\ Aw \\ Av \end{bmatrix}$$

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4   This is the Leontief inverse matrix of the intermediate input coefficient matrix A.

Who benefits from the emerging China? An International Input-Output Approach

49

where *Ad*, *Aw* and *Av* respectively represent the intermediate input coefficient matrix for endogenous countries, the intermediate input coefficient matrix for exogenous countries and the diagonal matrix of value-added coefficients.

The Leontief inverse matrix (*B*) is defined as

$$B = (I - Ad)^{-1}$$

where *I* is an identity matrix. The Leontief inverse matrix (*B*) is indicative of the direct and indirect effects induced by an increase in the final demand of endogenous countries.

By multiplying the total input matrix (*A*) with the Leontief matrix (*B*), we get the TIR matrix (*D*)

$$D = AB = \begin{bmatrix} Ad * B \\ Aw * B \\ Av * B \end{bmatrix}$$

We know that the TIR matrix contains three kinds of effects. There are indirect effects corresponding to endogenous country effects (*Ad**B), which represent the total (direct and indirect) intermediate input from endogenous countries caused by an increase in the final demand of the endogenous countries. There are also direct effects that are considered domestic effects and these can be decomposed into two effects, the exogenous countries effect (*Aw**B), which represents the total intermediate input from exogenous countries that is induced by an increase in the final demand of the endogenous countries, and the value-added effect (*Av**B) which represents the total induced value-added of endogenous countries that is caused by an increase in the final demand of the endogenous countries[5].

The Asian IIO table has been compiled and published for five years by the Institute of Developing Economies, Japanese External Trade Organization (IDE). In this paper, we use tables for the years 1990, 1995 and 2000. These tables comprise 10 endogenous countries (Indonesia, Malaysia, the Philippines, Singapore, Thailand, China, Taiwan, Korea, Japan and USA) and two exogenous countries (Hong Kong, HK; and rest of the world, ROW)[6]. Tables for the years 1990 and 1995 are composed of 78 production sectors, while the table for the year 2000 is composed of 76 production sectors. Therefore, we integrate the three tables into 63 production sectors for a comparative study[7].

3. Results

The calculated results for the TIR measures are shown in Table 1, which shows the induced sums of each country obtained by multiplying the TIR matrix by the final demand

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5   See Shresta, N. (2008) for a detailed description of the model.

6   There are three exogenous countries (HK, EU and ROW) in the table for the year 2000. To be consistent with the tables for years 1990 and 1995, we aggregated these into two exogenous countries (HK and ROW).

7   See Appendix 1for details of the production sectors.

of China from 1990 to 2000. From Table 1, we can see that the induced sums of each country increase from 1990 to 2000. The induced sums of Japan are largest, followed by those of ROW and the U.S.. However, in contrast to those of Japan, ROW and the U.S., the induced sums of Taiwan, Korea and ASEAN5 increase rapidly from relatively small initial value, respectively expanding by factors of 9.0, 27.2 and 5.6 from 1990 to 2000.

Table 1: Induced sums of each country based on China's final demand (100 billion dollars)

	1990	1995	2000
Indonesia	164.9	406.4	748.8
Malaysia	176.0	460.9	821.0
Philippines	18.1	49.1	190.1
Singapore	100.7	400.5	687.3
Thailand	65.9	319.4	510.3
Taiwan	394.2	964.4	3529.7
Korea	137.9	1668.9	3744.9
Japan	1808.9	6394.4	8373.6
USA	1430.0	3469.4	4612.9
ROW	1882.3	5290.9	7527.2
ASEAN5	525.5	1636.3	2957.5

Figure 2 shows the share of each country in the total induced sums based on China's final demand from 1990 to 2000. Although the shares of Japan, the U.S. and ROW are quite high, they decrease noticeably, whereas the shares of Taiwan and Korea increase significantly. This indicates a significant shift in China's imports of final goods away from Japan, the U.S. and ROW toward other Asian countries.

**Figure 2: Share of each country in total induced sums based on China's final demand**
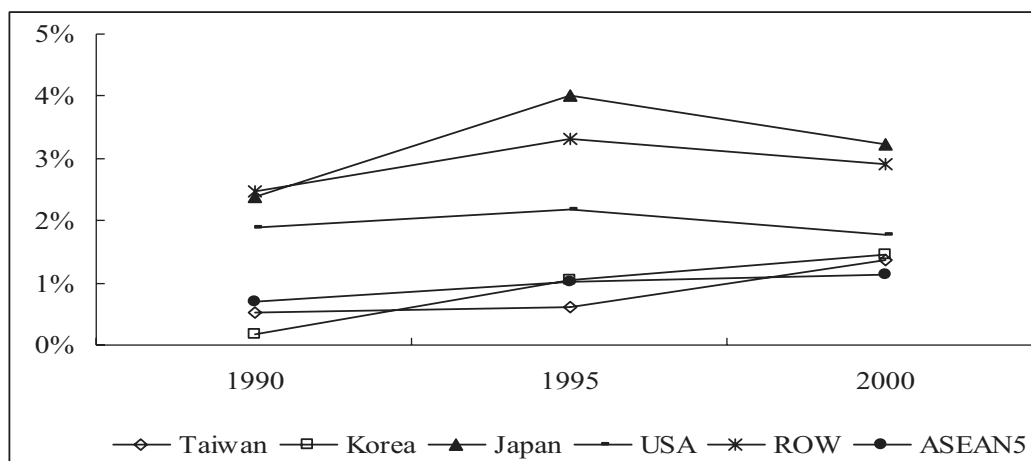
Results for the U.S. obtained by multiplying the TIR matrix with the final demand of the U.S. from 1990 to 2000 are shown in Table 2. The induced sums of ROW are the largest in 2000, followed by those of Japan and China. Although the induced sums of each country increase from 1990 to 2000, they do not show a rapid expansion comparable to those of China., which grew by a factor of 9.6 from 1990 to 2000.

Who benefits from the emerging China? An International Input-Output Approach

51

Table 2: Induced sums of each country based on U.S. final demand (100 billion dollars)

	1990	1995	2000
Indonesia	778.4	1523.5	2105.8
Malaysia	1000.6	2867.1	3391.6
Philippines	509.0	1188.9	1812.7
Singapore	1156.2	2464.2	2828.6
Thailand	813.7	1945.4	2665.2
China	1934.3	6552.0	18567.2
Taiwan	4373.3	4316.6	6919.1
Korea	3596.6	4868.5	7998.5
Japan	23220.3	32314.8	35890.6
ROW	17852.1	25830.4	43428.4
ASEAN5	4258.0	9989.1	12804.0

Figure 3 shows the share of each country in the total induced sums based on U.S. final demand. The shares of China and ROW increase, whereas Japan's share decreases. On the other hand, the shares of Taiwan, Korea and the ASEAN5 are fairly stable.

Figure 3: Share of each country in total induced sums based on USA final demand
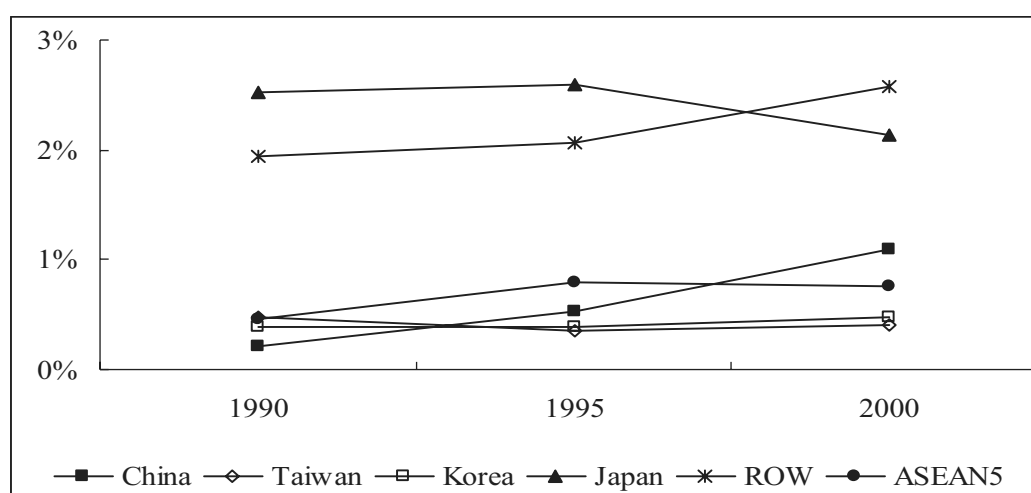

Comparing the induced sums of each country based on the final demand of the U.S. and that of China, we see that the induced sums of each country based on U.S. final demand are quite a bit larger than those for China. Hence, it seems unlikely that during this period China became a global economic locomotive that could replace the U.S. as a force promoting growth in Asian countries. However, the different trends regarding the share of each country in the total induced sums based on the final demands of the two countries indicate that China is becoming an extremely important market for Asian countries-especially for Korea, Taiwan and the ASEAN5- to which these countries export final goods and benefit accordingly.

As mentioned, while macro-level results give a broad picture for each country, they do not reveal other important aspects since various sectors are aggregated. Hence, we also examine our results at the industry-level in this paper. It is impractical to explain the features

of each individual industry classified in the IIO table, so we report on only three industries. This is sufficient to show how industry-level results differ from macro-level results.

Boilers, Engines and Turbines

Figure 4: Share of each country (Boilers, Engines and Turbines)
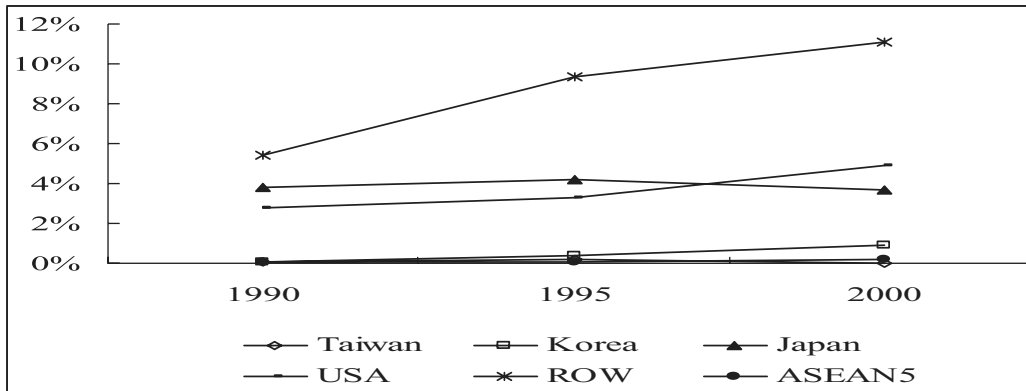
The share of each country in the total induced sums based on China's final demand for the boilers, engines and turbines industry is shown in Fig. 4. Japan's share is declining, whereas those of the U.S. and ROW are rising. Those of the ASEAN5 and Korea increase slightly. This shows that most of China's demand for imported products from the boilers, engines and turbines industry satisfied by countries outside East Asia during this period, prominently by the U.S. and ROW.

Heavy Electric Machinery

Figure 5: Share of each country (Heavy Electric Machinery)
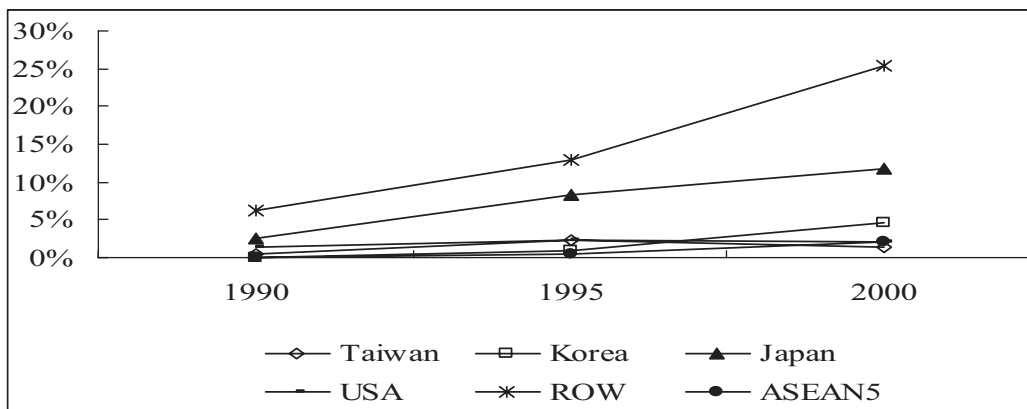

Figure 5 shows the share of each country for the heavy electric machinery industry. Here, we can see that the trend for each country is quite different from the macro-level results. The shares of Japan and ROW are high and rise sharply. As heavy electric machinery products are typically capital equipment, this trend is consistent with relocation of the production facilities of ROW and Japanese companies.

Electronics and Electronic Products

Figure 6: Share of each country (Electronics and Electronic Products)
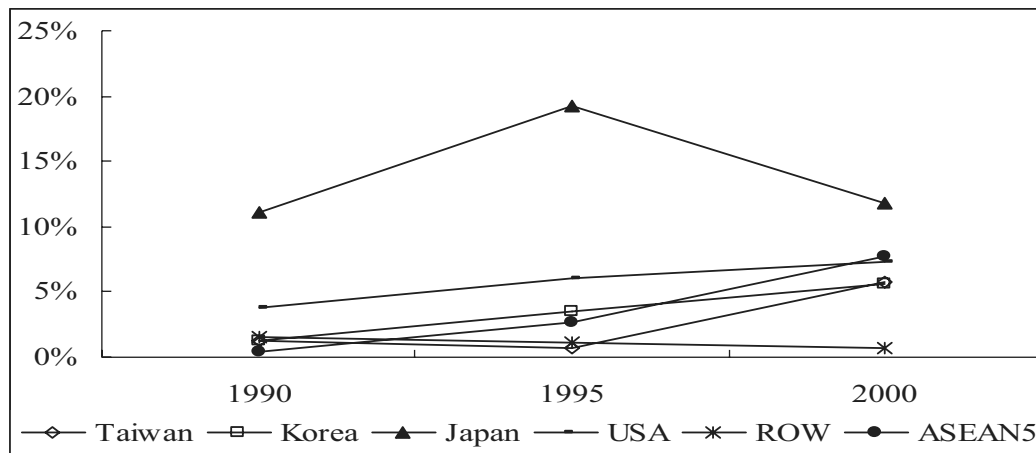
Unlike the results for the heavy electric machinery industry, those for the electronics and electronic products industry (Fig. 6) show Japan's share decreasing in the latter part of the period, whereas the shares of Taiwan, Korea and the ASEAN5 increase sharply. This indicates a significant shift in China's imports of consumption goods rather than capital goods away from Japan and toward other Asian countries, especially Taiwan and Korea. Moreover, similar trends can be seen in the pulp and paper industry, basic industrial chemicals industry, refined petroleum and its products industry, and iron and steel industries[8]. This also indicates from another aspect that the international division of labor improved during this period.

To sum up, we find that the expansion of China's final demand has had a positive economic effect on other Asian countries. Taiwan and Korea showed sharp gains in shares of both total induced effects and in sums. However, the share of each country in the total induced sums shows different trend at the industry-level. Japan had a high and increasing share in heavy industries, such as the heavy electric machinery and precision machines industry, whereas Taiwan, Korea and the ASEAN5 rapidly increased their shares in the electronics and electronic products, pulp and paper, and iron and steel industries.

Completing an Asian IIO table requires a huge amount of money, labor and time. Therefore, the publication of such tables is seriously delayed[9]. If some means of estimating more current input-output relationships could be determined, this would contribute significantly to economic analysis. Towards this end, Mori and Sasaki (2007) estimated an input coefficient matrix of the Asian IIO table for the year 2005 by applying the "Trade-RAS" method[10] to the published Asian IIO table for the year 2000. Here, we apply the estimated Asian IIO table for the year 2005 to our analysis to examine recent changes at the macro-

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8   See Appendix 2 for details.

9   The latest table (for the year 2000) was published in 2006.

10   This is developed by Okada and Takagawa (2004).

level[11].

      From Table 3, we can see that the induced sums of each country increase continuously from the year 2000, with those of ROW the largest in 2005, followed by those of Japan and Korea. From the rate of change, we can see that the ASEAN5, Taiwan and Korea increase rapidly, by respective factors of 12.7, 15.9 and 59.8 between 1990 and 2005. In addition, the induced sums of these countries approach or exceed those of the U.S.by 2005[12].

Table 3: Induced sums of each country based on China's final demand (100 billion dollars)

	2005		2005
Indonesia	1586.6	Taiwan	6266.4
Malaysia	1479.8	Korea	8247.7
Philippines	375.1	Japan	13694.8
Singapore	1914.6	USA	7997.8
Thailand	1329.8	ROW	18165.3
ASEAN5	6685.9		

      Concerning the share of each country in the total induced sums based on the respective final demand of the U.S. and China, we can see the ratios of the ASEAN5, Taiwan and Korea rise in China's case. In contrast, the ratios of these countries show a downward tendency or remain stable for the U.S.[13].

      Although the induced amount based on China's final demand is still small-just one third that of the U.S. in 2005- the different trends regarding the share of each country in the total induced sums based on the final demands of the two countries from 1990 to 2005 tell us that China is becoming an extremely important market for Asian countries, especially for Korea, Taiwan and the ASEAN5.

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11   Mori and Sasaki (2007) do not implement the Asian IIO analysis at the industry level. This is because the "Trade -RAS" method is known to achieve predictive accuracy only at the macro-level, and because complete industry data for the period 2000-2005 is not available for the East Asian countries.

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13   See Appendix 4 for details.

Conclusion

In this paper, we have examined the impact on Asian countries of China's expanding imports of final goods by using the International Input-Output (IIO) approach from 1990 to 2005. We found that the induced sums of Japan were largest at the macro-level. However, Japan's share was diminishing. Compared with the induced sums of Japan, the induced sums of Korea, the ASEAN5 and Taiwan were relatively small, but the shares of these countries were increasing, especially sharply for Taiwan and Korea. Our comparison of the different trends for the share of each country in the total induced sums based on the final demand of either the U.S. or China indicates that China is becoming an extremely important market for other Asian countries-especially Korea, Taiwan and the ASEAN5-to which these countries export final goods and significantly benefit. At the industry-level, our results show different trends for the share of each country in the total induced sums, demonstrating that the international division of labor improved during the period studied. For example, Japan had high and rising share in heavy industries, such as the heavy electric machinery and precision machines industry, while Taiwan, Korea and the ASEAN5 rapidly increased their shares in industries such as electronics and electronic products, pulp and paper, and iron and steel.

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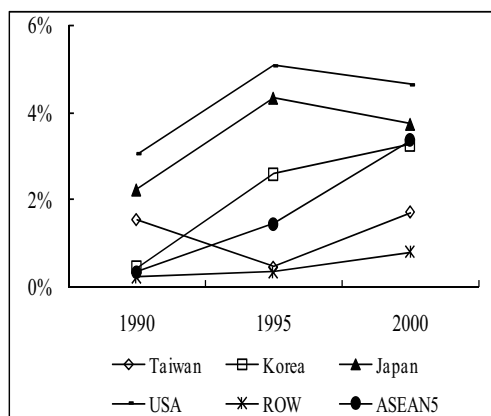
Appendix 1

Details of production sectors

| Code	Description	Code	Description	Code	Description
001	Paddy	022	Other made-up textile products	043	Metal products
002	Other grain	023	Leather and leather products	044	Boilers, Engines and turbines
003	Food crops	024	Timber	045	Ordinary and specialized machinery
004	Non-food crops	025	Wooden furniture	046	Heavy electric machinery
005	Livestock and poultry	026	Other wooden products	047	Electronics and electronic products
006	Forestry	027	Pulp and paper	048	Other electric machinery and appliance
007	Fishery	028	Printing and publishing	049	Motor vehicles
008	Crude petroleum and natural gas	029	Synthetic resins and fiber	050	Other transport equipment
009	Iron ore	030	Basic industrial chemicals	051	Shipbuilding
010	Other metallic ore	031	Chemical fertilizers and pesticides	052	Precision machines
011	Non-metallic ore and quarrying	032	Drugs and medicine	053	Other manufacturing products
012	Milled grain and flour	033	Other chemical products	054	Electricity, gas and water supply
013	Fish products	034	Refined petroleum and its products	055	Building construction
014	Slaughtering, meat products and dairy products	035	Plastic products	056	Other construction
015	Other food products	036	Tires and tubes	057	Wholesale and retail trade
016	Beverage	037	Other rubber products	058	Transportation
017	Tobacco	038	Cement and cement products	059	Telephone and telecommunication
018	Spinning	039	Glass and glass products	060	Finance and insurance
019	Weaving and dyeing	040	Other non-metallic mineral products	061	Education and research
020	Knitting	041	Iron and steel	062	Other services
021	Wearing apparel	042	Non-ferrous metal	063	Public administration and Unclassified

Appendix 2

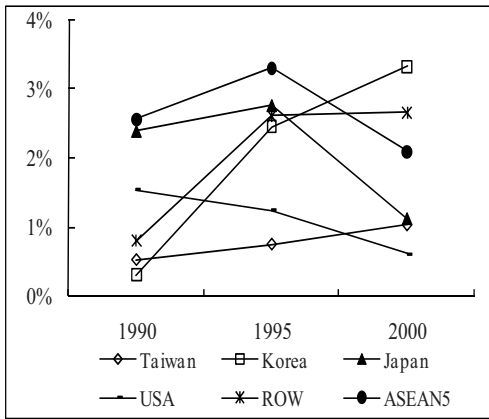### Share of each country in total induced sums based on China's final demand
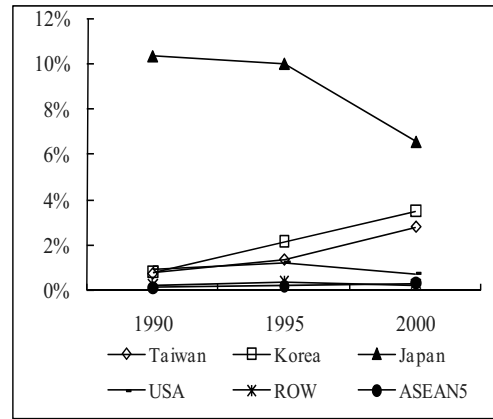
Pulp and Paper Industry

Basic Industrial Chemicals Industry
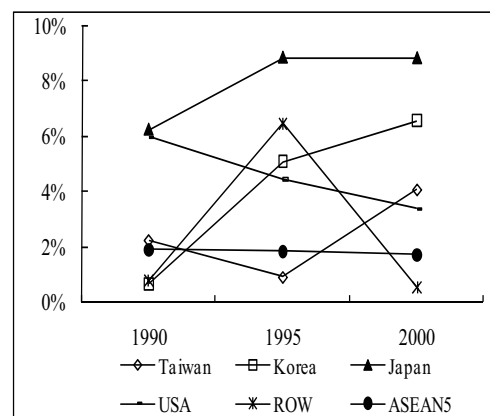
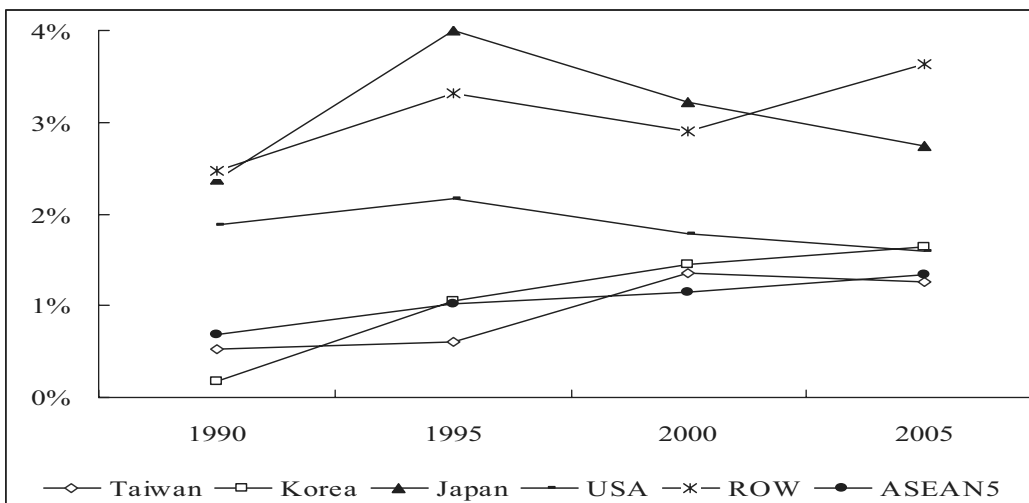**Refined Petroleum and its products Industry**

Iron and Steel Industry

Appendix 3

Induced sums of each country based on USA final demand (US 100 billion dollars)

	2005		2005
Indonesia	2915.3	Taiwan	39594.5
Malaysia	4734.9	Korea	8213.0
Philippines	2494.3	Japan	11457.1
Singapore	5134.2	USA	38733.8
Thailand	4329.0	ROW	74482.6
ASEAN5	19607.6		

Appendix 4

Share of each country in total induced sums based on Chinese final demand

Who benefits from the emerging China? An International Input-Output Approach

59

Share of each country in total induced sums based on USA final demand