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Abstract

This paper analyses the changing patterns of Japanese foreign direct investment (FDI) and the activities of Japanese multinational firms in different industries in China before and after the East Asian crisis in 1997 and 1998, and investigates changes in their impact on interdependence between China and Japan in the process of economic integration in East Asia. In order to analyse structural changes in international production linkages between the Chinese economy, Japanese multinational firms and the Japanese economy, we perform an input-output analysis on the basis of the recompilation of the *Asian International Input-output Tables* for 1995 and 2000, taking into account the activities of Japanese multinational firms in China. In particular, we examine the production-inducing effects of Japanese multinational firms and their contributions to value added in the Chinese economy in 1995 and 2000. Furthermore, the implication of structural changes in international production linkages promoted by the activities of Japanese multinational firms in China is investigated from the viewpoint of the industrial specificities of the production and transaction processes of Japanese multi-national firms in different manufacturing industries.

1. Introduction

Japanese foreign direct investment (FDI) is one of the most important driving forces of economic integration and structural change in the East Asian economy as it promotes the evolution of international production linkages. In particular, Japanese FDI has acquired greater importance in interdependence between China and Japan recently. Japanese FDI increased in the mid-1990s, as the Japanese economy experienced an appreciation of the yen. When the East Asian crisis occurred in 1997 and 1998, it fell very sharply. After the crisis, Japanese FDI in China soon recovered, and has continued to increase. This increasing trend of FDI and production activities of Japanese multinational firms has made international production linkages much stronger between China and Japan.

The aim of this paper is to analyse the changing patterns of Japanese FDI and the activities of Japanese multinational firms in different industries in China before and after the East Asian crisis, and to investigate changes in their impact on interdependence between China and Japan in the process of economic integration in East Asia. In order to analyse international production linkages, we make an analysis of international input-output tables, taking into account the activities of Japanese multinationals in China, and we examine the production-inducing effects of Japanese multinationals on the Chinese economy. Furthermore, the implication of increasing international production linkages promoted by the activities of Japanese multinationals in China is investigated from the viewpoint of the production and transaction processes of Japanese multinational firms. In this regard, the following three points are specifically addressed.

Firstly, we investigate the diversity and evolution of the activities of Japanese multinationals in different industries in China in different periods. Many researchers have analysed the positive impact of FDI on the Chinese economy both theoretically and empirically.[1] However, there are few studies on the industrial specificities of Japanese FDI. In this paper we analyse the dynamic effects of Japanese FDI and the activities of Japanese multinationals on the Chinese economy, especially focusing on their industrial specificities. Furthermore, we analyse different patterns which Japanese

[1] For example, Huang (2001) suggested that FDI induced economic growth in China, introducing advanced operation and management practices. Liu and Song (1997) argued that FDI promoted economic growth in China via its influence on demand and supply conditions as well as firm strategies. Zhang (1999) and Sun (1998) found bidirectional causation between FDI and economic growth, and Zhang (2001) showed that the impact of FDI on growth increased in China.

FDI exhibited before and after the East Asian crisis.

Secondly, we undertake an input-output analysis to investigate the international production linkages between Japanese multinationals and the Chinese economy. The input-output analysis has the special advantage of taking account of intermediate inputs and backward linkages from a macroeconomic point of view. In particular, the analysis is very useful in examining international production linkages. For example, Hasebe (2002) analysed the independence of production between East Asian countries, based on the *Asian International Input-Output Table* (1985, 1990, and 1995). Takagawa and Okada (2004) developed the analysis of the interdependence of the Asian-Pacific economy on the basis of the *Asian International Input-Output Table* (2000) which they originally estimated. Many researchers have analysed the impact of Japanese multinationals on the Chinese economy, but research based on the international input-output analysis has not been developed sufficiently. In this situation, Yamada's studies are considered as pioneering ones to analyse the activities of Japanese multinationals in the framework of the international input-output analysis (Yamada(2001), (2002) and (2004)).[2] In this paper, we will analyse changes in the impacts of Japanese multinationals on the Chinese economy on the basis of a comparison between the *Asian International Input-Output Tables* for 1995 and 2000, following the theoretical framework developed by Yamada.

Thirdly, the implications of structural changes in international production linkages are explored by analysing the behaviours and organizations of Japanese firms in the manufacturing sector.[3] Especially as for Japanese multinationals in the electrical machinery and transportation equipment industries in China, Fujimoto and Shintaku (2005) emphasised that the impacts of the "modularisation" of components in products on the local procurement of Japanese multinationals are different between these

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[2] Yamada(2001) analysed the interdependence between the Japanese, Asian and US economies and the impact of Japanese multinationals on the Asian and US economies, based on the *Asian International Input-Output Table* for 1990, and Yamada(2002) also carried out significant research to recompile the *US-Japan International Input-Output Table* into three parts: Japan, US, and Japanese multinationals, and to analyse their interdependence. Yamada (2004) recompiled the *Asian International Input-Output Table* for 1995 and analysed the interdependence between Japanese overseas activities, the Japanese, Asian and US economies. Wang (2004) analysed the impact of the activities of Japanese multinationals on the Chinese economy, following the theoretical framework developed by Yamada.

[3] For example, Kiyota, Matsumura, Urata and Wei (2005) examined the determinants of backward linkages of Japanese overseas affiliates, focusing on local procurements, and found that the length of operation had positive impacts on the local procurements of the affiliates in Asian counties. Furthermore, it is suggested that the greater local sales orientation leads to the higher local procurements in the textile, general machinery, electrical machinery and transportation machinery industries.

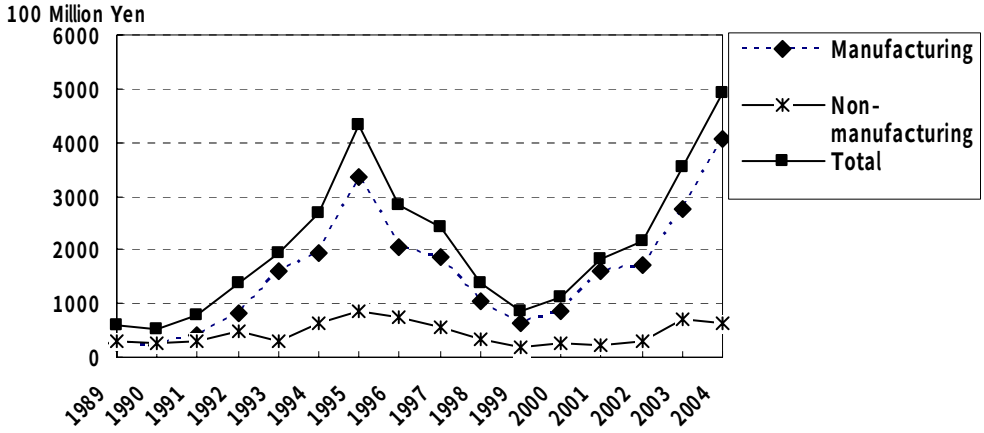
industries. In this paper we discuss recent structural changes in international production linkages which are promoted by the activities of Japanese multinationals in China from such aspects as the evolution of production and transaction processes of Japanese multinationals in the different manufacturing industries in the process of economic integration (Isogai, Ebizuka and Uemura (2000), Uemura (2004).

2. Japanese FDI and the Activities of Japanese Multinationals in China

2.1 Historical Trend of Japanese FDI in China

First of all, we will overview the historical trend of Japanese FDI in the different industries in China in recent years. As FDI is influenced very much by financial conditions, Japanese FDI was affected by the East Asian crisis in 1997 and 1998. In particular, it has shown different patterns in the different industries before and after the East Asian crisis. The different patterns of Japanese FDI are shown in FIGURE 1a, FIGURE1b and FIGURE1c. [4]

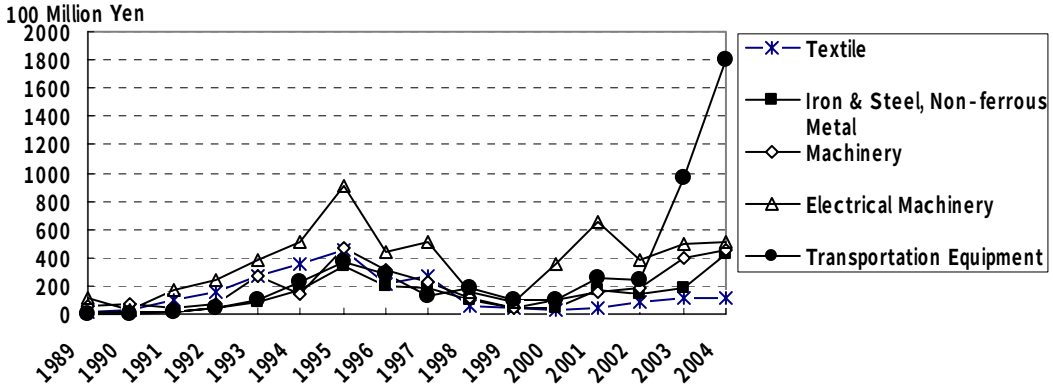
FIGURE 1a. Japanese FDI in China



Source: Ministry of Finance(Japan), *Foreign Direct Investment.*

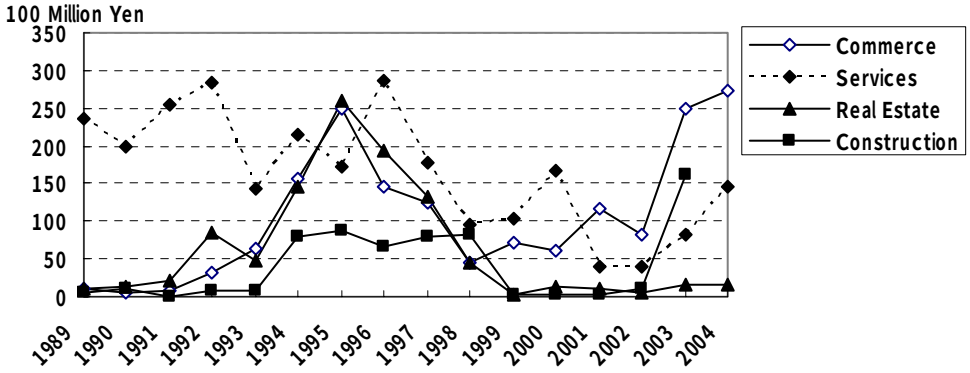
[4] The data are from the Ministry of Finance, *Foreign Direct Investment.* This data is reporting-based, and is often larger than the actual amount of Japanese FDI. In Figure 1a, Hong Kong is excluded in the data of China even after 1997.

FIGURE 1b. Japanese FDI in China (Manufacturing)



Source: Minstry of Finance(Japan), *Foreign Direct Investment*

FIGURE 1c. Japanese FDI in China (Non-manufacturing)



Source: Ministry of Finance(Japan), *Foreign Direct Investment*

As we can see in FIGURE 1a-c, Japanese FDI has fluctuated very largely in the manufacturing industry since the late 1980s. In fact, it increased very much in the 1994 and 1995, when the Japanese economy was faced with an appreciation of the yen. In particular, Japanese FDI increased very remarkably in electrical machinery and transportation equipment in the manufacturing sector and commerce and real estate in the non-manufacturing sector. When the East Asian crisis occurred in 1997 and 1998, Japanese FDI declined very sharply in most of the industries. The number of new projects approved in each year continued to decrease, and the contracted FDI became lower than that in the early 1990s. Especially, Japanese FDI dropped very dramatically in real estate and commerce, because it was influenced very much by difficult financial conditions in the East Asian crisis.

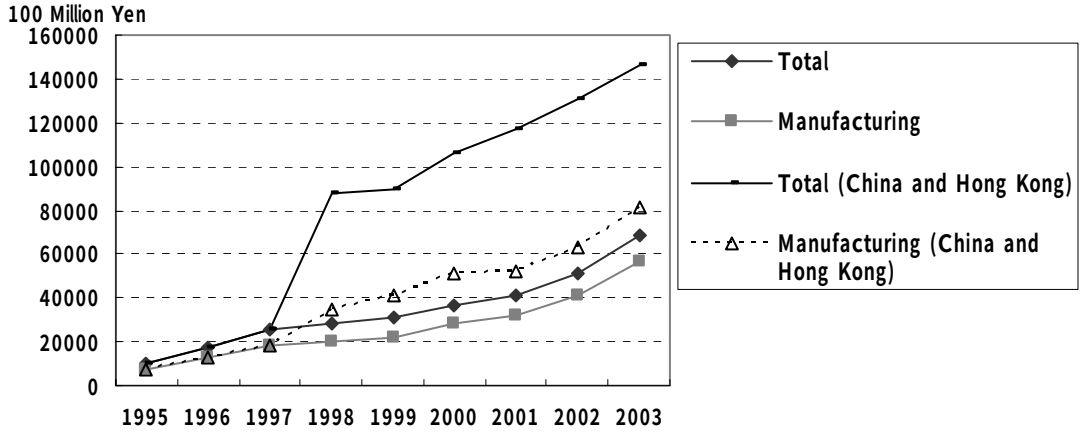
Japanese FDI started to recover in the manufacturing sector in 2000, and it has continued to grow since then. The remarkable growth of Japanese FDI is seen in transportation equipment, and this explains the considerable part of the increase in

Japanese FDI in the manufacturing sector in China after 2000. Japanese FDI in electrical machinery started to recover in 2000, but dropped in 2002, being influenced by the recession in the electrical machinery industry. In the non-manufacturing sector, the recovery in commerce was also very remarkable from 2003, but Japanese FDI has remained at a low level in other non-manufacturing industries.

2.2 Activities of Japanese Multinationals in China

The sales activities of Japanese overseas affiliates in China are examined below.[5] The sales of Japanese overseas affiliates slowed after the East Asian crisis, but they started to recover soon after, as seen in FIGURE 2a. If we include the sales in Hong Kong in the data, the slow down was more severe in the Asian economic crisis because of a decrease in the non-manufacturing sector in Hong Kong in the East Asian crisis. The trends of the sales of Japanese overseas affiliates are diversified in different industries in China, as seen in FIGURE 2b. The sales of transportation equipment have been growing continuously since the mid-1990s, supported by the expansion of Chinese domestic demand which was not affected so much by the East Asian crisis. The sales of iron and steel as well as textile have stayed at a low level. Commerce dropped in 1999, as it was influenced by the East Asian crisis. Electrical machinery was not affected so much by the East Asian crisis, but it dropped very sharply in 2001 and 2002, influenced by the collapse of the IT boom.

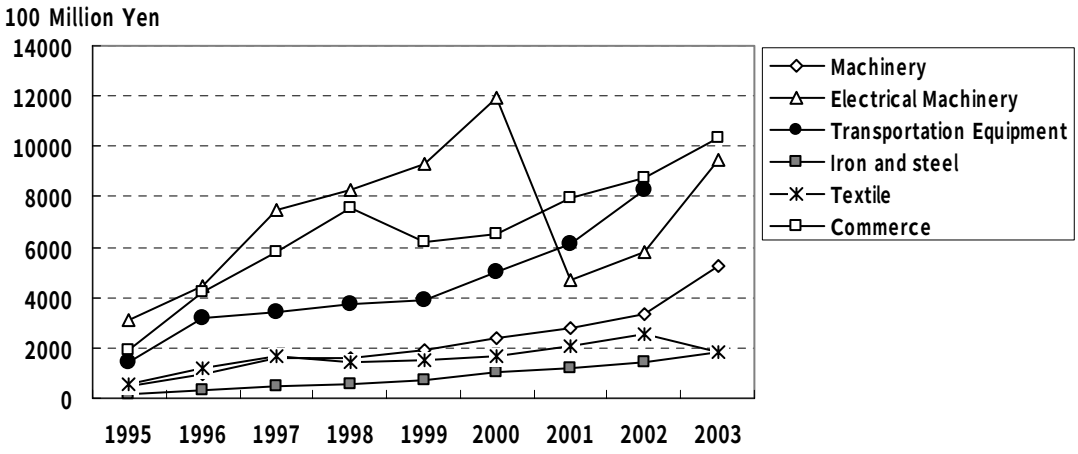
FIGURE 2a The Sales of Japanese Overseas Affiliates in China



Source: METI, *Basic Survey on Overseas Business Activities*

[5] We use the METI, *Basic Survey on Overseas Business Activities*. We can have data on the sales in China excluding Hong Kong, but we cannot have the data on the current profits/sales ratio and the procurement ratio of Japanese overseas affiliates in China.

FIGURE2b. The Sales of Japanese Overseas Affiliated in China (industries)

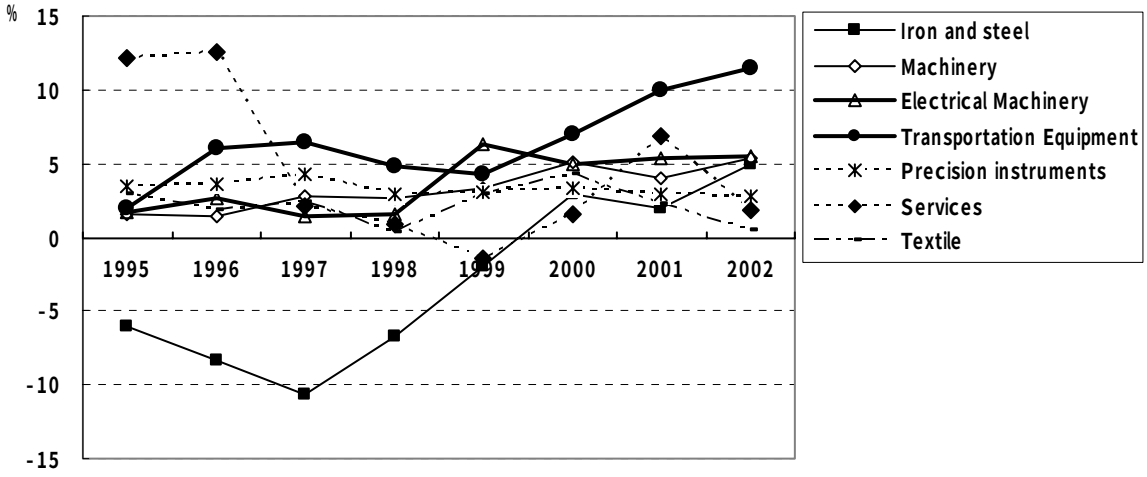


Source: METI, *Basic Survey on Overseas Business Activities*

2.3 Profitability of Japanese Multinationals in China

Behind the large fluctuation of Japanese FDI, there have been changes in the profitability of Japanese overseas affiliates in China since the mid-1990s. The diversified trends of the current profit/sales ratio of Japanese overseas affiliates in the different industries in China are shown in FIGURE 3.

FIGURE 3. Current Profit/Sales Ratios of JMNs in China



Source: METI, *Basic Survey on Overseas Business Activities.*

The current profit-sales ratios of Japanese overseas affiliates decreased very sharply in iron and steel in the manufacturing sector as well as services in the non-manufacturing sector in the East Asian crisis in1997 and 1998. On the contrary, the current profit-sales ratio of Japanese overseas affiliates in transportation equipment

was relatively stable in the late 1990s, and grew remarkably in the early 2000s. In electrical machinery, the current profit-sales ratio rose in 1999, but was stagnant because of the IT recession at the beginning of the 2000s.

2.4 Local Procurements of Japanese Multinationals in China

Local procurement is one of the most important factors to promote international production linkages and the transformation of the "value-chain" of production and transaction processes. Local procurement ratio is defined as the share of local intermediate inputs to total costs. The local procurement ratios of Japanese overseas affiliates in China have gradually increased in recent years, but there are also diversified trends in the different industries, as shown in TABLE 1 and FIGURE 4.

The local procurement ratios of Japanese overseas affiliates in machinery and transportation equipment were relatively high in 1995, and they have been increasing gradually at a high level. The high and stable local procurement ratio of transportation equipment is very impressive. On the contrary, there has been a remarkable change in the local procurement ratio in electrical machinery since the middle of the 1990s. In fact, the local procurement ratio of Japanese overseas affiliates in transportation equipment was 43.3%, while that in electrical machinery was 18.7% in 1995. Therefore, there was a very big gap of local procurements between those two industries in the middle of the 1990s. However, the local procurement ratio has gradually increased in the electrical machinery industry in recent ten years, and the gap has disappeared completely. Behind this change in the production and transaction processes of Japanese electrical machinery firms, there seems to be the transformation of "value chains" in those firms and the growth of Chinese suppliers. Especially, the "modularisation" of components in products promoted the open procurements of electrical machinery firms, and that this also increased the local procurement of Japanese multinationals in the electrical machinery industry in China (Fujimoto and Shintaku (2005)).

The local procurement ratio of Japanese overseas affiliates in textiles also increased rapidly in the second half of the 1990s. Then, the ratio fell in 2000, and recovered a little from 2000 to 2002. The local procurement ratio of Japanese overseas affiliates in iron and steel has been gradually decreasing with some fluctuations. This is rather exceptional to the increasing trend of the local procurement ratios in the manufacturing industries.

We will see what industries Japanese overseas affiliates procure components and materials from in Section 4, in which we will investigate the input coefficients of

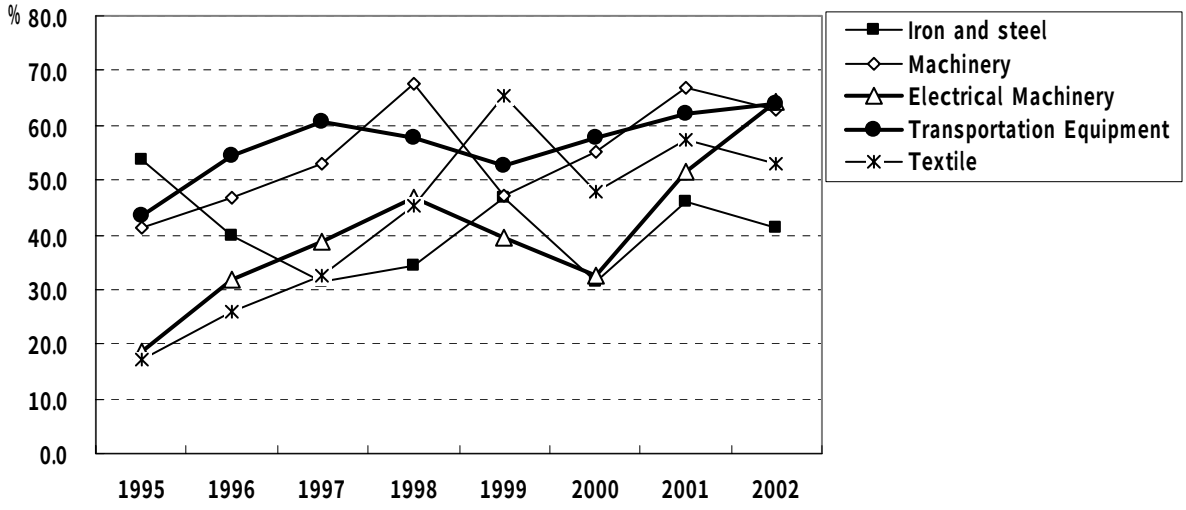
Japanese overseas affiliates in different industries in the manufacturing sector in China.

TABLE 1 Local Procurement Ratios of JMNs in China

	1995	1996	1997	1998	1999	2000	2001	2002
Total	34.1	38.8	43.9	47.7	45.3	40.0	42.4	43.7
Manufacturing (Total)	29.1	40.3	45.4	51.1	45.8	42.8	50.7	48.8
Food	94.1	97.7	98.1	92.3	79.8	84.7	83.7	80.8
Textile	17.0	26.0	32.4	45.3	65.3	48.0	57.3	52.8
Wood and Pulp	63.5	37.2	34.3	56.3	82.7	84.8	x	95.7
Chemical Products	65.1	46.8	68.1	50.9	53.1	59.7	52.9	53.0
Oil and Coal	9.0	3.7	81.4	26.0	18.0	x	x	91.9
Iron and steel	53.8	39.9	31.4	34.4	46.6	31.4	45.9	41.1
Non-ferrous Metals	71.3	30.6	24.2	53.5	49.0	79.4	64.0	30.2
Machinery	41.3	46.9	52.9	67.6	47.2	55.3	66.9	62.8
Electrical Machinery	18.7	31.7	38.7	46.6	39.4	32.6	51.4	64.4
Information and Communication Machinery	x	x	x	x	x	x	37.5	36.1
Transportation Equipment	43.3	54.5	60.7	57.6	52.5	57.7	62.1	64.1
Precision Instruments	14.9	8.0	36.9	39.8	50.3	52.3	49.8	30.6
Other Manufacturing	x	x	x	x	x	x	55.0	55.9
Non-manufacturing (Total)	x	x	x	x	x	x	33.5	37.3
Agriculture	95.2	94.9	91.4	76.8	86.3	x	x	82.3
Mining	100.0	x	85.7	92.2	88.2	x	x	x
Construction	99.9	x	75.7	100.0	91.9	97.1	94.3	99.9
Transportation and Communication	x	x	x	x	x	x	79.5	92.6
Wholesale and Retail Trade	58.0	23.9	39.2	38.2	39.0	34.2	31.9	35.8
Services	72.1	84.2	23.7	85.5	82.9	46.1	85.9	39.4
Other non-manufacturing	x	x	x	x	x	x	x	99.9

Source: METI, *Basic Survey on Overseas Business Activities.*

FIGURE 4 Local Procurement Ratios



Source: METI, *Basic Survey on Overseas Business Activities*

3. International Production Linkage of Japanese Multinationals in China: An Input-Output Analysis

3.1 Recompilation of the China-Japan Input-Output Table

A. Recompilation Procedure

The input-output analysis has the special advantage of taking account of intermediate inputs and backward linkages from the viewpoint of macroeconomic input-output structures. In particular, an international input-output table describes the interdependent structures of transactions between industries among particular countries. In order to analyse structural changes in international production linkages, we recompile the China-Japan international input-output table into three parts: China, Japanese multinationals (JMNs) and Japan, and make a comparative analysis of the input-output tables for 1995 and 2000. We analyse changed in the impact of the activities of JMNs on interdependence between the Chinese and Japanese economies before and after the East Asian crisis.

In the recompilation of the China-Japan International Input-Output Table to include Japanese multinationals (JMNs), we extract the intermediate demand between China, JMNs, and Japan. Then, we formulate a new input-output table consisting of three parts: China, JMNs, and Japan. This basic framework of recompilation procedures was originally developed by Yamada (2002). The main procedures of recompilation are summarized as follows (also Figure 5).

(1) Compilation of 16-sector I-O of JMNs for 1995
(2) Estimation of Input-output structures of JMNs
(3) Estimation of value added structures of JMNs
(4) Estimation of international freight and insurance of JMNs
(5) Compilation of export vectors of JMNs
(6) Recompiling the I-O table and re-adjustment

In FIGURE 5, the first column of the recompiled China-JMNs-Japan I-O table shows the input structure of each industrial sector in China. The second column shows the input structure of each industrial sector in JMNs. The third column shows the input structure of each industrial sector in Japan. The fourth and fifth columns show the final demands from China and Japan respectively. The sixth column shows the exports from China, JMNs and Japan to the rest of the world. The seventh column is the statistical discrepancies generated in the process of recompiling the China-JMNs-Japan I-O Table. More detailed recompilation procedures in our analysis are seen in the Appendix.

FIGURE 5 China-JMNs-Japan I-O Table

China, JMNs and Japan I-O Table		Intermediate Demand			Final Demand		Export	Discre-pancy	Total Output
		China	JMNs	Japan	China	Japan			
Intermediate Inputs	China	x_{ij}^{CC}	x_{ij}^{CM}	x_{ij}^{CJ}	F_i^{CC}	F_i^{CJ}	E_i^C	D_i^C	X_i^C
	JMNs	x_{ij}^{MC}	x_{ij}^{MM}	x_{ij}^{MJ}	F_i^{MC}	F_i^{MJ}	E_i^M	D_i^M	X_i^M
	Japan	x_{ij}^{JC}	x_{ij}^{JM}	x_{ij}^{JJ}	F_i^{JC}	F_i^{JJ}	E_i^J	D_i^J	X_i^J
International Freight & Insurance		B_j^C	B_j^M	B_j^N	BF_C	BF_J			
Import		C_j^C	C_j^M	C_j^J	CF_C	CF_J			
Tariffs		T_j^C	T_j^M	T_j^J	TF_C	TF_J			
Value added		V_j^C	V_j^M	V_j^J					
Total Output		X_j^C	X_j^M	X_j^J					

Source: Yamada (2002) with author's revision.

x_{ij}^{rs} - The intermediate input of the product of sector *i* of country *r* (China JMNs or Japan) used by the industry *j* of country *s* (China, JMNs or Japan).

F_i^{rs} - The product of sector *i* of country *r* (China, JMNs or Japan) used by the final demand of country *s* (China, JMNs or Japan).

E_i^r - Export vector of country *r* to the rest of the world excluding country *s* (China, JMNs or Japan).

X_i^r - Total output of the sector *i* of I country *r* (China, JMNs or Japan).

B_j^r BF_r - The international freight and insurance costs of country *r* (China, JMNs or Japan) deducted from intermediate inputs and final demand.

C_j^r CF_r - Import vectors of intermediate input and final demand of country *r* from the rest of the world excluding country *s* (China, JMNs or Japan).

T_j^r TF_r - Total import duty and tax vectors of country *r* (China, JMNs or Japan).

V_j^r - The value added of sector *i* of country *r* (China, JMNs or Japan).

X_j^r - Total input of industry j of country *r* (China, JMNs or Japan).

B. Data Sources

The *Asian International Input-Output Table*: The China-Japan I-O tables (1985, 1990, 1995 and 2000) can be obtained from the *Asian International Input-Output Table* by Institute of Developing Economies (IDE) in Japan.

METI, *Basic Survey on Overseas Business Activities*: This survey is the most commonly cited statistics on the activities of Japanese overseas affiliates. The Ministry of Economy, Trade and Industry (METI) provides the data of investment position, sales,

procurements and profits of Japanese overseas affiliates by industry and host region.[6]

JASME, (*Survey on Activities of Japanese Small and Medium Enterprises in China*):JASME (Japan Finance Corporation for Small and Medium Enterprise) conducts a survey of Japanese business activities in China from 2000. The data covers JASME's 903 clients in China in 14 manufacturing and 3 non-manufacturing industries. Compared with METI's survey, the coverage and reliability might have a problem, but JASME survey gives us important information on intermediate input relations between JMNs in China by industries. This data provides us with where the inputs come from, i.e., local Chinese firms, JMNs themselves or the multinationals in China.

3.2. Industrial Classification

In the METI, *Basic Survey on Overseas Business Activities*, the data on the activities of Japanese overseas affiliates are aggregated into twelve industries in the manufacturing sector and six industries in non-manufacturing sector. METI's survey provides the data of 18 sectors, and the *Asian International Input-Output Table* (2000) provided by Takagawa and Okada (2004) has 19 sectors (electrical machinery is included into "machinery"). Therefore, we use the 16-sector classification here. The original China-Japan I-O tables (1995) have 78 sectors and 19 sectors, but we have to integrate them into a 16 sectors in our analysis. [7] TABLE 2 shows the sector classification of our new I-O tables.

TABLE 2 New Industrial Classification

1	Agriculture	9	Iron and Steel
2	Mining	10	Machinery
3	Food	11	Transportation Equipment
4	Textile	12	Construction
5	Wood and Pulp	13	Wholesale and Retail Trade
6	Chemical	14	Public Services
7	Petroleum and Coal	15	Other Services
8	Non-Ferrous Metals	16	Others

[6] The response rates of METI's survey are about 60%, which is a limitation of the data. In fact, the response rate was 60.4% in 1995 and 62.9% in 2000.

[7] In the input-output analysis in this paper, "electrical machinery" is not classified as a independent sector, but it is included in "machinery", because we use the *Asian International Input-Output Table:24 Sectors*(2000). We will make another input-output analysis, setting "electrical machinery" as a sector in the classification on the basis of the *Asian International Input-Output Table:78 Sectors*(2000).

3.3. Theoretical Framework of International Input-output Analysis

In our study, we use the theoretical framework of input-output analysis which was originally developed by Yamada (2001, 2002) so that we can illustrate how production in the Chinese economy is promoted by the production activities of JMNs which are located in China.

We construct an International I-O Table with three parts: China, JMNs, and Japan, using the following notations, X_1:Chinese production X_2:the production of JMNs, X_3: Japanese production. A typical input-output model with these three parts can be written as follows.

$$\begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} F_{11} \\ F_{21} \\ F_{31} \end{bmatrix} + \begin{bmatrix} F_{13} \\ F_{23} \\ F_{33} \end{bmatrix} + \begin{bmatrix} E_1 \\ E_2 \\ E_3 \end{bmatrix} = \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} \tag{1}$$

Where, A_{12} , A_{22} , A_{32} represent the input coefficient matrices of JMNs, $A_{21}X_1$, $A_{22}X_2$, $A_{23}X_3$ represent the sales of intermediate goods of JMNs respectively. F_{21} represents the sales of final goods of JMNs in Chinese markets, F_{23} represents the export of final goods from JMNs to Japan, and E_2 represents the export of final goods of JMNs to the other countries.

A. Induced Production by Unit Change in Final goods Production

Equation (1) can be rewritten as follows.

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} I - A_{11} & -A_{12} & -A_{13} \\ -A_{21} & I - A_{22} & -A_{23} \\ -A_{31} & -A_{32} & I - A_{33} \end{bmatrix}^{-1} \left\{ \begin{bmatrix} F_{11} \\ F_{21} \\ F_{31} \end{bmatrix} + \begin{bmatrix} F_{13} \\ F_{23} \\ F_{33} \end{bmatrix} + \begin{bmatrix} E_1 \\ E_2 \\ E_3 \end{bmatrix} \right\} \tag{2}$$

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{bmatrix} \left\{ \begin{bmatrix} F_{11} \\ F_{21} \\ F_{31} \end{bmatrix} + \begin{bmatrix} F_{13} \\ F_{23} \\ F_{33} \end{bmatrix} + \begin{bmatrix} E_1 \\ E_2 \\ E_3 \end{bmatrix} \right\} \tag{3}$$

Note that the final demand is described as follows,

$$F_{11}+F_{13}+E_1=F_C \quad F_{21}+F_{23}+E_2=F_M \quad F_{31}+F_{33}+E_3=F_J$$

F_C denotes the supply of final goods by China, F_M denotes the supply of final goods by JMNs, and F_J denotes the supply of final goods by Japan.

With newly defined F_C, F_M, F_J, equation (3) can also be rewritten as follows.

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{bmatrix} \begin{bmatrix} F_C \\ F_M \\ F_J \end{bmatrix} \tag{4}$$

Thus, with equation (4), we can investigate how much production is induced by a unit change in final goods supply in different sectors.

B. Relative Contribution to Each Additional Final Goods Production

To calculate the induced value added by an additional unit production of JMNs, we need to multiply a diagonal matrix with value added ratios $\hat{v}$ with the induced-production coefficient vector.

$$\begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} \hat{v}_1 & 0 & 0 \\ 0 & \hat{v}_2 & 0 \\ 0 & 0 & \hat{v}_3 \end{bmatrix} \begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{bmatrix} \begin{bmatrix} F_C \\ F_M \\ F_J \end{bmatrix}, \quad \hat{v} = \begin{bmatrix} \hat{v}_1 & 0 & 0 \\ 0 & \hat{v}_2 & 0 \\ 0 & 0 & \hat{v}_3 \end{bmatrix} \tag{5}$$

Moreover, induced import from the ROW(the rest of the world) can also be calculated by multiplying a diagonal matrix with import ratios A_R with the induced-production coefficient vector.

$$\begin{bmatrix} M_{R1} \\ M_{R2} \\ M_{R3} \end{bmatrix} = \begin{bmatrix} A_{R1} & 0 & 0 \\ 0 & A_{R2} & 0 \\ 0 & 0 & A_{R3} \end{bmatrix} \begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{bmatrix} \begin{bmatrix} F_C \\ F_M \\ F_J \end{bmatrix}, \quad A_R = \begin{bmatrix} A_{R1} & 0 & 0 \\ 0 & A_{R2} & 0 \\ 0 & 0 & A_{R3} \end{bmatrix} \tag{6}$$

From the cost components of the input-output model, the following equation can be obtained.

$$\begin{aligned} &\begin{bmatrix} l & l & l \end{bmatrix} \begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix} + \begin{bmatrix} l & l & l \end{bmatrix} \begin{bmatrix} A_{R1} & 0 & 0 \\ 0 & A_{R2} & 0 \\ 0 & 0 & A_{R3} \end{bmatrix} \\ &+ \begin{bmatrix} l & l & l \end{bmatrix} \begin{bmatrix} \hat{v}_1 & 0 & 0 \\ 0 & \hat{v}_2 & 0 \\ 0 & 0 & \hat{v}_3 \end{bmatrix} = \begin{bmatrix} l & l & l \end{bmatrix} \end{aligned} \tag{7}$$

where l is a vector whose components are one. Thus, the sum of the value added and import can also be obtained as follows.

$$
\begin{aligned}
&[\,\hat{i} \quad \hat{i} \quad \hat{i}\,]\left\{\begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} + \begin{bmatrix} M_{R1} \\ M_{R2} \\ M_{R3} \end{bmatrix}\right\} \\
&= [\,\hat{i} \quad \hat{i} \quad \hat{i}\,]\left\{\begin{bmatrix} \hat{v}_1 & 0 & 0 \\ 0 & \hat{v}_2 & 0 \\ 0 & 0 & \hat{v}_3 \end{bmatrix} + \begin{bmatrix} A_{R1} & 0 & 0 \\ 0 & A_{R2} & 0 \\ 0 & 0 & A_{R3} \end{bmatrix}\right\}\begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{bmatrix}\begin{bmatrix} F_C \\ F_M \\ F_J \end{bmatrix} \\
&= [\,\hat{i} \quad \hat{i} \quad \hat{i}\,]\left\{\begin{bmatrix} I & 0 & 0 \\ 0 & I & 0 \\ 0 & 0 & I \end{bmatrix} - \begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix}\right\}\begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{bmatrix}\begin{bmatrix} F_C \\ F_M \\ F_J \end{bmatrix} \\
&= [\,\hat{i} \quad \hat{i} \quad \hat{i}\,]\begin{bmatrix} F_C \\ F_M \\ F_J \end{bmatrix}
\end{aligned}
\tag{8}
$$

Equation (8) shows that the sum of induced value added and induced import equals to the sum of the additional final demand F_C, F_M and F_J. Applying equation (8) can help us to calculate each part's contributions to the additional final goods production by summing them up for China, JMNs, and Japan.

3.4. Results of the Analysis

A. Share of JMNs in Production in each Industry in China

Before performing the input-output analysis, we report the relative share of JMNs in production in each industry in China in 1995 and 2000. The production of JMNs increased very rapidly in China during the 1990s. Accordingly, the share of JMNs has risen continuously, although the Chinese economy has achieved rapid economic growth at the same time.

As we can see in TABLE 3, the share of JMNs in production shows a large increase from 0.43%, 2.20%, 2.83%, 0.77% to 0.74%, 3.81%, 4.00%, 2.47% in the textile, machinery, and transportation equipment, wholesale and retail trade industries, respectively. Therefore, production in those industries in China has been promoted very much by Japanese FDI in China. Especially, the share of JMNs in production in the transportation equipment industry increased very much from 1995 to 2000, supported by the vigorous FDI of JMNs with increasing profitability which was seen in Section 2. Therefore, Japanese FDI has acquired greater importance in the machinery and transportation equipment industries in China recently. On the contrary, shares increased relatively little from 0.56%, 0.29% to 0.69%, 0.49% in the chemical, iron and steel industries, respectively.

TABLE 3 The Share of JMNs in Production in China

$1,000

	1995	Production in China(including JMNs)	Production of JMNs	The Share of JMNs
1	Agriculture	243,563,223	155,477	0.06%
2	Mining	57,339,982	4,640	0.01%
3	Food	128,324,490	165,151	0.13%
4	Textile	136,979,090	582,701	0.43%
5	Wood & pulp	46,521,066	29,034	0.06%
6	Chmeical	100,209,788	560,054	0.56%
7	Petroleum & Coal	31,667,384	20,337	0.06%
8	Non-Ferrous Metals	71,478,146	52,814	0.07%
9	Iron & Steel	66,278,940	194,726	0.29%
10	Machinery	191,125,091	4,203,568	2.20%
11	Transportation Equipment	53,406,511	1,512,369	2.83%
12	Construction	178,698,366	29,554	0.02%
13	Wholesale and Retail Trade	153,463,690	1,180,942	0.77%
14	Public Service	37,729,526	0	0.00%
15	Other Service	198,404,776	98,086	0.05%
16	Others	179,330,784	304,307	0.17%

	2000	Production in China(including JMNs)	Production of JMNs	The Share of JMNs
1	Agriculture	311,929,221	203,749	0.07%
2	Mining	96,223,763	0	0.00%
3	Food	180,359,772	782,518	0.43%
4	Textile	208,902,146	1,542,498	0.74%
5	Wood & pulp	66,582,193	194,859	0.29%
6	Chmeical	188,765,743	1,300,084	0.69%
7	Petroleum & Coal	95,985,424	26,130	0.03%
8	Non-Ferrous Metals	76,764,869	666,976	0.87%
9	Iron & Steel	196,524,815	955,303	0.49%
10	Machinery	377,896,055	14,384,690	3.81%
11	Transportation Equipment	117,346,364	4,692,400	4.00%
12	Construction	267,648,902	53,985	0.02%
13	Wholesale and Retail Trade	245,646,262	6,068,071	2.47%
14	Public Service	183,488,595	0	0.00%
15	Other Service	389,068,238	469,750	0.12%
16	Others	108,009,683	2,208,871	2.05%

Source: METI, ***Basic Survey on Overseas Business Activities***

B. Induced Production by Unit Change in Final Goods Production

Production in the Chinese industries is induced by an increase in final goods production of JMNs in China, which is driven by the demand for the products of JMNs in each industry in China. To investigate the production-inducing effect by a unit change in the final goods production of JMNs in different industries in China, we calculate the "Leontief inverse" of the input matrices of the China-JMNs-Japan I-O tables for 1995 and 2000. In particular, we analyse coefficients in the Leontief inverse matrices for 1995 and 2000, which are shown in TABLE 4.

TABLE 4 Subtotals of Column Values in the Leontief Inverse Matrix

--Changes in Final Demand for JMNs--

1995				
		CHINA	**JMNs**	**JAPAN**
Final Goods Production of JMNs	Food	1.27	1.03	0.08
	Textile	0.24	1.02	0.99
	Wood and Pulp	0.88	1.03	0.47
	Chemical	1.21	1.05	0.06
	Petroleum and Coal	0.81	1.01	0.01
	Non-Ferrous Metals	0.96	1.09	0.35
	Iron and Steel	1.45	1.04	0.06
	Machinery	0.26	1.03	0.64
	Transportation Equipment	0.67	1.06	0.94
2000				
		CHINA	JMNs	JAPAN
Final Goods Production of JMNs	Food	0.91	1.09	0.02
	Textile	0.81	1.05	0.52
	Wood & Pulp	1.24	1.08	0.19
	Chemical	0.88	1.04	0.43
	Petroleum and Coal	0.91	1.00	0.17
	Non-Ferrous Metals	1.22	1.02	0.29
	Iron and Steel	0.51	1.03	0.72
	Machinery	0.69	1.06	0.62
	Transportation Equipment	0.81	1.04	0.90

Figure 6a The Production-inducing Effect of JMNs on China

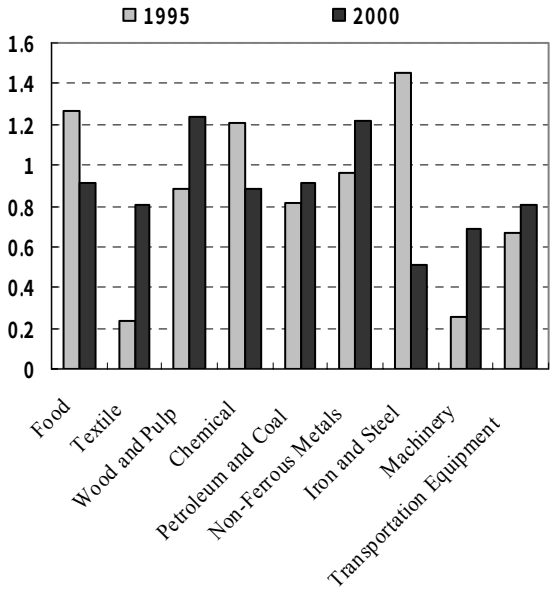
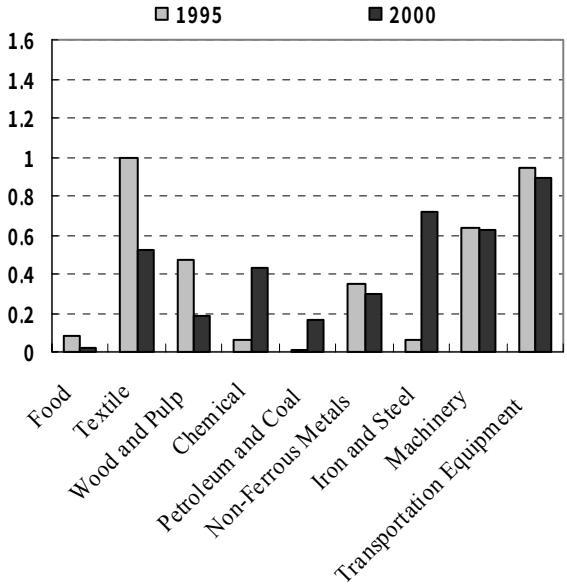


Figure 6b The Production-inducing Effect of JMNs on Japan



In TABLE 4, FIGRE 6a and FIGURE 6b, we can make the following observations. Firstly, in 1995, a unit increase in the final goods production of JMNs in iron and steel, food, chemical, non-ferrous metals, wood and pulp, and transportation equipment had a

significant impact on the Chinese economy, with the values of 1.45, 1.27, 1.21, 0.96, 0.88 and 0.67 units, respectively. The production-inducing effects of JMNs in machinery and textile were limited and one unit increase in final goods production of JMNs in these industries results in 0.26, and 0.24 units change, respectively.[8]

Secondly, in 2000, a unit increase in the final goods production of JMNs in wood and pulp, and non-ferrous metals had a relatively significant impact on China with the values of 1.24 and 1.22 units, respectively. The production-inducing effects of JMNs in textile, transportation equipment, and machinery became sufficiently strong with the values of 0.81, 0.81 and 0.69, respectively. Taking into account the considerable increase in the production of JMNs in the textile, transportation equipment, and machinery industries in China, their impact on China is great. On the contrary, the production-inducing effects of JMNs in iron and steel was small on China in 2000.

Thirdly, JMNs in food, wood and pulp, petroleum and coal, and non-ferrous metals with higher production-inducing effects on China seem to have a cooperative purchasing relationship with local firms and strong backward linkages in China. The production-inducing effects of JMNs in machinery and textile were very limited in 1995, and JMNs in those industries purchased a small amount of raw materials and components from local firms in China. However, the production-inducing effects increased in machinery and textile from 1995 to 2000, that is, from 0.26, 0.24 to 0.48, 081, respectively. In other words, the backward linkages of JMNs became much stronger in machinery and textile. On the contrary, the production-inducing effects on China decrease in food, chemical, and iron and steel from 1995 to 2000, that is, from 1.27, 1.21, 1.45 to 0.91, 0.88, 0.51, respectively.[9]

Fourthly, the production-inducing effects of JMNs in transportation equipment on the Japanese economy were very strong in both 1995 and 2000. This can be explained by the large amount of induced export of machinery goods and the components of transportation equipment from Japan to China. However, the effect slightly declined in transportation equipment from 1995 to 2000. The production-inducing effect decreased remarkably in the textile industry from 1995 to 2000. The effect on exports from Japan to China, which is typically seen in the transportation equipment industry, is often called "induced-export effect". We will investigate it in more detail in Section 4.[10]

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[8] Wang(2004) analysed the production-inducing effects of JMNs in China, recompiling the *Asian International Input-Output Table* (1995) with the sector classification of "electrical machinery" as a industrial sector, and found that the production-inducing effects of JMNs in transportation equipment was much stronger than that in electrical machinery in 1995.

[9] The operation of JMNs was very preliminary in both chemical, and iron and steel in 1995, and this seems to be reflected in the sharp decline in the production-inducing effects of JMNs on China.

[10] As for the explanation of "induced export effect", see Yamada (2002).

C. Relative Contributions of JMNs to Value Added

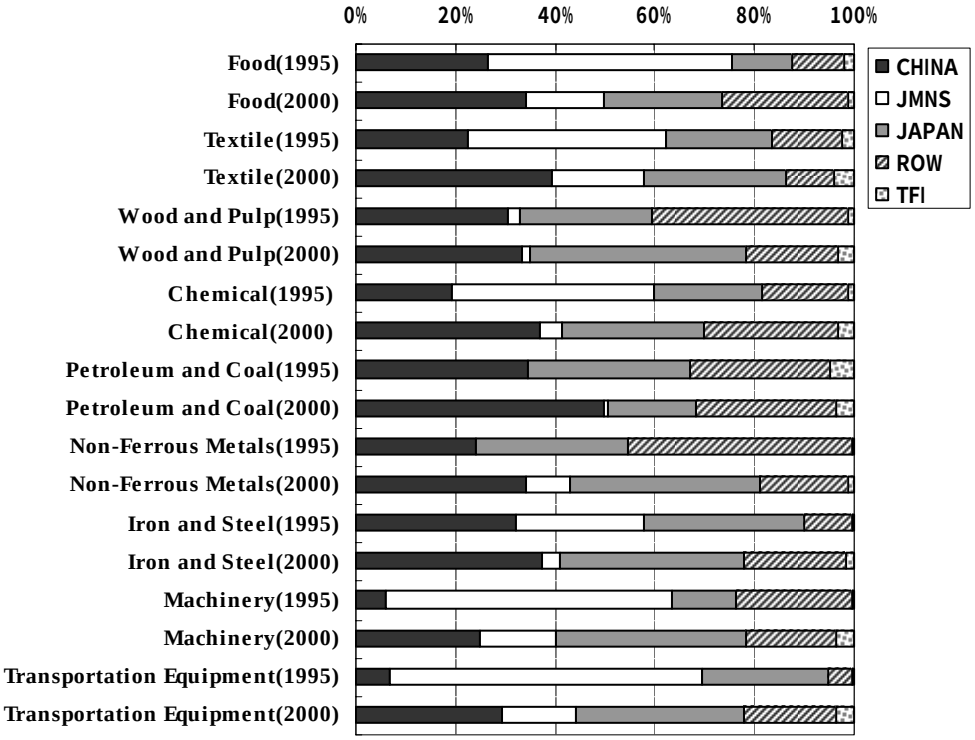
The results of relative contributions to final goods production of equation (8) are presented in TABLE 5 and FIGURE 7. This shows the distribution of the effects of an additional increase in the final goods production of JMNs in each sector, which falls into the categories of the value added of three parts (China, JMNs, and Japan), import from ROW, and the cost of freight and insurance.

TABLE 5 Relative Contributions to Final Goods Production

1995							
		CHINA	JMNS	JAPAN	ROW	TFI	TOTAL
Final Goods Production of JMNs	Food	26.54	49.07	11.92	10.54	1.93	100.00
	Textile	22.37	40.00	21.33	14.01	2.29	100.00
	Wood and Pulp	30.35	2.67	26.58	39.32	1.08	100.00
	Chemical	19.08	40.92	21.51	17.18	1.31	100.00
	Petroleum and Coal	34.48	0.20	32.30	28.36	4.66	100.00
	Non-Ferrous Metals	24.19	0.06	30.20	45.01	0.55	100.00
	Iron and Steel	32.13	25.68	32.30	9.47	0.41	100.00
	Machinery	6.08	57.40	12.97	23.07	0.47	100.00
	Transportation Equipment	6.95	62.33	25.41	4.89	0.42	100.00
2000							
		CHINA	JMNS	JAPNA	ROW	TFI	TOTAL
Final Goods Production of JMNs	Food	34.03	15.97	23.32	25.47	1.20	100.00
	Textile	39.48	18.38	28.31	9.93	3.90	100.00
	Wood and Pulp	33.38	1.52	43.48	18.23	3.39	100.00
	Chemical	37.14	4.25	28.31	27.24	3.06	100.00
	Petroleum and Coal	49.86	0.81	17.75	28.07	3.51	100.00
	Non-Ferrous Metals	34.31	8.56	38.37	17.67	1.09	100.00
	Iron and Steel	37.32	3.70	37.00	20.39	1.59	100.00
	Machinery	24.89	15.29	38.05	17.99	3.78	100.00
	Transportation Equipment	29.29	15.08	33.61	18.52	3.50	100.00

Note: ROW represents the rest of the world, and TFI represents tariff, freight and insurance.

FIGURE 7 Relative Contributions to Final Goods Production



In TABLE 5, we can make the following observations on the results. Firstly, in 1995, significant contribution of JMNs in petroleum and coal, iron and steel, wood and pulp, and food to the value added in the Chinese economy was seen with the values of 34.48, 32.13, 30.35 and 26.54, respectively. JMNs in textile, chemical, transportation equipment, and machinery were very small sources of value added contribution to the Chinese economy. They generated only 22.37, 19.08, 6.95, and 6.08, respectively.

Secondly, in 2000, significant contribution of JMNs in petroleum and coal , textile, iron and steel, and chemicals to the value added in the Chinese economy was seen with the values of 49.86, 39.48, 37.32, and 37.14, respectively. JMNs in machinery and transportation equipment were relatively small sources of value added contributions to the Chinese economy, though the contribution increased very remarkably in machinery and transportation equipment, exhibiting 24.89 and 29.29, respectively.

Thirdly, JMNs in the industries with the high contribution of valued added to the Chinese economy seem to have a strong backward linkages in China. JMNs in the industries with low contribution of value added to the Chinese economy, such as textiles, and machinery, had weak backward linkages with local firms in China, and they were very small sources of value added contribution to the Chinese economy in 1995. However, the contribution of JMNs in those industries to the China economy increased remarkably from 1995 to 2000. This means that the activities of Japanese multinationals have obtained stronger backward linkages with local firms in China, and have increasingly contributed to the formation of value added in the Chinese economy.

4. Changes in International Production Linkages and Japanese Firms

4.1 Investigation of Input Structures of Japanese Multinationals

In order to consider structural changes in international production linkages between China, Japanese multinationals and Japan in the East Asian economic integration, we investigate thoroughly changes in input structures of JMNs, comparing the input coefficients of the three-part input-output tables for 1995 and 2000, which is shown in TABLE 6. The input coefficients of JMNs represent the structures of "value chain" of production and transaction processes of Japanese multinational firms in China.

Firstly, the input coefficients of JMNs in the textile industry are relatively high from the agriculture, textile, chemical, and wholesale and retail industries in China. This shows that JMNs in the textile industry purchase a large amount of materials from local material producers and traders in China. Furthermore, the input coefficients of JMNs in the textile industry increased considerably from local firms in the textile

industry and wholesale and retail traders in China from 1995 to 2000.

TABLE 6 Changes in Input Coefficients from 1995 to 2000

		JMNs							
		Textile		Iron & Steel		Machinery		Transportation Equipment	
		1995	2000	1995	2000	1995	2000	1995	2000
CHINA	1 Agriculture	0.02294	0.02227	0.00019	0.00010	0.00054	0.00008	0.00253	0.00012
	2 Mining	0.00019	0.00001	0.06687	0.00636	0.00002	0.00203	0.00001	0.00134
	3 Food	0.00063	0.01552	0.00122	0.00019	0.00006	0.00003	0.00027	0.00000
	4 Textile	0.04510	0.21958	0.00469	0.00043	0.00254	0.00212	0.01486	0.00391
	5 Wood & Pulp	0.00080	0.00152	0.00228	0.00118	0.00050	0.00566	0.00198	0.00198
	6 Chemical	0.01173	0.01546	0.00786	0.00154	0.00101	0.01226	0.00200	0.00443
	7 Petroleum & Coal	0.00021	0.00006	0.05046	0.02497	0.00007	0.00498	0.00062	0.00473
	8 Non-Ferrous Metals	0.00028	0.00002	0.01661	0.00211	0.01314	0.00516	0.05486	0.00203
	9 Iron & Steel	0.00012	0.00051	0.22406	0.14118	0.00079	0.05890	0.03344	0.04377
	10 Machinery	0.00159	0.00003	0.05932	0.00125	0.06440	0.10094	0.03749	0.04213
	11 Transportation Equipment	0.00010	0.00000	0.00776	0.00000	0.00005	0.00402	0.05263	0.13891
	12 Construction	0.00031	0.00000	0.00804	0.00000	0.00000	0.00048	0.00000	0.00038
	13 Wholesale and Retail Trad	0.01271	0.03447	0.04023	0.01272	0.01583	0.01850	0.02993	0.01518
JMNs	1 Agriculture	0.00000	0.00333	0.00000	0.00001	0.00000	0.00001	0.00000	0.00001
	2 Mining	0.00000	0.00000	0.00000	0.00095	0.00000	0.00039	0.00000	0.00015
	3 Food	0.00002	0.00232	0.00004	0.00003	0.00000	0.00001	0.00001	0.00000
	4 Textile	0.01455	0.03281	0.00151	0.00006	0.00082	0.00040	0.00479	0.00043
	5 Wood & Pulp	0.00003	0.00023	0.00008	0.00018	0.00002	0.00108	0.00007	0.00022
	6 Chemical	0.00122	0.00231	0.00082	0.00023	0.00010	0.00234	0.00021	0.00049
	7 Petroleum & Coal	0.00001	0.00001	0.00271	0.00373	0.00000	0.00095	0.00003	0.00053
	8 Non-Ferrous Metals	0.00010	0.00000	0.00584	0.00032	0.00462	0.00098	0.01927	0.00023
	9 Iron & Steel	0.00000	0.00008	0.00693	0.02110	0.00002	0.01122	0.00103	0.00486
	10 Machinery	0.00032	0.00000	0.01123	0.00019	0.02321	0.01923	0.01405	0.00468
	11 Transportation Equipment	0.00001	0.00000	0.00102	0.00000	0.00001	0.00077	0.00692	0.01543
	12 Construction	0.00000	0.00000	0.00000	0.00000	0.00000	0.00009	0.00000	0.00004
	13 Wholesale and Retail Trad	0.00150	0.00515	0.00473	0.00190	0.00186	0.00352	0.00352	0.00169
JAPAN	1 Agriculture	0.00117	0.00022	0.00000	0.00005	0.00009	0.00000	0.00005	0.00001
	2 Mining	0.00000	0.00001	0.00009	0.00000	0.00000	0.00004	0.00001	0.00000
	3 Food	0.00000	0.00058	0.00000	0.00057	0.00090	0.00000	0.00049	0.00000
	4 Textile	0.25923	0.09999	0.00000	0.00086	0.00153	0.00099	0.00115	0.00268
	5 Wood & Pulp	0.00065	0.01020	0.00000	0.00446	0.00350	0.00005	0.00114	0.00003
	6 Chemical	0.14522	0.03271	0.00012	0.00465	0.00515	0.01797	0.00497	0.00913
	7 Petroleum & Coal	0.00477	0.00237	0.00035	0.00729	0.00095	0.00031	0.00089	0.00045
	8 Non-Ferrous Metals	0.00154	0.00027	0.00170	0.00401	0.02071	0.00852	0.01254	0.00304
	9 Iron & Steel	0.00000	0.00171	0.00462	0.21029	0.01172	0.04365	0.01725	0.05390
	10 Machinery	0.00000	0.00329	0.00000	0.00921	0.13967	0.17337	0.02969	0.08776
	11 Transportation Equipment	0.00000	0.00087	0.00000	0.00127	0.00085	0.00001	0.21683	0.17045
	12 Construction	0.00000	0.00185	0.00000	0.00513	0.00203	0.00000	0.00122	0.00000
	13 Wholesale and Retail Trad	0.06127	0.04356	0.00102	0.04651	0.04385	0.03081	0.03389	0.03691

Note: Shadow indicates more than 0.01.

Secondly, the input coefficients of JMNs in the iron and steel industry from petroleum and coal, and machinery industries in China decreased very much from 1995 to 2000. On the contrary, the input coefficients of JMNs in the iron and steel industry were high from the iron and steel industry itself in both China and Japan. The strong intra-industrial production linkages between firms are the remarkable specificity of the iron and steel industry.

Thirdly, the change in the input coefficients of JMNs in the machinery industry arouses great interest, because it implies changes in the behaviours and organizational architectures of Japanese machinery firms. The input coefficients from the iron and steel, and machinery industries in China as well as those from the iron and steel, and machinery in Japan increased remarkably from 1995 to 2000. This is a change in the input-output structures of JMNs in the machinery industry behind the increase in their local procurements which we have seen in Section 2.

Fourthly, the input coefficients of JMNs in the transportation equipment industry from the iron and steel, machinery, and transportation equipment, and wholesale and retail trade industries in China were very high and stable in both 1995 and 2000. The input coefficients of JMNs in the transportation equipment industry from JMNs within the same industry became higher from 1995 to 2000, and this showed that JMNs have been increasingly supported by subcontractors or related firms which are shifted to China. It is also very important that the export of iron and steel as well as machinery goods from Japan to JMNs in China increased very much from 1995 to 2000. This means that the "induced export effect" of the operation and plant investment of JMNs has increased in the transportation equipment industry in China.

4.2 Evolution of Japanese Multinational Firms behind Increasing International Production Linkages

In order to understand structural changes in international production linkages in the East Asian economic integration, we investigate them from the viewpoint of the industrial specificities of the "value chain" of production process as well as the behaviours of Japanese multinational firms. The interpretation of the changes in international production linkages of Japanese multinationals is given from the viewpoint of the institutional analysis of the Japanese firm system.[11] The summary of the analysis is shown in TABLE 7.

The backward linkages of Japanese multinationals in the transportation equipment industry were much stronger than those in the electrical machinery and textile industries in 1995. Correspondingly, Japanese multinationals in the transportation equipment industry had stronger production-inducing effects on the Chinese economy. The production process is highly integrated in the transportation equipment industry, so production has been supported by subcontractors and related firms which not only

[11] As for relevant researches on the Japanese firm as a system, see Aoki and Dore (1994). Aoki (2001) also summarizes the recent development of the theoretical framework of "comparative institutional analysis".

remain in Japan but also transfer their plants to China. In the transportation equipment, especially, car industry, the production process is not easily modularised, so Japanese multinational firms have kept the high and stable level of local procurements, supported by the activities of subcontractors which transfer their plants to China. Furthermore, the market strategy of Japanese multinational firms was "Chinese-market-oriented" in the transportation equipment industry, so they developed strong ties with their subcontractors and local firms, supported by the expansion of the Chinese market and their high profitability which was seen in Section 2.

TABLE 7 Interpretation of International Production Linkages -From the Institutional Point of View-

		Japanese Multinationals (JMNs) in China			
		Textile	**Iron and Steel**	**Machinery (especially Electrical Machinery)**	**Transportation Equipment**
Backward Linkages	**CHINA**	Increasing local procurements, the purchase of materials from agriculture and commercial sectors	Low local procurements, and decreasing production-inducing effect	Increasing local procurements and increasing production-inducing effects from the late 1990s	Profitable operation with high local procurements and strong production-inducing effects
	JMNs	Purchasing materials from JMNs within the textile industry	Purchasing materials from JMNs within the iron and steel industry	Increasing open procurements and weakened production linkages between JMNs	Transfer of subcontractors' plants to China
	JAPAN	Decreasing procurements from domestic plants in Japan	Little import of manufactured goods from Japan	Import of components from related firms in Japan	Induced-export effect from Japanese subcontractors and steel producers
Industrial Specificities of Institutional Architectures		Spinning and manufacturing processes depend on low wage workers	The process industry with big centralized plants	Increasing modularization of products, but some integrated production processes remain, Export market-oriented originally, but increasingly Chinese market-oriented	Integrated production process with subcontractor networks (Just-in-time), Chinese market-oriented

In the machinery, especially, electrical machinery industry, assembly lines were transferred to China, but a lot of the components were procured from their subcontractors or related firms in Japan in the mid-1990s. This was caused by the specific characters of the electrical machinery industry that production and transaction processes are integrated into a "vertical value chain". However, the design rules of electrical products, for example, PC and VTR, have been "modularised" in the 1990s.[12] Accordingly, the local procurements of Japanese multinationals in the electrical

[12] As for the "architecture" of manufacturing firms in China, see Fujimoto and Shintaku (2005). The original idea of design rules and "modularization" was presented by Baldwin and Clark (2000).

machinery industry have rapidly increased in China, and this has produced stronger production-promoting effects and has created more value-added in the Chinese manufacturing industry. As for the behaviour of electrical machinery firms, the market strategy of those firms was "export-oriented" in the mid-1990s, but it has been shifted gradually to "Chinese-market-oriented" recently. This has also promoted the local procurements of electrical machinery firms in China.[13]

On the contrary, in Japan, the creation of value added has been diminished very much in the manufacturing and assembly processes in electrical machinery plants, and business has been shifted to the design department as well as the solution department in Japan. Accordingly, the decrease in value added creation in the manufacturing and assembly processes in the "value chain" causes the restructuring of firm organisation and a reduction in manufacturing workers in electrical machinery firms in Japan.[14] In this sense, there is asymmetry in value-added creation between electrical machinery firms in Japan and Japanese multinationals in China. The creation of value added has decreased in manufacturing and assembly processes in Japan, while the manufacturing and assembly plants of Japanese multinationals in China have increasingly promoted the value-added creation in the Chinese manufacturing industry.

5. Conclusions

As structural changes in international production linkages in economic integration process are caused by interactions between the behaviours of firms and the evolution of macroeconomic structures, we have analysed the changes, focusing on international input-output structures and the production and transaction processes of Japanese firms. The results of our analysis are summarised as follows.

Firstly, Japanese FDI in China reached a peak in the mid-1990s, and fell sharply in the East Asian crisis. Then, it recovered, and has subsequently increased with different patterns in different industries. Japanese FDI has fluctuated in the manufacturing sector, affected by the East Asian crisis. Japanese FDI has grown remarkably with high profitability in the transportation equipment industry after the crisis. Japanese FDI in the electrical machinery industry also started to recover in 2000, but it dropped

[13] As for the relationship between market strategy and local procurement, see Wang (2004), and Kiyota, Matsumura, Urata and Wei (2005). In our international input-output analysis, we don't check changes in the backward linkages of electrical machinery firms before and after the collapse of the IT boom because of the limitation of the data.

[14] Uemura (2004) analyses the effects of changing value chains in electrical machinery firms on the employment system on the basis of a questionnaire survey. The change also affects the boundary of firm in the electrical machinery industry. As for the dynamic theory of the boundary of firm, see Langlois (1995).

with the sharp decline in sales in the collapse of the IT boom in 2002. In the non-manufacturing sector, the sales of Japanese multinationals in commerce dropped very much with a decrease in profitability in the East Asian crisis.

Secondly, international production linkages have become deeper and wider, promoted by Japanese multinationals. In particular, the local procurement ratios of Japanese multinationals have increased in China. The procurement ratios were high in the transportation equipment industry in the mid-1990s, while they were very low in the electrical machinery and textile industries. However, the local procurement ratios have risen in those industries, and according to our international input-output analysis, the intermediate inputs of Japanese multinationals from local firms have also increased in China. The production-inducing effect of Japanese multinationals in the transportation equipment industry was larger than that in the machinery industry in 1995, but the effect increased in the machinery industry from 1995 to 2000. Namely, the backward linkages of Japanese multinationals have increased considerably in the machinery, especially electrical machinery, industry in China behind the East Asia crisis.

Thirdly, different backward linkages of Japanese multinationals between different industries imply the industrial specificities of "value chain" of Japanese firms. The backward linkages of Japanese multinationals in the transportation equipment industry were stronger than those in the electrical machinery industry in China in the mid-1990s. In the electrical machinery industry, assembly lines were shifted to China with the procurement of components from subcontractors in Japan, because production processes were still vertically integrated. However, with the modularisation of electrical products, the local procurements of Japanese multinationals have rapidly increased in the electrical machinery industry. In the transportation equipment industry, production processes have continued to be integrated, so the level of local procurements has been stable with the shift of Japanese subcontractors' plants to China. International production linkages will be stronger, promoted by the activities of Japanese multinationals. This will determine the evolution of the production and transaction processes of Japanese firms as well as the growth pattern of the Chinese manufacturing industry in the process of economic integration in East Asia.

Appendix

The detailed procedure of recompiling the China-Japan Input-output table is as follows.

Step 1: Estimation of the Total Input Values of JMNs

For JMNs in China, total inputs and value added of each sector are estimated by multiplying production value by the coefficient of the corresponding sector of China or Japan. Whether to use the coefficient of corresponding sector of China or Japan depends on the technological level of JMNs. Here, a survey of the technological level of JMNs in China by sectors from the 26th METI survey will be used as our empirical evidence. TABLE 8 is the technological level survey by METI. For JMNs whose technological levels are shown to be the same as Japan, the coefficient of the corresponding sector of Japan is used, while the coefficient of China is used for the rest of the sectors.

TABLE 8 Comparison of Technological Levels Between JMNs and Japan

Technological Level	Same	Lower	Total
Agriculture	13 (72.2)	5 (27.8)	18 (100.0)
Mining	1 (100.0)	- (-)	1 (100.0)
Food	21 (63.6)	12 (36.4)	33 (100.0)
Textiles	89 (64.0)	50 (36.0)	139 (100.0)
Wood & Pulp	4 (44.4)	5 (55.6)	9 (100.0)
Chemical Products	37 (67.3)	18 (32.7)	55 (100.0)
Iron & Steel	16 (88.9)	2 (11.1)	18 (100.0)
Non-ferrous Metals	4 (44.4)	5 (55.6)	9 (100.0)
General Machinery	14 (37.8)	23 (62.2)	37 (100.0)
Electric Machinery	65 (53.7)	56 (46.3)	121 (100.0)
Transport Equipment	17 (34.7)	32 (65.3)	49 (100.0)
Precision instruments	5 (26.3)	14 (73.7)	19 (100.0)
Petroleum & Coal	- (-)	1 (100.0)	1 (100.0)
Other Manufacturing	42 (53.2)	37 (46.8)	79 (100.0)
Construction	5 (83.3)	1 (16.7)	6 (100.0)
Commerce	5 (62.5)	3 (37.5)	8 (100.0)
Services	5 (55.6)	4 (44.4)	9 (100.0)
Others	1 (50.0)	1 (50.0)	2 (100.0)

Source: METI, *The 26th Basic Survey on Overseas Business Activities* (1998)

Step 2: Estimation of the Value Added Coefficients of JMNs

In this research, the value added coefficient of each sector is based on the new estimated input coefficient. The value added coefficient of wood & pulp and iron & steel is adjusted by information from the METI data to make sure the coverage of the firms more accurate, and these revised data are used in the recompilation work.

Step 3: Estimation of the Inputs and Value Added Values of JMNs

For JMNs in China, total inputs and value added of each sector are estimated by multiplying production value by the newly defined input coefficient and value added coefficient in the previous step. Then, with the procurement ratios by region from the METI survey, we divide total input into three regions: China, Japan and ROW. The METI survey provides us the portion of purchases of raw materials, parts and semi-finished products, and merchandise of each sector in the term of local procurement, imports from Japan and ROW. We estimate input values by multiplying total input by the procurement ratio. Thereafter, we divide the input values into values by sector, using the input coefficient estimated in step 1.[15]

Step 4: Separation of Activities of JMNs from China

Subtracting the value of each input and value added of JMNs from the corresponding values of China, we estimate the value of those of non-JMNs activities in China.

Step 5: Separation of Inputs from JMNs in Japan

Inputs from China include those from JMNs in China. We use the following equation for separation. Input Value from JMNs in Japan

$$= \text{Intermediate Input Value from China} \times \left(\frac{\text{Sales Value of JMNs to Japan}}{\text{Export Value from China to Japan}} \right)$$

Then, we estimate the sum of input values from JMNs in China for each input category, and the ratio of this to the corresponding sum of China. [16]

Step 6: Separation of Inputs from JMNs in Non-JMNs Activities

China activities are composed of two, one for JMNs and the other for non-JMNs according to step 4. Input of non-JMNs still includes that from JMNs, which should be separated. Input value from JMNs in China

[15] For commerce, other service and other industries, the result might be meaningless because of the definition and discrepancy. However, the main object of this paper is to analyze the economic impact of manufacturing sector. It will not matter so much.

[16] The METI survey provides a total sales statistics by sector composed of local sales, exports to Japan and exports to third countries. Unfortunately, it doest not tell us whether these sales are of intermediate goods or final goods, so the exports vales are the sum of intermediate goods and final goods.

$$= \text{Intermediate Input Value from China} \times \left(\frac{\text{Local Sales Value of JMNs}}{\text{Input of China}} \right)$$

Then, we estimate the sum of input values from JMNs in China for each input category, and the ratio of this to the corresponding sum of China. The remaining input values are those for Non-JMNs in China.

Step 7: Intermediate Input within JMNs

The METI survey provides data on local procurement, but it does not give us accurate data on transaction relations between JMNs in China by industries. In order to divide the input from China by JMNs into two: that from the JMNs and from the non-JMNs in China, a survey conducted by JASME in 2000 will be used in this research. Data for the year 1995 is unavailable. Even though there is a 5- year time lag, we use this data as second best. Thereafter, we estimate the sum of input among JMNs for each input category, and the ratio of it to the corresponding sum.

Step 8: Final Demand of Japan

Japanese final demand from China is divided into two: that from JMNs and Non-JMNs. We use the ratio of sales from JMNs to Japan to the China sales of final goods in China. We obtain final demand from JMNs by multiplying this ratio to the purchase from China for each sector. Final demand from the non-JMNs China is the subtraction of the value of JMNs from that of China.

Step 9: Final Demand of China

The Chinese domestic final demand is also divided into two: that from JMNs and Non-JMNs. Here we estimate ratios of local sales of JMNs, after subtracting intermediate goods to China sales of final goods in the same market. Using these rations, we obtain appropriate values in the same way as in Step 8.

Step 10: Export to the ROW

Export to ROW is estimated; assuming that JMNs' sales to the third countries are equal to it. Export from the Non-JMNs in China is the subtraction of the value of JMNs from the total export of China.

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