

CITS WP 2005-11

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November 2005

**Center for International Trade Studies (CITS) Working Paper**

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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 their impact on the Chinese manufacturing industry and Japanese firms in the process of economic integration in East Asia. In order to analyse structural changes in international production linkages between China, Japanese multinational firms and Japan, 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.

**Keywords:** Japanese FDI, the Chinese economy, economic integration, input-output analysis, production linkage, production-inducing effect, modularisation, local procurement

## 1. INTRODUCTION

The inflow of foreign direct investment (FDI) has played an important role in promoting economic development in China, since economic reform began. In particular, Japanese FDI has acquired greater importance in China recently. Japanese FDI increased in the middle of the 1990s, as the Japanese economy experienced the appreciation of the yen. When the East Asian crisis occurred in 1997 and 1998, Japanese FDI fell very sharply. After the crisis, Japanese FDI in China soon recovered, and increased continuously. This increasing trend of FDI and production activities of Japanese multinational firms has made “international production linkages” much stronger between China and Japan. Therefore, increasing Japanese FDI which causes a shift of manufacturing plants to China is one of the most important factors to promote economic integration and to cause structural changes in the East Asian economy.

The aim of this paper is to analyse the changing patterns of Japanese FDI and the activities of Japanese multinationals in the different industries in China before and after the East Asian crisis, and to investigate their impact on the Chinese manufacturing industry and Japanese firms. Especially, 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 focused on.

Firstly, we investigate the diversity and evolution of multinationals' activities in different industries in China in different periods. Many researchers have analysed the impact of FDI on the Chinese economy theoretically and empirically. For example, Huang (2001) suggested that FDI induced China's economic growth, introducing advanced operation and management practices. Liu and Song (1997) argued that FDI promoted China's economic growth 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 the impact of FDI on growth appeared to increase in China. However, there are few researches on the industrial specificities of Japanese FDI. In this paper we analyse the dynamic effects of Japanese FDI and Japanese multinationals' activities on the Chinese economy, especially focusing on their industrial specificities. Furthermore, we analyse different patterns which Japanese FDI exhibited before and after the East Asian crisis.

Secondly, we make 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 the viewpoint of macroeconomic structures. In particular, the analysis based on international input-output tables is very useful to examine 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 has analysed Japanese multinationals' impact on the Chinese economy empirically, but researches based on the international input-output analysis have not been developed sufficiently. In this situation, M.Yamada's studies should be referred to as pioneering ones to analyse Japanese multinationals' activities in the framework of the international input-output analysis. 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*(1990), and Yamada(2002) also carried out a 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* (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 M.Yamada. 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.<sup>1</sup>

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. Kiyota, Matsumura, Urata and Wei (2005) examined the determinants of backward linkages of Japanese overseas affiliates, focusing on local

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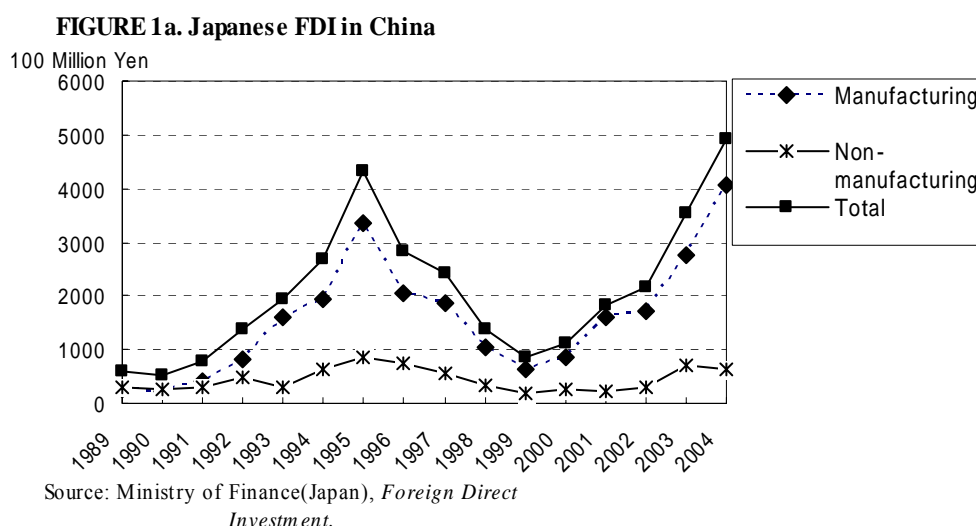
<sup>1</sup> *Asian International Input-Output Tables* are provided by Institute of Developing Economy (IDE), but the table for 2000 has not been available yet. Therefore, we utilize the *Asian International Input-Output Table* (2000) which Takagawa and Okada (2004) originally estimated on the based of *Direction of Trade Statistics*, IMF. They adopted the "trade-RAS method" to estimate the input coefficients of the *Asian International Input-Output Table* (2000). We are really grateful to Izumi Takagawa and Toshihiro Okada, Bank of Japan, for permitting us to use their table in this research.

procurements, and found that the length of operation had positive impacts on the local procurements of the affiliates in Asian countries. 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. Especially as for Japanese affiliates in China, Fujimoto and Shintaku (2005) empathised that 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. 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 process and firm organisation which influence Japanese manufacturing firms (Isogai, Ebizuka and Uemura (2000), Uemura (2004).

## 2 .JAPANESE FDI AND THE ACTIVITIES OF JAPANESE MULTINATIONALS IN CHINA

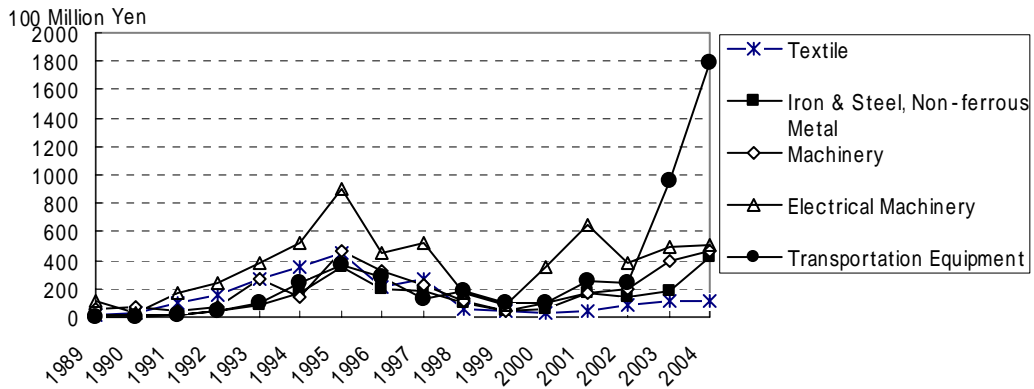
### 2.1 Historical Trend of Japanese FDI in China

First of all, we will overview the historical trend of Japanese FDI in the different industries in China in recent years. The Japanese FDI has increased in the Chinese economy since the 1980s, but it has shown different patterns in the different industries before and after the East Asian crisis in 1997 and 1998. The different patterns of Japanese FDI are shown in FIGURE 1a, FIGURE 1b and FIGURE 1c.<sup>2</sup>



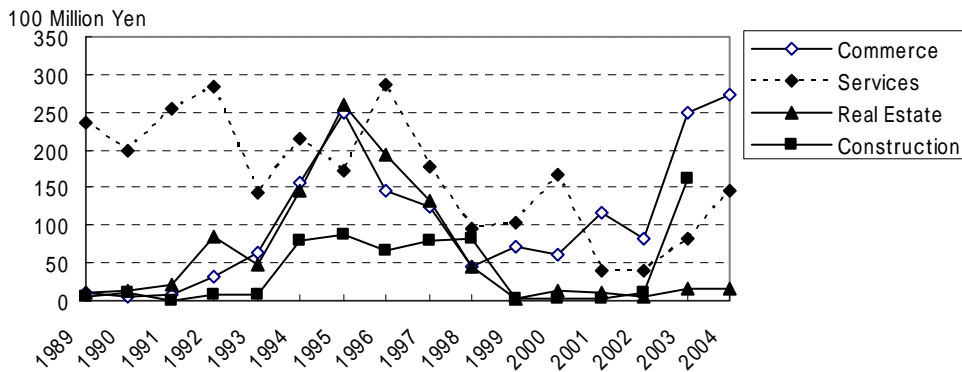
<sup>2</sup> The data are from the Ministry of Finance, *Foreign Direct Investment*. In Figure 1a, Hong Kong is excluded in the data of China even after 1997.

**FIGURE 1b. Japanese FDI in China (Manufacturing)**



Source: Ministry 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, 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 the 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 the East Asian crisis.

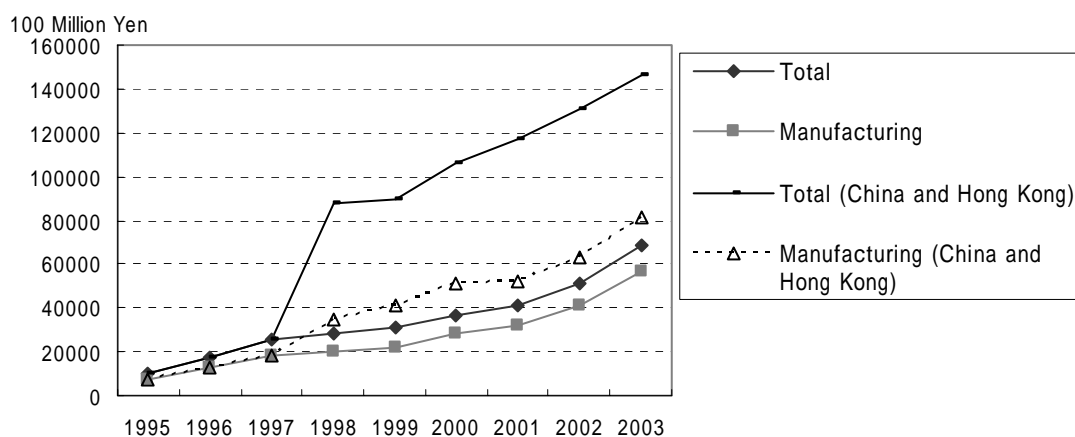
Japanese FDI started to recover in the manufacturing sector in 2000, and it has

grown continuously 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 was rather stagnant from 2002 to 2004, 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 been rather stagnant in other non-manufacturing industries.

## 2.2 Activities of Japanese Multinationals in China

We examine the amount of sales of Japanese overseas affiliates in China, as it shows the level of their activities.<sup>3</sup> The sales of Japanese overseas affiliates were a little stagnant 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, they were stagnant more severely 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. The sales of transportation equipment have been growing continuously in these ten years, while those of iron and steel as well as textile have been very stagnant. Commerce dropped in 1999, as it was influenced very much by the East Asian crisis in 1997 and 1998. Electrical machinery was not affected so much by the East Asian crisis, but it dropped very sharply in 2001 and 2002, influenced by the IT recession.

**FIGURE 2a The Sales of Japanese Overseas Affiliates in China**

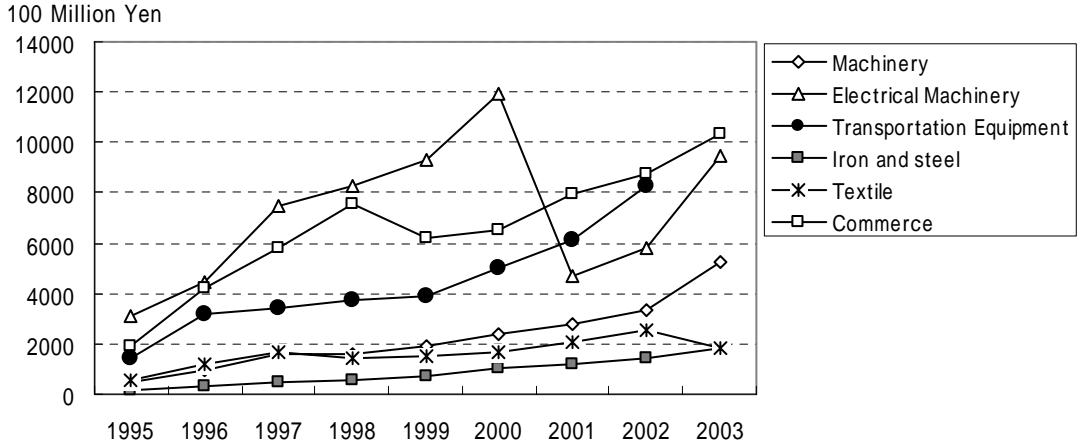


Source: METI, *Basic Survey on Overseas Business Activities*

<sup>3</sup> 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)**

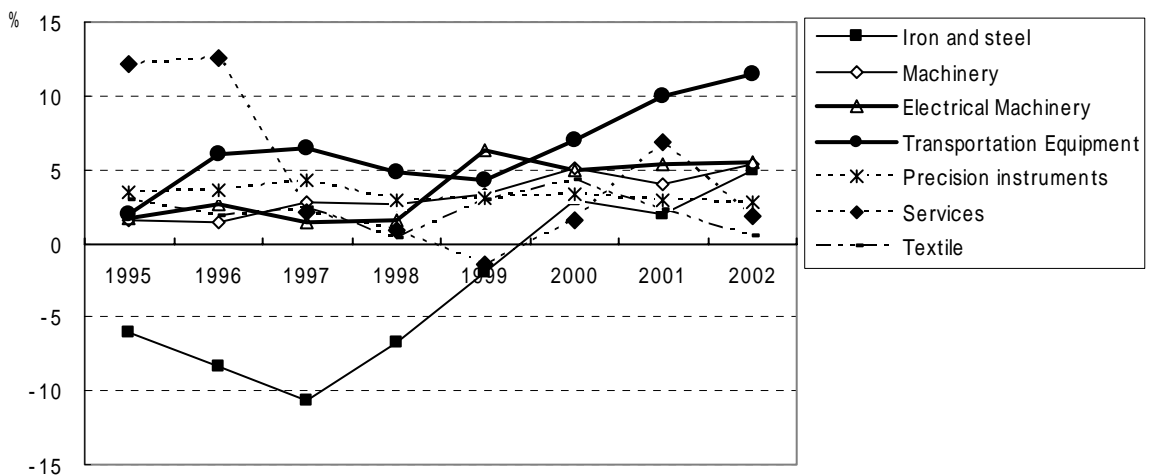


Source: METI, *Basic Survey on Overseas Business Activities*

### 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 middle of the 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 JMN's 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 in 1997 and 1998. On the contrary,

the current profit/sales ratio of transportation equipment was relatively stable in the late 1990s, and grew continuously 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. Therefore, there has been a very interesting change in the relationship between the local procurement ratio in electrical machinery and that in transportation equipment 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 the 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 Japanese electrical machinery firms and the growth of Chinese suppliers.

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.

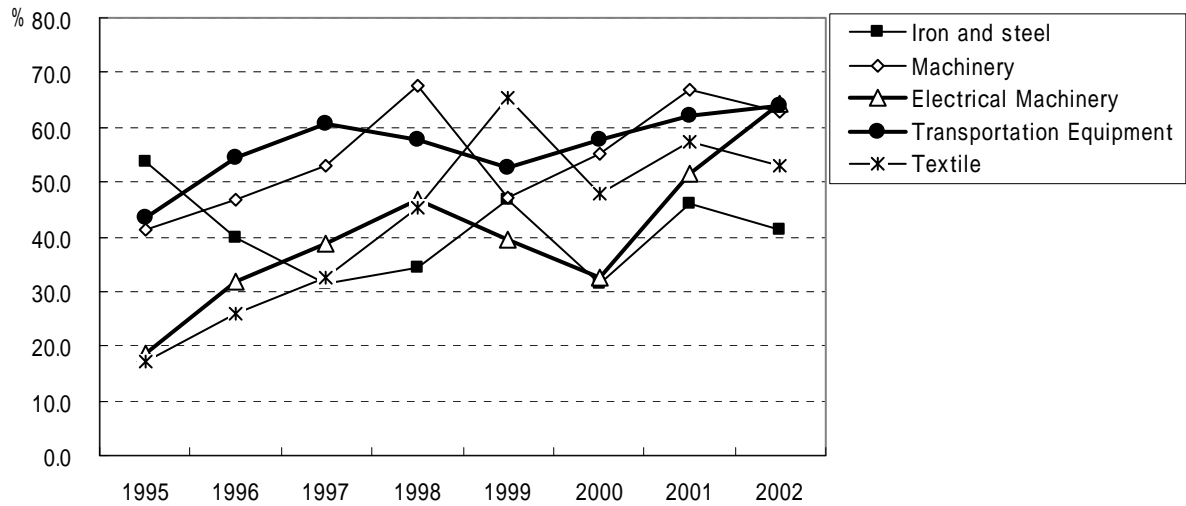
We will see what industries Japanese overseas affiliates procure components and materials from in Section 4, in which we will investigate the input coefficients of Japanese overseas affiliates in different industries in the manufacturing sector in China.

**TABLE 1 Local Procurement Ratios of JMNs in China**

	1995	1996	1997	1998	1999	2000	2001	2002
<b>Total</b>	34.1	38.8	43.9	47.7	45.3	40.0	42.4	43.7
<b>Manufacturing (Total)</b>	29.1	40.3	45.4	51.1	45.8	42.8	50.7	48.8
<b>Food</b>	94.1	97.7	98.1	92.3	79.8	84.7	83.7	80.8
<b>Textile</b>	17.0	26.0	32.4	45.3	65.3	48.0	57.3	52.8
<b>Wood and Pulp</b>	63.5	37.2	34.3	56.3	82.7	84.8	x	95.7
<b>Chemical Products</b>	65.1	46.8	68.1	50.9	53.1	59.7	52.9	53.0
<b>Oil and Coal</b>	9.0	3.7	81.4	26.0	18.0	x	x	91.9
<b>Iron and steel</b>	53.8	39.9	31.4	34.4	46.6	31.4	45.9	41.1
<b>Non-ferrous Metals</b>	71.3	30.6	24.2	53.5	49.0	79.4	64.0	30.2
<b>Machinery</b>	41.3	46.9	52.9	67.6	47.2	55.3	66.9	62.8
<b>Electrical Machinery</b>	18.7	31.7	38.7	46.6	39.4	32.6	51.4	64.4
<b>Information and Communication</b>	x	x	x	x	x	x	37.5	36.1
<b>Transportation Equipment</b>	43.3	54.5	60.7	57.6	52.5	57.7	62.1	64.1
<b>Precision Instruments</b>	14.9	8.0	36.9	39.8	50.3	52.3	49.8	30.6
<b>Other Manufacturing</b>	x	x	x	x	x	x	55.0	55.9
<b>Non-manufacturing (Total)</b>	x	x	x	x	x	x	33.5	37.3
<b>Agriculture</b>	95.2	94.9	91.4	76.8	86.3	x	x	82.3
<b>Mining</b>	100.0	x	85.7	92.2	88.2	x	x	x
<b>Construction</b>	99.9	x	75.7	100.0	91.9	97.1	94.3	99.9
<b>Transportation and Communication</b>	x	x	x	x	x	x	79.5	92.6
<b>Wholesale and Retail Trade</b>	58.0	23.9	39.2	38.2	39.0	34.2	31.9	35.8
<b>Services</b>	72.1	84.2	23.7	85.5	82.9	46.1	85.9	39.4
<b>Other non-manufacturing</b>	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 LINKAGES OF JAPANESE MULTI-NATIONALS 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 the impact of the activities of JMNs on the Chinese economy in these different periods 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	Discrepancy	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		$B_j^c$	$B_j^m$	$B_j^j$	$BF_c$	$BF_j$			
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 and 1995) can be obtained from the *Asian International Input-Output Table* by Institute of Developing Economies (IDE) in Japan. In making the China-Japan I-O Table for 2000, we use the *Asian International Input-Output Table* which was originally estimated by Takagawa and Okada(2004). They use the *Direction of Trade Statistics* (IMF) to infer an Asian International I-O Table on the basis of the table for 1995.

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.

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.<sup>4</sup> 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

<sup>4</sup> In the input-output analysis in this paper, “electrical machinery” is not classified as a independent sector, but it is included in “machinery”, because of the limitation of sector classification of the *Asian International Input-Output Table(2000)* provided by Takagawa and Okada(2004). When the *International Input-Output Table (2000)* by the Institute of Developing Economy becomes available, we will make another input-output analysis, setting “electrical machinery” as a sector in the classification.

### 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.

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

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.

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

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

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.

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

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.

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

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.

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

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

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

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



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

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, JMN, and Japan.

### 3.4. Results of the Analysis

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

Before we make the input-output analysis, we see 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%, 0.06%, 2.20%, 2.83% to 1.31%, 0.93%, 7.21%, 4.40% in the textile, chemical, machinery, and transportation equipment industries, respectively. Therefore, production in those industries has been promoted very much by vigorous Japanese FDI in China. On the contrary, shares increased relatively little from 0.29%, 0.77% to 0.44%, 1.27% in the iron and steel, and wholesale and retail trade industries, respectively.

\$1,000				
	1995	Production in China(including JMN's)	Production of JMN's	The Share of JMN's
1	Agriculture	243563223	155477	0.06%
2	Mining	57339982	4640	0.01%
3	Food	128324490	165151	0.13%
4	Textile	136979090	582701	0.43%
5	Wood & pulp	46521066	29034	0.06%
6	Chmeical	100209788	560054	0.56%
7	Petroleum & Coal	31667384	20337	0.06%
8	Non-Ferrous Metals	71478146	52814	0.07%
9	Iron & Steel	66278940	194726	0.29%
10	Machinery	191125091	4203568	2.20%
11	Transportation Equipment	53406511	1512369	2.83%
12	Construction	178698366	29554	0.02%
13	Wholesale and Retail Trade	153463690	1180942	0.77%
14	Public Service	37729526	0	0.00%
15	Other Service	198404776	98086	0.05%
16	Others	179330784	304307	0.17%
	2000	China(including JMN's)	JMN's	The Share of JMN's
1	Agriculture	251220000	—	—
2	Mining	77275000	—	—
3	Food	213050000	1026122	0.48%
4	Textile	246330000	3227783	1.31%
5	Wood & pulp	105465000	194805	0.18%
6	Chmeical	193420000	1800445	0.93%
7	Petroleum & Coal	85064000	26122	0.03%
8	Non-Ferrous Metals	90878000	970482	1.07%
9	Iron & Steel	239660000	1061744	0.44%
10	Machinery	435640000	31393701	7.21%
11	Transportation Equipment	106690000	4691095	4.40%
12	Construction	194800000	196967	0.10%
13	Wholesale and Retail Trade	188730000	2399555	1.27%
14	Public Service	35281000	0	0.00%
15	Other Service	244060000	1270807	0.52%
16	Others	125882000	4008887	3.18%

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

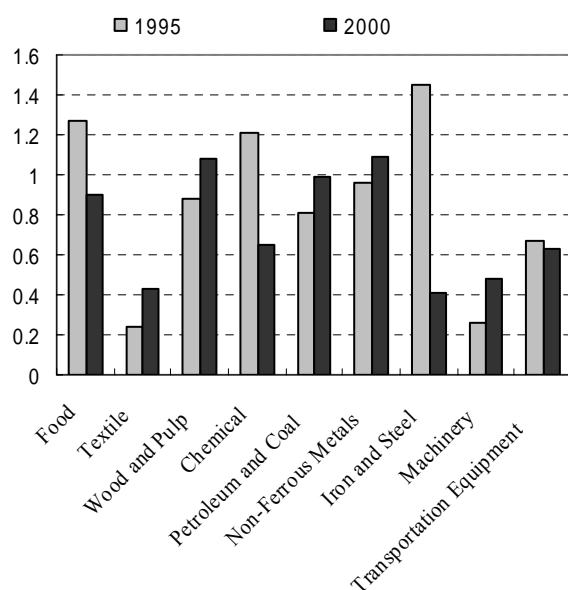
## **B. Induced Production by Unit Change in Final Goods Production**

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

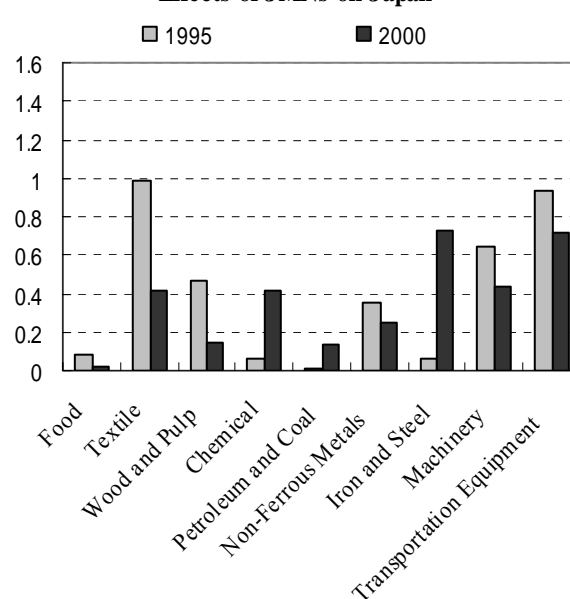
**TABLE 4 Subtotals of Column Values in the Leontief Inverse Matrix  
--Changes in Final Demand for JMNs--**

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	0.90	1.06	0.02
	Textile	0.43	1.02	0.42
	Wood & Pulp	1.08	1.05	0.15
	Chemical	0.65	1.02	0.42
	Petroleum and Coal	0.99	1.02	0.14
	Non-Ferrous Metals	1.09	1.04	0.25
	Iron and Steel	0.41	1.02	0.73
	Machinery	0.48	1.03	0.44
	Transportation Equipment	0.63	1.03	0.72

**FIGURE 6a The Production-inducing Effects of JMNs on China**



**FIGURE 6b The Production-inducing Effects of JMNs on Japan**



In TABLE 4, FIGURE 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.<sup>5</sup>

Secondly, in 2000, a unit increase in the final goods production of JMNs in non-ferrous metals, wood and pulp, petroleum and coal, food, chemical and transportation equipment had a relatively significant impact on the Chinese industries, with the values of 1.09, 1.08, 0.99, 0.90, 0.65 and 0.63 units, respectively. The production-inducing effects of JMNs in iron and steel became very small on the Chinese economy. The production-inducing effects of JMNs in machinery and textile became much stronger with the values of 0.48 and 0.43, respectively. Taking into account the considerable increase in the production of JMNs in the machinery and textile industries in China, we see their great impact on the Chinese manufacturing industry.

Thirdly, JMNs in industrial sectors with higher production-inducing effects seem to have a significant cooperative purchasing relationship with local firms in China. On the contrary, the production-inducing effects of JMNs in such industries as the machinery and textile industries were very limited in 1995, and this means that JMNs in the machinery and textile industries purchased a small number of raw materials and components from local firms in China at that time. However, the production-inducing effects increased very much in machinery and textile from 1995 to 2000, that is, from 0.26, 0.24 to 0.48, 0.43, respectively. In other words, the backward linkages of Japanese multinationals have been much stronger in the machinery (especially true in electrical machinery) and textile industries.

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. On the contrary, the effect decreased remarkably in the textile industry from 1995 to 2000. The effect on exports from Japan to China is often called “induced-export effect”, and we will investigate it in more detail in Section 4.<sup>6</sup>

### **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

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<sup>5</sup> Wang(2004) analyzed 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.

<sup>6</sup> As for the explanation of “induced export effect”, see Yamada (2002).

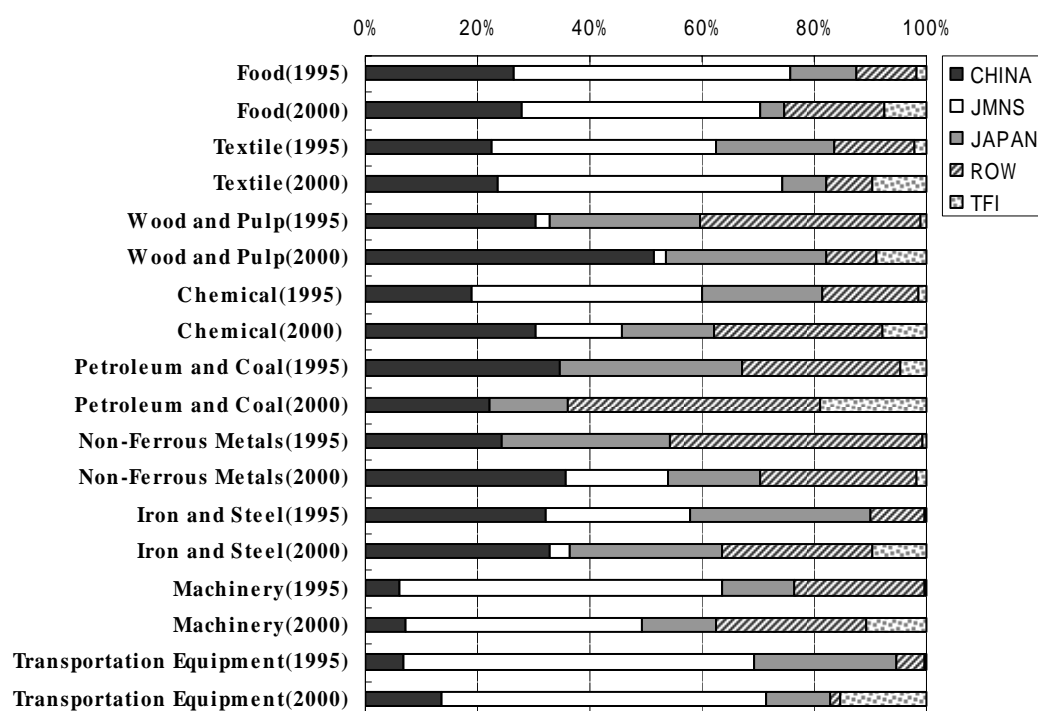
additional increase in the final goods production of JMNs in each sector, which falls into the categories of the value added of three parts (China, JMNs, and Japan), import from ROW, and the cost of freight and insurance.

**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	27.87	42.37	4.28	17.97	7.52	100.00
	Textile	23.48	50.98	7.75	8.30	9.50	100.00
	Wood and Pulp	51.32	2.26	28.70	8.67	9.04	100.00
	Chemical	30.29	15.33	16.65	29.75	7.98	100.00
	Petroleum and Coal	21.98	0.23	13.83	45.05	18.91	100.00
	Non-Ferrous Metals	35.59	18.36	16.39	27.77	1.90	100.00
	Iron and Steel	32.94	3.33	27.29	26.79	9.65	100.00
	Machinery	7.09	42.03	13.32	27.00	10.56	100.00
	Transportation Equipment	13.61	57.66	11.49	1.73	15.51	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 wood and pulp, non-ferrous metals, iron and steel, chemicals, and food to the value added in the Chinese economy was seen with the values of 51.32, 35.39, 32.94, 30.29, and 27.87, respectively. JMNs in textiles, petroleum and coal, transportation equipment, and machinery are relatively small sources of value added contributions to the Chinese economy, though the contribution increased in transportation equipment. They generate only 23.48, 21.98, 13.61, and 7.09, respectively.

Thirdly, JMNs in the industries with the high contribution of valued added to the Chinese economy seem to have a significant purchasing relationship of intermediate goods with local firms in China. JMNs in the industries with low contribution of value added to the Chinese economy, such as textiles, and machinery, had relatively small 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 from 1995 to 2000. This means that the activities of Japanese multinationals have obtained stronger 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 Japanese multinationals(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	0.01420	0.00019	0.00009	0.00054	0.00014	0.00253	0.00012
	2 Mining	0.00019	0.00000	0.06687	0.00214	0.00002	0.00063	0.00001	0.00085
	3 Food	0.00063	0.01206	0.00122	0.00003	0.00006	0.00046	0.00027	0.00056
	4 Textile	0.04510	0.09829	0.00469	0.00145	0.00254	0.00389	0.01486	0.00690
	5 Wood & Pulp	0.00080	0.00130	0.00228	0.00083	0.00050	0.00531	0.00198	0.00544
	6 Chemical	0.01173	0.01262	0.00786	0.00112	0.00101	0.00854	0.00200	0.00775
	7 Petroleum & Coal	0.00021	0.00011	0.05046	0.00899	0.00007	0.00443	0.00062	0.00620
	8 Non-Ferrous Metals	0.00028	0.00003	0.01661	0.00143	0.01314	0.00494	0.05486	0.00576
	9 Iron & Steel	0.00012	0.00025	0.22406	0.12980	0.00079	0.03964	0.03344	0.03736
	10 Machinery	0.00159	0.00022	0.05932	0.00046	0.06440	0.08188	0.03749	0.04273
	11 Transportation Equipment	0.00010	0.00000	0.00776	0.00000	0.00005	0.00467	0.05263	0.09222
	12 Construction	0.00031	0.00000	0.00804	0.00000	0.00000	0.00170	0.00000	0.00384
	13 Wholesale and Retail Trade	0.01271	0.05435	0.04023	0.00876	0.01583	0.01213	0.02993	0.01578
JMNs	1 Agriculture	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	2 Mining	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	3 Food	0.00002	0.00265	0.00004	0.00001	0.00000	0.00010	0.00001	0.00012
	4 Textile	0.01455	0.01469	0.00151	0.00022	0.00082	0.00058	0.00479	0.00103
	5 Wood & Pulp	0.00003	0.00018	0.00008	0.00011	0.00002	0.00072	0.00007	0.00074
	6 Chemical	0.00122	0.00110	0.00082	0.00010	0.00010	0.00074	0.00021	0.00067
	7 Petroleum & Coal	0.00001	0.00000	0.00271	0.00000	0.00000	0.00000	0.00003	0.00000
	8 Non-Ferrous Metals	0.00010	0.00000	0.00584	0.00003	0.00462	0.00010	0.01927	0.00012
	9 Iron & Steel	0.00000	0.00004	0.00693	0.01939	0.00002	0.00592	0.00103	0.00558
	10 Machinery	0.00032	0.00004	0.01123	0.00009	0.02321	0.01560	0.01405	0.00814
	11 Transportation Equipment	0.00001	0.00000	0.00102	0.00000	0.00001	0.00052	0.00692	0.01025
	12 Construction	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	13 Wholesale and Retail Trade	0.00150	0.00168	0.00473	0.00027	0.00186	0.00038	0.00352	0.00049
JAPAN	1 Agriculture	0.00117	0.00075	0.00000	0.00005	0.00009	0.00000	0.00005	0.00000
	2 Mining	0.00000	0.00000	0.00009	0.00059	0.00000	0.00000	0.00001	0.00000
	3 Food	0.00000	0.00049	0.00000	0.00068	0.00090	0.00000	0.00049	0.00000
	4 Textile	0.25923	0.08044	0.00000	0.00092	0.00153	0.00011	0.00115	0.00000
	5 Wood & Pulp	0.00065	0.00847	0.00000	0.00485	0.00350	0.00000	0.00114	0.00000
	6 Chemical	0.14522	0.02567	0.00012	0.00587	0.00515	0.00149	0.00497	0.00130
	7 Petroleum & Coal	0.00477	0.00220	0.00035	0.01081	0.00095	0.00083	0.00089	0.00312
	8 Non-Ferrous Metals	0.00154	0.00019	0.00170	0.00353	0.02071	0.00407	0.01254	0.00011
	9 Iron & Steel	0.00000	0.00136	0.00462	0.20810	0.01172	0.02026	0.01725	0.06253
	10 Machinery	0.00000	0.00212	0.00000	0.00794	0.13967	0.15872	0.02969	0.10483
	11 Transportation Equipment	0.00000	0.00074	0.00000	0.00120	0.00085	0.00000	0.21683	0.10447
	12 Construction	0.00000	0.00141	0.00000	0.00474	0.00203	0.00000	0.00122	0.00000
	13 Wholesale and Retail Trade	0.06127	0.03846	0.00102	0.04988	0.04385	0.01568	0.03389	0.02801

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.<sup>7</sup> The summary of the analysis is shown in TABLE 7.

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<sup>7</sup> 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”.



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 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 which are located in China.

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

		Japanese Multinationals (JMN) in China			
		Textile	Iron and Steel	Machinery (especially Electrical Machinery)	Transportation Equipment
<b>Backward Linkages</b>	<b>CHINA</b>	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
	<b>JMN</b>	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
	<b>JAPAN</b>	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
<b>Industrial Specificities of Institutional Architectures</b>		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 middle of the 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.<sup>8</sup> Accordingly, the local procurements of Japanese multinationals in the electrical 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 middle of the 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.<sup>9</sup>

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.<sup>10</sup> 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

Structural changes in international production linkages are caused by interactions between the behaviours of firms and the evolution of macroeconomic structures, so we have analysed structural changes in international production linkages promoted by the activities of Japanese multinationals from the viewpoint of both international input-output structures and the production and transaction processes of Japanese firms. The main results of our analysis are summarised as follows.

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<sup>8</sup> 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).

<sup>9</sup> As for the relationship between market strategy and local procurement, see Wang (2004), and Kiyota, Matsumura, Urata and Wei (2005).

<sup>10</sup> Uemrua (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 (1996).

Firstly, Japanese FDI in China reached a peak in 1995, and fell sharply after the East Asian crisis. Then, it recovered at the end the 1990s, and has subsequently increased with different patterns in different industries. Japanese FDI has fluctuated very much in the manufacturing sector, while it has been rather stable in the non-manufacturing sector. Japanese FDI has grown remarkably with high profitability in the transportation equipment industry, and this explains the considerable increase in Japanese FDI in the manufacturing sector in China after 2000. Japanese FDI in the electrical machinery industry also started to recover in 2000, but was rather stagnant after 2002, being affected by the sharp decline in sales in the IT recession. In the non-manufacturing sector, the sales of Japanese overseas affiliates in commerce dropped very much with a decrease in profitability after the East Asian crisis, but Japanese FDI recovered in commerce in the early 2000s. However, Japanese FDI is still stagnant in other non-manufacturing industries in China.

Secondly, international production linkages have been deeper and wider recently, promoted by Japanese multinationals' activities. In particular, the local procurement ratios of Japanese overseas affiliates have increased remarkably with different patterns in different industries in China. In fact, the procurement ratios were relatively high in the transportation equipment industry in the middle of the 1990s, while they were very low in the electrical machinery and textile industries. However, the local procurement ratio increased considerably in those industries, and the gap between electrical machinery and transportation equipment disappeared completely in 2002. According to our international input-output analysis, the intermediate inputs of Japanese multinationals from local companies have also increased in China recently. The production-inducing effect of Japanese multinationals in the transportation equipment industry was larger than that in the machinery industry in 1995. However, the effect increased in the machinery industry from 1995 to 2000, while it was rather stable at the high level in the transportation equipment industry. The backward linkages of Japanese multinationals have increased considerably in the machinery, especially electrical machinery, industry in China. The contribution of Japanese multinationals' activities to the value added of the Chinese economy increased from 1995 to 2000. This means that the activities of Japanese multinationals have increasingly contributed to the formation of value added in the Chinese manufacturing industry.

Thirdly, different backward linkages of Japanese multinationals between different manufacturing industries imply the industrial specificities of the "value chain" of production process and the behaviours 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 1995. In the electrical machinery industry, assembly lines were shifted to China with the procurement of components from their subcontractors or related firms in Japan, because production processes in the electrical machinery industry were integrated into a vertical chain. However, the design rules of electrical products have been modularised recently. Accordingly, the local procurements of Japanese multinationals have rapidly increased in the electrical machinery industry in China, and this has caused more effects of value added creation on the Chinese manufacturing industry. On the contrary, the creation of value added in the manufacturing and assembly processes has decreased in Japan, and business has been shifted to design and solution activities. In the transportation equipment industry, production processes are more integrated, so the level of local procurements has been stable, supported by the shift of the plants of Japanese subcontractors to China.

International production linkages will be stronger between Japan and China, promoted by the activities of Japanese multinationals and local firms in China. 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 how to recompile 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 industrial technological level of JMNs. Here, a survey of the technological level of JMNs in China by sectors from the 26<sup>th</sup> METI survey will be used as our empirical evidence. TABLE 8 is the technological level survey by METI. In this research, for JMNs whose technological levels are shown to be the same as Japan, the coefficient of the corresponding sector of Japan will be used. For the rest of the sectors, the coefficient of China will be used.

**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)

Source: METI, *The 26<sup>th</sup> 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.<sup>11</sup>

### **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

<sup>11</sup> 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.

equation for separation. Input Value from JMNs in Japan

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

<sup>12</sup>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.

#### **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

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

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 ratios, we obtain appropriate values in the same way as in Step 8.

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<sup>12</sup> The METI survey provides a total sales statistics by sector composed of local sales, exports to Japan and exports to third countries. Unfortunately, it does not tell us whether these sales are of intermediate goods or final goods. So here the exports values are the sum of intermediate goods and final goods.

## 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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