Japanese Multinationals in China and International Production Linkages: Structural Changes and Co-ordination in the Industrial Interdependence

Hiroyasu Uemura* and Jian Wang**

Abstract

This paper analyses the changing patterns of Japanese foreign direct investment (FDI) and the activities of Japanese multinational firms in different industrial sectors 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 institutional 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 evolution of industrial specificities of the production and transaction processes of Japanese multi-national firms in different manufacturing industries.

Keywords: Japanese multinationals, the Chinese economy, economic integration, input-output analysis, international production linkage.

Code of the EAEPE research area: G – Macroeconomic Regulation and Institutions

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1. Introduction

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 changes in 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 co-ordination of production and transaction processes in Japanese multinational firms. In this regard, the following three points are specifically addressed.

Firstly, we investigate the evolution and diversity 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. 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 and Japanese economies, especially focusing on their industrial specificities. Furthermore, we analyse different patterns which Japanese 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 and Japanese economies. 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 Tables for 1985, 1990, and 1995. 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)).

Yamada(2001) analysed the interdependence between the Japanese, Asian and US economies and
paper, we will analyse changes in the impact 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 which was developed by Yamada.

Thirdly, the institutional implications of structural changes in international production linkages are explored by analysing the behaviours and organizations of Japanese firms in the manufacturing sector. Especially 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 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 co-ordination and evolution of production and transaction processes of Japanese multinationals in the different manufacturing industries in the process of Asian 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 1.

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3 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.
As we can see in FIGURE 1, Japanese FDI has fluctuated very largely in the manufacturing industry since the late 1980s. In fact, it increased very much in 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.

FIGURE 1. Japanese FDI in China

Source: Ministry of Finance (Japan), Foreign Direct Investment.
2.2 Activities of Japanese Multinationals in China

The sales activities of Japanese overseas affiliates in China are examined below.\(^4\) The sales of Japanese overseas affiliates slowed after the East Asian crisis, but they started to recover soon after. The trends of the sales of Japanese overseas affiliates are diversified in different industries in China, as seen in FIGURE 2. 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.

![FIGURE2. The Sales of Japanese Overseas Affiliated in China (Industries)](image)

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.

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\(^4\) 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.
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 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 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 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.

![FIGURE 4. Local Procurement Ratios](image)

Source: METI, Basic Survey on Overseas Business Activities

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.

3.1 Recompilation of the China-Japan Input-Output Table

A. Recompilation Procedure

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 changes 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).

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.
### FIGURE 5 China-JMNs-Japan I-O Table

|------------------------------------------------|

<table>
<thead>
<tr>
<th>China, JMNs and Japan I-O Table</th>
<th>Intermediate Demand</th>
<th>Final Demand</th>
<th>Export Dyscrepancy</th>
<th>Total Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>China, JMNs and Japan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate Inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>$x_{i}^{c}$</td>
<td>$x_{i}^{m}$</td>
<td>$F_{s}^{c}$</td>
<td>$E_{s}^{c}$</td>
</tr>
<tr>
<td>JMNs</td>
<td>$x_{i}^{c}$</td>
<td>$x_{i}^{m}$</td>
<td>$F_{s}^{c}$</td>
<td>$E_{s}^{c}$</td>
</tr>
<tr>
<td>Japan</td>
<td>$x_{i}^{c}$</td>
<td>$x_{i}^{m}$</td>
<td>$F_{s}^{c}$</td>
<td>$E_{s}^{c}$</td>
</tr>
<tr>
<td>International Freight &amp; Insurance</td>
<td>$B_{i}$</td>
<td>$B_{i}$</td>
<td>$B_{j}$</td>
<td>$BF_{i}$</td>
</tr>
<tr>
<td>Import</td>
<td>$C_{i}$</td>
<td>$C_{i}$</td>
<td>$C_{j}$</td>
<td>$CF_{i}$</td>
</tr>
<tr>
<td>Tariffs</td>
<td>$T_{i}$</td>
<td>$T_{i}$</td>
<td>$T_{j}$</td>
<td>$TF_{i}$</td>
</tr>
<tr>
<td>Value added</td>
<td>$V_{i}$</td>
<td>$V_{i}$</td>
<td>$V_{j}$</td>
<td></td>
</tr>
<tr>
<td>Total Output</td>
<td>$X_{i}$</td>
<td>$X_{i}$</td>
<td>$X_{i}$</td>
<td></td>
</tr>
</tbody>
</table>


- $x_{i,j}^{c}$: 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).
- $F_{i}^{c}$: The product of sector $i$ of country $r$ (China, JMNs or Japan) used by the final demand of country $s$ (China, JMNs or Japan).
- $E_{i}^{c}$: Export vector of country $r$ to the rest of the world excluding country $s$ (China, JMNs or Japan).
- $X_{i}$: Total output of the sector $i$ of country $r$ (China, JMNs or Japan).
- $B_{i}$: The international freight and insurance costs of country $r$ (China, JMNs or Japan) deducted from intermediate inputs and final demand.
- $C_{i}$: Import vectors of intermediate input and final demand of country $r$ from the rest of the world excluding country $s$ (China, JMNs or Japan).
- $T_{i}$: Total import duty and tax vectors of country $r$ (China, JMNs or Japan).
- $V_{i}$: The value added of sector $i$ of country $r$ (China, JMNs or Japan).
- $X_{i}$: Total input of industry $j$ of country $r$ (China, JMNs or Japan).

### B. Data Sources

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.\(^5\)

Japan Finance Corporation for Small Business (JASME) also conducts a survey of Japanese business activities in China from 2000. JASME survey provides us important information on the local purchases of Japanese subsidiaries in China by industries and origins of suppliers.

### 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 the non-manufacturing sector. METI’s survey provides the data of 18 sectors, so we use the 19-sector classification here. We integrate the original China-Japan I-O tables into 19 sectors in our analysis. TABLE1 shows the sector classification of our new I-O tables.

**TABLE 1 New Industrial Classification**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agriculture</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>Mining</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>Food</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>Textiles</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>Wood and Pulp</td>
<td>15</td>
</tr>
<tr>
<td>6</td>
<td>Chemicals</td>
<td>16</td>
</tr>
<tr>
<td>7</td>
<td>Petroleum and Coal</td>
<td>17</td>
</tr>
<tr>
<td>8</td>
<td>Non-Ferrous Metals</td>
<td>18</td>
</tr>
<tr>
<td>9</td>
<td>Iron and Steel</td>
<td>19</td>
</tr>
<tr>
<td>10</td>
<td>General Machinery</td>
<td></td>
</tr>
</tbody>
</table>

### 3.3. Theoretical Framework of the 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

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\(^5\) 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.
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.

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

(1)

Where, $A_{ij}$, $A_{22}$, $A_{32}$ represent the input coefficient matrices of JMNs, $A_{11}$, $A_{12}$, $A_{13}$, $A_{21}$, $A_{22}$, $A_{23}$, $A_{31}$, $A_{32}$, $A_{33}$ 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.

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

(2)

$$
\begin{bmatrix}
X_1 \\
X_2 \\
X_3
\end{bmatrix}
= 
\begin{bmatrix}
B_{11} & B_{12} & B_{13} \\
B_{21} & B_{22} & B_{23} \\
B_{31} & B_{32} & B_{33}
\end{bmatrix}
\begin{bmatrix}
F_{11} \\
F_{21} \\
F_{31}
\end{bmatrix}
= 
\begin{bmatrix}
F_{c} \\
F_{m} \\
F_{j}
\end{bmatrix}
$$

(3)

Note that the final demand is described as follows,

$$
F_{11} + F_{13} + E_1 = F_{c} \\
F_{21} + F_{23} + E_2 = F_{m} \\
F_{31} + F_{33} + E_3 = F_{j}
$$

$F_{c}$ 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.

$$
\begin{bmatrix}
X_1 \\
X_2 \\
X_3
\end{bmatrix}
= 
\begin{bmatrix}
B_{11} & B_{12} & B_{13} \\
B_{21} & B_{22} & B_{23} \\
B_{31} & B_{32} & B_{33}
\end{bmatrix}
\begin{bmatrix}
F_{c} \\
F_{m} \\
F_{j}
\end{bmatrix}
$$

(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 $\hat{\nu}$ with the induced-production coefficient vector.

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

(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.

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

(6)

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

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

(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.

$$
\begin{bmatrix}
l & l & l
\end{bmatrix}
\begin{bmatrix}
V_1 \\
V_2 \\
V_3
\end{bmatrix}
+\begin{bmatrix}
l & l & l
\end{bmatrix}
\begin{bmatrix}
M_{R1} \\
M_{R2} \\
M_{R3}
\end{bmatrix}
=\begin{bmatrix}
l & l & l
\end{bmatrix}
\begin{bmatrix}
0 & 0 & 0 \\
0 & 0 & 0 \\
0 & 0 & 0
\end{bmatrix}
$$

(8)

### 3.4. Results of the Analysis

#### A. 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 2.

TABLE 2 Subtotals of Column Values in the Leontief Inverse Matrix
--Changes in Final Demand for JMNs--

<table>
<thead>
<tr>
<th></th>
<th>1995</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CHINA</td>
<td>JMN</td>
</tr>
<tr>
<td>Food</td>
<td>1.27</td>
<td>1.03</td>
</tr>
<tr>
<td>Textiles</td>
<td>0.24</td>
<td>1.02</td>
</tr>
<tr>
<td>Wood and pulp</td>
<td>0.88</td>
<td>1.03</td>
</tr>
<tr>
<td>Chemicals</td>
<td>1.21</td>
<td>1.05</td>
</tr>
<tr>
<td>Petroleum and Coal</td>
<td>0.81</td>
<td>1.01</td>
</tr>
<tr>
<td>Non-Ferrous Metals</td>
<td>0.96</td>
<td>1.09</td>
</tr>
<tr>
<td>Iron and Steel</td>
<td>1.46</td>
<td>1.05</td>
</tr>
<tr>
<td>General Machinery</td>
<td>0.49</td>
<td>1.06</td>
</tr>
<tr>
<td>Electrical Machinery</td>
<td>0.23</td>
<td>1.03</td>
</tr>
<tr>
<td>Transportation Equipment</td>
<td>0.67</td>
<td>1.06</td>
</tr>
<tr>
<td>Precision Instruments</td>
<td>0.19</td>
<td>1.01</td>
</tr>
<tr>
<td>Other Manufacturing</td>
<td>0.73</td>
<td>1.03</td>
</tr>
</tbody>
</table>
In TABLE 2, we can make the following observations. Firstly, in 1995, a unit increase in the final goods production of JMNs in iron and steel, food, chemicals, non-ferrous metals, wood and pulp, petroleum and coal, and transportation equipment had a significant impact on the Chinese economy, with the values of 1.46, 1.27, 1.21, 0.96, 0.88, 0.81 and 0.67 units, respectively. The production-inducing effects of JMNs in precision instruments, electrical machinery, and textile are limited, and one unit increase in final goods production of JMNs in these industries results in 0.19, 0.23, and 0.24 units change, respectively.

Secondly, in 2000, a unit increase in the final goods production of JMNs in non-ferrous metals, wood and pulp, and food had a relatively significant impact on China with the values of 1.39, 1.36 and 1.00 units, respectively. The production-inducing effects of JMNs in general machinery, precision instruments, transportation equipment, textiles, and electrical machinery became sufficiently strong with the values of 0.86, 0.84, 0.82, 0.54 and 0.52, respectively. Taking into account the considerable increase in the production of JMNs in the textile, transportation equipment, general machinery, and electrical machinery industries in China, their impact on China is considerably great. On the contrary, the production-inducing effects of JMNs in iron and steel decreased in 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 precision instruments, electrical machinery and textiles 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 precision instruments, electrical machinery, textiles and general machinery from 1995 to 2000, that is, from 0.19, 0.23, 0.24, 0.49 to 0.84, 0.52, 0.54, 0.86, respectively. In other words, the backward linkages of JMNs became much stronger in precision instruments, electrical machinery, textiles, and general machinery. On the contrary, the production-inducing effects on China decrease in food, chemicals, and iron and steel from 1995 to 2000, that is, from 1.27, 1.21, 1.46 to 1.00, 0.87, 0.50, respectively.⁶

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. The production-inducing effect decreased remarkably in the textile industry from 1995 to 2000. The effect of the activities of Japanese multinationals 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 4.⁷

B. Relative Contributions of JMNs to Value Added

The results of relative contributions to final goods production of equation (8) are presented in TABLE 3. 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.

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⁶ 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.

⁷ As for the explanation of “induced export effect”, see Yamada (2002).
In TABLE 3, we can make the following observations on the results. Firstly, in 1995, significant contribution of JMNs in transportation equipment, wood and pulp, and non-ferrous metals to the value added in the Chinese economy was seen with the values of 39.57, 31.90 and 30.16, respectively. JMNs in textiles, precision instruments and general machinery were very small sources of value added contribution to the Chinese economy. They generated only 5.93, 6.45, 6.58, respectively.

Secondly, in 2000, significant contribution of JMNs in petroleum and coal, transportation equipment, iron and steel, and food to the value added in the Chinese economy was seen with the values of 56.38, 46.16, 45.94, and 41.86, respectively. JMNs in electrical machinery and precision instruments are relatively small sources of value added contributions to the Chinese economy with the values of 21.76 and 26.63, though the contribution increased in these industries.

Thirdly, JMNs in the industries with the high contribution of valued added to the Chinese economy seem to have strong backward linkages in China. JMNs in the industries with low contribution of value added to the Chinese economy, such as textiles,
precision machinery, general machinery and electrical 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 Chinese economy increased 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 economic integration processes in East Asia, 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 4. 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 4 Changes in Input Coefficients from 1995 to 2000

<table>
<thead>
<tr>
<th></th>
<th>Textile</th>
<th>JMNs</th>
<th>Iron &amp; Steel</th>
<th>Electrical Machinery</th>
<th>Transportation Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHINA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.02294</td>
<td>0.0319</td>
<td>0.00019</td>
<td>0.00000</td>
<td>0.06687</td>
</tr>
<tr>
<td>Mining</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Textiles</td>
<td>0.01237</td>
<td>0.0129</td>
<td>0.01035</td>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>Wood &amp; pulp</td>
<td>0.0286</td>
<td>0.0346</td>
<td>0.02268</td>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>Chemicals</td>
<td>0.02763</td>
<td>0.0276</td>
<td>0.03156</td>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>Petroleum and Coal</td>
<td>0.0021</td>
<td>0.0021</td>
<td>0.00139</td>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>Non-Ferrous Metals</td>
<td>0.0238</td>
<td>0.0258</td>
<td>0.02602</td>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>Iron &amp; Steel</td>
<td>0.0012</td>
<td>0.0012</td>
<td>0.00000</td>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>General Machinery</td>
<td>0.0316</td>
<td>0.0316</td>
<td>0.00140</td>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>Electric Machinery</td>
<td>0.0003</td>
<td>0.0003</td>
<td>0.00000</td>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>Transportation Equipment</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.00000</td>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>Precision Instruments</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.00000</td>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>Other Manufacturing</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.00000</td>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>Construction</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.00000</td>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>Wholesale and Retail Trade</td>
<td>0.0172</td>
<td>0.0172</td>
<td>0.00000</td>
<td>0.00000</td>
<td>0.00000</td>
</tr>
</tbody>
</table>

Note: Shadowing indicates more than 0.01.

Secondly, the input coefficients of JMNs in the iron and steel industry from petroleum and coal, and general machinery industries in China decreased 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 Japan and China. The strong
intra-industrial production linkages between firms in Japan and China are the remarkable specificity of the iron and steel industry.

Thirdly, the change in the input coefficients of JMN in the electrical machinery industry arouses great interest, because it implies changes in the behaviours and organizational architectures of Japanese electrical machinery firms. The input coefficients from the non-ferrous metals, electrical machinery, and wholesale and retail trade industries in China increased remarkably from 1995 to 2000. This is an important change in the input-output structures of JMN in the electrical machinery industry behind the increase in their local procurements which we have seen in Section 2.

Fourthly, the input coefficients of JMN in the transportation equipment industry from the non-ferrous metals, iron and steel, electrical machinery, transportation equipment, other manufacturing, and wholesale and retail trade industries in China were high and stable in both 1995 and 2000. The input coefficients of JMN in the transportation equipment industry from JMN within the same industry increased from 1995 to 2000, and this showed that JMN 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 JMN in China increased greatly from 1995 to 2000. This means that the “induced export effect” of the operation and plant investment of JMN has increased in the transportation equipment industry.

4.2 Evolution of Japanese Multinational Firms Behind Increasing International Production Linkages

In order to understand structural changes in international production linkages in economic integration processes in East Asia, 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. The summary of the analysis is shown in TABLE 5.

As for relevant researches on the firm system and institutional arrangement in Japan, see Aoki and Dore (1994). Aoki (2001) also summarizes the recent development of the theoretical framework of “comparative institutional analysis”. Boyer and Yamada (eds.) (2000) analyzes institutional arrangements in the post-war Japanese economy and its growth regimes for different periods from the viewpoint of “regulation theory”. Coriat, B., Petit, P. and Schméder, G. (2006) also explains how globalisation and economic integration are in process, affecting each other, and emphasizes that FDI flows, which promote regional integration processes, still remain unstable in East Asia.
## TABLE 5 Interpretation of International Production Linkages -From the Institutional Point of View-

<table>
<thead>
<tr>
<th>Backward Linkages</th>
<th>Textile</th>
<th>Iron and Steel</th>
<th>Electrical Machinery</th>
<th>Transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHINA</td>
<td>Increasing local procurements, the purchase of materials from agriculture and commercial</td>
<td>Low local procurements, and decreasing production-inducing effect</td>
<td>Increasing local procurements and increasing production-inducing effects from the late 1990s</td>
<td>Profitable operation with high local procurements and strong production-inducing effects</td>
</tr>
<tr>
<td>JMNs</td>
<td>Purchasing materials from JMNs within the textile industry</td>
<td>Purchasing materials from JMNs within the iron and steel industry</td>
<td>Increasing open procurements and weakened production linkages between JMNs</td>
<td>Transfer of subcontractors’ plants to China</td>
</tr>
<tr>
<td>JAPAN</td>
<td>Decreasing procurements from domestic plants in Japan</td>
<td>Little import of manufactured goods from Japan</td>
<td>Import of components from related firms in Japan</td>
<td>Induced-export effect from Japanese subcontractors and steel producers</td>
</tr>
</tbody>
</table>

### Industrial Specificities of Institutional Architectures

<table>
<thead>
<tr>
<th>Textile</th>
<th>Iron and Steel</th>
<th>Electrical Machinery</th>
<th>Transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spinning and manufacturing processes depend on low wage workers</td>
<td>The process industry with big centralized plants</td>
<td>Increasing modularization of products, but some integrated production processes remain, Export market-oriented originally, but increasingly Chinese market-oriented</td>
<td>Integrated production process with subcontractor networks (Just-in-time), Chinese market-oriented</td>
</tr>
</tbody>
</table>

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, supported by the expansion of the Chinese market and their high profitability which was seen in Section 2.

In the 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 co-ordinated in a
“vertical value chain”. However, the design rules of electrical products, for example, PC and VTR, have been “modularised”, and the co-ordinating mechanism of production and transaction processes has changed since the mid-1990s. 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 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.

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. 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. In this sense, there is asymmetry in value-added creation between electrical machinery firms operating 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. Conclusion

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

9 As for the “architecture” of manufacturing firms in China, see Fujimoto (2007), Fujimoto and Shintaku (2005). The original idea of design rules and “modularization” was presented by Baldwin and Clark (2000).

10 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.

11 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).
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 dropped 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 during the East Asian crisis.

Secondly, international production linkages have become deeper and wider recently, promoted by the activities of 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 electrical machinery industry in 1995, but the effect increased considerably in the electrical 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.

Thirdly, different backward linkages of Japanese multinationals in 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, supported by the shift of Japanese subcontractors’ plants to China. In the future, 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.

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