Input-Output Analysis of the Interdependence between Japan and China through Japanese Overseas Production [1]

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Abstract

As is well known, China has been expanding for 30 years after opening her economy and introducing market mechanism in it. In that process, foreign direct investment has taken important role, and many foreign firms including Japan have built their plants and branches in China. These overseas production changes the pattern of international trade between Japan and China. METI, Japan and National Bureau of Statistics, China has cooperatively compiled 2007 Japan-China International Input-Output table, with 77 sectors for each country. This table captures the latest interdependent structure between them. Using METI Statistics "Survey of Overseas Business Activities," we reconstruct the table as one that extracts Japanese production activities from China. Here we use micro data of about 3600 establishments in this Survey Statistics. The table consists of Japan, China except Japanese subsidiaries, and Japanese subsidiary activities in China with 30 sectors for each. With this recompiled input-output table, we discuss on two topics. One is the regional contribution of value added and import against one unit increase of final demand in Japanese subsidiary sector. The other is simulation analysis of production shift from Japan to China.

Keywords: *Overseas Production, Production shift, Micro Data, Input-Output Analysis*

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Contents

1. Introduction

Globalization of economies has made firms in developed countries expand their plants and branches to foreign countries, and to supply their products to all countries in the world. Their motivations would be considered reduction of the production costs, strengthening of the competitive advantages, and development of new market, and so on. International relocation of production plans introduces segmentation and internationalization of the production process, in which international trade within firm or within industry takes important role.

Figure 1 shows Japanese foreign direct investment and regional shares of her overseas production in 2007. Because yen was appreciated to dollar gradually after latter half of 1980s, Japanese firms started advancing their plants and blanches abroad, the US, Europe, and Asian countries, especially China.

On the other hand, Chinese economy has been continuously growing after the introduction of market mechanism into its own economy. Foreign direct investment from abroad took important role in this expansion. Figure 2 shows the trend of foreign direct investment in China after 1985 and shares of investing countries in 2007. Though the FDI ratio to GDP has been declining after the peak of 1994, the value are still growing. The largest investing region is Hong Kong, 38 percent, and the investment from Asian countries are more than half, and Japan invests to China was about 5 percent.

The economic interdependence between Japan and China has strengthened more and more through the international trade and direct investment. The Japan-China Input Output Tables is one of the important tools to investigate such relations. Here we will focus on the production activities of Japanese subsidiaries in China, and investigate the role of the Japanese firms in the economic relation between Japan and China, reconstructing the Japan-China International Input-Output table, that includes production activities of Japanese subsidiaries in China as explicit sectors.

Figure 1

Figure 2

Basic idea of reconstructing an international input-output table to include Japanese overseas activities as explicit sectors was proposed in Yamada (2001), and Yamada (2002). In these papers, using 1995 Japan-US international input-output table of METI, he investigated the impact analysis of Japanese overseas production in the US on Japanese economy. METI (2005) applied this analytical framework to their research using 2000 Japan-US international input-output table. Yamada (2004, 2006, 2007) examined comparative analysis of overseas production activities of Japanese subsidiaries in the US and Asia, using 1995 and 2000 IDE Asia International Input-Output Table. Teng Jiang and Fang Wenhui (2008) applied almost similar analytical framework to Japan-China relations, using 1995 and 2000 Japan-China international Input-Output Table. This paper runs on the same line with following two characteristics: firstly to apply the latest economic structures of 2007 Japan-China International Input-Output Table, secondly to use micro data of Basic Survey of Overseas Business Activities, METI, Japan[2].

In the next section, we discuss the theoretical framework of reconstructed Japan-China International Input-Output Analysis on Japanese Overseas Production.

[2] Though focusing on the overseas production of Japanese firms, our model is different as the enterprise input output model as Albino, Dietzenbacher, and Kühtz (2003), Marangoni, Colombo, and Fezzi (2004), and Matsumoto and Fujimoto (2008).

In the third section, the method to reconstruct the Input-output table for the analysis will be explained briefly. Induced value added and import by one unit of final demand and some simulation analysis on production shift of Japanese firms from Japan and China are examined in the following sections. Brief concluding comments appear finally.

2. Theoretical Model

Typical international input-output table of two countries is expressed as Table 1. Here, the suffix "j" notes Japan, and the suffix "c" China. Vector $\mathbf{x}_i$ means output of i-th country, and matrix $\mathbf{X}_{ij}$ is intermediate input matrix, showing input of i-th country's products in j-th country's activities. Vector $\mathbf{F}_{ij}$ indicates final demand of i-th country's products in j-th country, and Vector $\mathbf{E}_i$ and $\mathbf{M}_i$ mean export and import of i-th country's products to the rest of the world (ROW) respectively.

Here we focus the Japanese overseas production in China. These activities are included Chinese transactions. So output vector $\mathbf{x}_c$ is able to be divided into two vectors; $\mathbf{x}_2$ for non-Japanese subsidiaries and $\mathbf{x}_3$ for Japanese subsidiaries. Intermediate input matrices, final demand vectors, and export vectors of China are also able to be separated into production activities of Japanese subsidiaries and others. When we treat Japanese subsidiaries in China as separate activities and express the suffix 1 for Japan, the suffix 2 for Chinese without Japanese subsidiaries, and suffix 3 for Japanese subsidiaries in China, the input-output table in Table 1 is revised as Table 2.

Table 1

Table 2

In Table 2, $\mathbf{X}_{i3}$ shows the intermediate input of Japanese subsidiaries from each country or region. Some inputs are imported from Japan, some are obtained from the others in China, and some are from the ROW. $\mathbf{F}_{i3}$ means the investment demand of

Japanese subsidiaries. Some machines are imported from Japan, some are gained in China, and some are from the ROW.

Our purpose is to recompile the input output table in table 1 to that in table 2, using METI survey database. However, it is difficult to separate final demand into two parts, though total investment of Japanese subsidiaries is able to be estimated. We have little information on how much investment is obtained from each region; Japan, China, and the ROW. So we have to concentrate our attention to the input structure of Japanese subsidiaries in China, shown as Table 3, where there is no separation in final demand of Japanese subsidiaries.

Table 3

The input-output model for table 3 is expressed as the following,

$$\begin{bmatrix} \mathbf{x}_1 \\ \mathbf{x}_2 \\ \mathbf{x}_3 \end{bmatrix} = \begin{bmatrix} \mathbf{A}_{11} & \mathbf{A}_{12} & \mathbf{A}_{13} \\ \mathbf{A}_{21} & \mathbf{A}_{22} & \mathbf{A}_{23} \\ \mathbf{A}_{31} & \mathbf{A}_{32} & \mathbf{A}_{33} \end{bmatrix} \begin{bmatrix} \mathbf{x}_1 \\ \mathbf{x}_2 \\ \mathbf{x}_3 \end{bmatrix} + \begin{bmatrix} \mathbf{F}_{11} \\ \mathbf{F}_{21} \\ \mathbf{F}_{31} \end{bmatrix} + \begin{bmatrix} \mathbf{F}_{12} \\ \mathbf{F}_{22} \\ \mathbf{F}_{32} \end{bmatrix} + \begin{bmatrix} \mathbf{E}_1 \\ \mathbf{E}_2 \\ \mathbf{E}_3 \end{bmatrix} \quad (1),$$

where matrix $\mathbf{A}_{ij}$ means input coefficient matrix of j-th country on i-th country's product. Solving the equation (1), we obtain the output determined by final demands as the equation (2).

$$\begin{bmatrix} \mathbf{x}_1 \\ \mathbf{x}_2 \\ \mathbf{x}_3 \end{bmatrix} = \begin{bmatrix} \mathbf{B}_{11} & \mathbf{B}_{12} & \mathbf{B}_{13} \\ \mathbf{B}_{21} & \mathbf{B}_{22} & \mathbf{B}_{23} \\ \mathbf{B}_{31} & \mathbf{B}_{32} & \mathbf{B}_{33} \end{bmatrix} \left(\begin{bmatrix} \mathbf{F}_{11} \\ \mathbf{F}_{21} \\ \mathbf{F}_{31} \end{bmatrix} + \begin{bmatrix} \mathbf{F}_{12} \\ \mathbf{F}_{22} \\ \mathbf{F}_{32} \end{bmatrix} + \begin{bmatrix} \mathbf{E}_1 \\ \mathbf{E}_2 \\ \mathbf{E}_3 \end{bmatrix} \right) \quad (2),$$

In this equation, matrix $\mathbf{B}_{ij}$ is the Leontief inverse matrix. Multiplying value added coefficient matrix $\hat{\mathbf{V}}_i$ and import coefficient matrix $\mathbf{A}_{4j}$ to the output vector, the corresponding value added vectors and import vectors are reduced respectively.

$$\begin{bmatrix}\mathbf{V}_1\\ \mathbf{V}_2\\ \mathbf{V}_3\end{bmatrix}=\begin{bmatrix}\hat{\mathbf{V}}_1 & \mathbf{0} & \mathbf{0}\\ \mathbf{0} & \hat{\mathbf{V}}_2 & \mathbf{0}\\ \mathbf{0} & \mathbf{0} & \hat{\mathbf{V}}_3\end{bmatrix}\begin{bmatrix}\mathbf{x}_1\\ \mathbf{x}_2\\ \mathbf{x}_3\end{bmatrix}$$
$$=\begin{bmatrix}\hat{\mathbf{V}}_1\mathbf{B}_{11} & \hat{\mathbf{V}}_1\mathbf{B}_{12} & \hat{\mathbf{V}}_1\mathbf{B}_{13}\\ \hat{\mathbf{V}}_2\mathbf{B}_{21} & \hat{\mathbf{V}}_2\mathbf{B}_{22} & \hat{\mathbf{V}}_2\mathbf{B}_{23}\\ \hat{\mathbf{V}}_3\mathbf{B}_{31} & \hat{\mathbf{V}}_3\mathbf{B}_{32} & \hat{\mathbf{V}}_3\mathbf{B}_{33}\end{bmatrix}\left[\begin{bmatrix}\mathbf{F}_{11}\\ \mathbf{F}_{21}\\ \mathbf{F}_{31}\end{bmatrix}+\begin{bmatrix}\mathbf{F}_{12}\\ \mathbf{F}_{22}\\ \mathbf{F}_{33}\end{bmatrix}+\begin{bmatrix}\mathbf{E}_1\\ \mathbf{E}_2\\ \mathbf{E}_3\end{bmatrix}\right] \quad (3),$$

$$\begin{bmatrix}\mathbf{M}_1\\ \mathbf{M}_2\\ \mathbf{M}_3\end{bmatrix}=\begin{bmatrix}\mathbf{A}_{41} & \mathbf{0} & \mathbf{0}\\ \mathbf{0} & \mathbf{A}_{42} & \mathbf{0}\\ \mathbf{0} & \mathbf{0} & \mathbf{A}_{43}\end{bmatrix}\begin{bmatrix}\mathbf{x}_1\\ \mathbf{x}_2\\ \mathbf{x}_3\end{bmatrix}$$
$$=\begin{bmatrix}\mathbf{A}_{41}\mathbf{B}_{11} & \mathbf{A}_{41}\mathbf{B}_{12} & \mathbf{A}_{41}\mathbf{B}_{13}\\ \mathbf{A}_{42}\mathbf{B}_{21} & \mathbf{A}_{42}\mathbf{B}_{22} & \mathbf{A}_{42}\mathbf{B}_{23}\\ \mathbf{A}_{43}\mathbf{B}_{31} & \mathbf{A}_{43}\mathbf{B}_{32} & \mathbf{A}_{43}\mathbf{B}_{33}\end{bmatrix}\left[\begin{bmatrix}\mathbf{F}_{11}\\ \mathbf{F}_{21}\\ \mathbf{F}_{31}\end{bmatrix}+\begin{bmatrix}\mathbf{F}_{12}\\ \mathbf{F}_{22}\\ \mathbf{F}_{33}\end{bmatrix}+\begin{bmatrix}\mathbf{E}_1\\ \mathbf{E}_2\\ \mathbf{E}_3\end{bmatrix}\right] \quad (4).$$

Here, the sum of the value added and import demand induced by some independent change of final demand equals to the value of the total change. We can evaluate the contributions of each region in term of the induced value added and import demand.

Furthermore, $\mathbf{F}_{31}$, $\mathbf{F}_{32}$, $\mathbf{E}_3$ exhibit the export to Japan of final goods produced by Japanese subsidiaries, the sales of final goods by Japanese subsidiaries to Chinese local market, and export to the ROW, respectively. If we set all other final demand as zero in equations (2), (3), and (4), we are able to acquire the output, value added, and import demands that are induced by the final goods produced by Japanese subsidiaries.

$$\begin{bmatrix}\mathbf{x}_1\\ \mathbf{x}_2\\ \mathbf{x}_3\end{bmatrix}=\begin{bmatrix}\mathbf{B}_{11} & \mathbf{B}_{12} & \mathbf{B}_{13}\\ \mathbf{B}_{21} & \mathbf{B}_{22} & \mathbf{B}_{23}\\ \mathbf{B}_{31} & \mathbf{B}_{32} & \mathbf{B}_{33}\end{bmatrix}\left[\begin{bmatrix}\mathbf{0}\\ \mathbf{0}\\ \mathbf{F}_{31}\end{bmatrix}+\begin{bmatrix}\mathbf{0}\\ \mathbf{0}\\ \mathbf{F}_{32}\end{bmatrix}+\begin{bmatrix}\mathbf{0}\\ \mathbf{0}\\ \mathbf{E}_3\end{bmatrix}\right],$$

$$\begin{bmatrix}\mathbf{V}_1\\ \mathbf{V}_2\\ \mathbf{V}_3\end{bmatrix}=\begin{bmatrix}\hat{\mathbf{V}}_1\mathbf{B}_{11} & \hat{\mathbf{V}}_1\mathbf{B}_{12} & \hat{\mathbf{V}}_1\mathbf{B}_{13}\\ \hat{\mathbf{V}}_2\mathbf{B}_{21} & \hat{\mathbf{V}}_2\mathbf{B}_{22} & \hat{\mathbf{V}}_2\mathbf{B}_{23}\\ \hat{\mathbf{V}}_3\mathbf{B}_{31} & \hat{\mathbf{V}}_3\mathbf{B}_{32} & \hat{\mathbf{V}}_3\mathbf{B}_{33}\end{bmatrix}\left[\begin{bmatrix}\mathbf{0}\\ \mathbf{0}\\ \mathbf{F}_{31}\end{bmatrix}+\begin{bmatrix}\mathbf{0}\\ \mathbf{0}\\ \mathbf{F}_{33}\end{bmatrix}+\begin{bmatrix}\mathbf{0}\\ \mathbf{0}\\ \mathbf{E}_{31}\end{bmatrix}\right],$$

$$\begin{bmatrix}\mathbf{M}_1\\ \mathbf{M}_2\\ \mathbf{M}_3\end{bmatrix}=\begin{bmatrix}\mathbf{A}_{41}\mathbf{B}_{11} & \mathbf{A}_{41}\mathbf{B}_{12} & \mathbf{A}_{41}\mathbf{B}_{13}\\ \mathbf{A}_{42}\mathbf{B}_{21} & \mathbf{A}_{42}\mathbf{B}_{22} & \mathbf{A}_{42}\mathbf{B}_{23}\\ \mathbf{A}_{43}\mathbf{B}_{31} & \mathbf{A}_{43}\mathbf{B}_{32} & \mathbf{A}_{43}\mathbf{B}_{33}\end{bmatrix}\left[\begin{bmatrix}\mathbf{0}\\ \mathbf{0}\\ \mathbf{F}_{31}\end{bmatrix}+\begin{bmatrix}\mathbf{0}\\ \mathbf{0}\\ \mathbf{F}_{33}\end{bmatrix}+\begin{bmatrix}\mathbf{0}\\ \mathbf{0}\\ \mathbf{E}_{31}\end{bmatrix}\right].$$

On the other hand, in equation (2), final goods produced in Japan consists of three parts; demand of domestic market in Japan $\mathbf{F}_{11}$, export to China $\mathbf{F}_{12}$, and export to the ROW $\mathbf{E}_1$. Any change of these three parts affects not only Japanese production but also production in China, Japanese subsidiaries and non-Japanese subsidiaries. Such impacts on value added, directly and indirectly, are evaluated from the following equation,

$$\begin{bmatrix}\mathbf{V}_1\\ \mathbf{V}_2\\ \mathbf{V}_3\end{bmatrix} = \begin{bmatrix}\hat{\mathbf{V}}_1\mathbf{B}_{11} & \hat{\mathbf{V}}_1\mathbf{B}_{12} & \hat{\mathbf{V}}_1\mathbf{B}_{13}\\ \hat{\mathbf{V}}_2\mathbf{B}_{21} & \hat{\mathbf{V}}_2\mathbf{B}_{22} & \hat{\mathbf{V}}_2\mathbf{B}_{23}\\ \hat{\mathbf{V}}_3\mathbf{B}_{31} & \hat{\mathbf{V}}_3\mathbf{B}_{32} & \hat{\mathbf{V}}_3\mathbf{B}_{33}\end{bmatrix}\begin{bmatrix}\mathbf{e}_1\\ \mathbf{0}\\ \mathbf{0}\end{bmatrix} \qquad (5),$$

where $\mathbf{e}_1$ shows one unit change of some sector in Japan.

Similarly, expressing one unit change of some sector in China, non-Japanese subsidiaries and Japanese subsidiaries as $\mathbf{e}_2$ and $\mathbf{e}_3$, respectively, we can evaluate the effects on value added as the followings,

$$\begin{bmatrix}\mathbf{V}_1\\ \mathbf{V}_2\\ \mathbf{V}_3\end{bmatrix} = \begin{bmatrix}\hat{\mathbf{V}}_1\mathbf{B}_{11} & \hat{\mathbf{V}}_1\mathbf{B}_{12} & \hat{\mathbf{V}}_1\mathbf{B}_{13}\\ \hat{\mathbf{V}}_2\mathbf{B}_{21} & \hat{\mathbf{V}}_2\mathbf{B}_{22} & \hat{\mathbf{V}}_2\mathbf{B}_{23}\\ \hat{\mathbf{V}}_3\mathbf{B}_{31} & \hat{\mathbf{V}}_3\mathbf{B}_{32} & \hat{\mathbf{V}}_3\mathbf{B}_{33}\end{bmatrix}\begin{bmatrix}\mathbf{0}\\ \mathbf{e}_2\\ \mathbf{0}\end{bmatrix} \qquad (6),$$

$$\begin{bmatrix}\mathbf{V}_1\\ \mathbf{V}_2\\ \mathbf{V}_3\end{bmatrix} = \begin{bmatrix}\hat{\mathbf{V}}_1\mathbf{B}_{11} & \hat{\mathbf{V}}_1\mathbf{B}_{12} & \hat{\mathbf{V}}_1\mathbf{B}_{13}\\ \hat{\mathbf{V}}_2\mathbf{B}_{21} & \hat{\mathbf{V}}_2\mathbf{B}_{22} & \hat{\mathbf{V}}_2\mathbf{B}_{23}\\ \hat{\mathbf{V}}_3\mathbf{B}_{31} & \hat{\mathbf{V}}_3\mathbf{B}_{32} & \hat{\mathbf{V}}_3\mathbf{B}_{33}\end{bmatrix}\begin{bmatrix}\mathbf{0}\\ \mathbf{0}\\ \mathbf{e}_3\end{bmatrix} \qquad (7).$$

Here we obtain the effect of the production shift by Japanese firms to China, reducing one unit of final demand in Japan and increasing one unit of final demand in the corresponding sector of China, Japanese subsidiary.

$$\begin{bmatrix}\mathbf{V}_1\\ \mathbf{V}_2\\ \mathbf{V}_3\end{bmatrix} = \begin{bmatrix}\hat{\mathbf{V}}_1\mathbf{B}_{11} & \hat{\mathbf{V}}_1\mathbf{B}_{12} & \hat{\mathbf{V}}_1\mathbf{B}_{13}\\ \hat{\mathbf{V}}_2\mathbf{B}_{21} & \hat{\mathbf{V}}_2\mathbf{B}_{22} & \hat{\mathbf{V}}_2\mathbf{B}_{23}\\ \hat{\mathbf{V}}_3\mathbf{B}_{31} & \hat{\mathbf{V}}_3\mathbf{B}_{32} & \hat{\mathbf{V}}_3\mathbf{B}_{33}\end{bmatrix}\begin{bmatrix}-\mathbf{e}_1\\ \mathbf{0}\\ \mathbf{e}_3\end{bmatrix} \qquad (8)$$

This is one method to measure the effect of production shift of Japanese firm to China; concretely, (1) the case that Japanese firm changes domestically supplied final goods to import goods produced in China, (2) the case that they change the exported goods from Japan to local production in China, and (3) the case that they change final goods, which is exported from Japan to the world market like US, to those that they produce

in China and export to the third market.

On the other hand, the final goods that are produced in Japan might be substituted by those that produced by Chinese firms. Such effect is calculated as the following,

$$\begin{bmatrix} \mathbf{V}_1 \\ \mathbf{V}_2 \\ \mathbf{V}_3 \end{bmatrix} = \begin{bmatrix} \hat{\mathbf{V}}_1 & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \hat{\mathbf{V}}_2 & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \hat{\mathbf{V}}_3 \end{bmatrix} \begin{bmatrix} \mathbf{B}_{11} & \mathbf{B}_{12} & \mathbf{B}_{13} \\ \mathbf{B}_{21} & \mathbf{B}_{22} & \mathbf{B}_{23} \\ \mathbf{B}_{31} & \mathbf{B}_{32} & \mathbf{B}_{33} \end{bmatrix} \begin{bmatrix} -\mathbf{e}_1 \\ \mathbf{e}_2 \\ \mathbf{0} \end{bmatrix} \quad (9).$$

In this case, (1) the case that the final goods that are produced in Japan are replaced import goods from Chinese firms, (2) the case that the final goods, that are exported from Japan to China, is substituted by the local goods of Chinese firms, and (3) the case that the exported goods from Japan to the world market are replaced those of Chinese firms.

3. Reconstruction of Japan-China International Input-Output Table

In this section, we discuss about the method to reconstruct the Input-Output Table suitable to treat Japanese overseas production as explicit sector. Table 4 shows the relation between the original Input-Output table in Table 1 and the modified table in Table 3. Here, the values of shaded area have to be estimated in some way. Comparing each definition of sectors between 2007 Japan-China International Input-Output Table and the Survey of Overseas Business Activities of METI, we firstly compile the Input-Output Table from 77 sectors to 63 sectors. Then, using the information of METI survey micro data on sales and procurement of Japanese subsidiary in China, we reconstruct the table[3].

[3] Sample sizes for Chia (main land) are 3521 and 3781 for 2006 and 2007 Overseas Business Survey, METI, respectively. Survey data are of fiscal year. Among them we pick up 3332 and 3648 sample respectively, excluding data without information on production value. We calculate, for each year, sales and purchasing intermediate goods by region for 63 sectors. There are differences in sample size by sector for two year. So we calculated sales and purchasing values of calendar year as weight average of two year values, after adjusting size of 2006 suit to that of 2007.

Table 4

From the METI survey database, we are able to acqurie the following information. At first, we regard the sales values for each sector of Japanese subsidiary as product values, $\mathbf{X_3}$, ignoring the change of inventory[4]. Then we obtain the output of non-Japanese subsidiary in China, $\mathbf{X_2}$, by subtracting output of Japanese subsidiary, $\mathbf{X_3}$ from Chinese output, $\mathbf{X_c}$.

Assuming the ratio of purchase values of intermediate goods to total sales values equal to the intermediate input ratio, we are able to estimate the total value of intermediate input for each sector of Japanese subsidiary. This equals to the column sum of $\mathbf{X_{13}}$, $\mathbf{X_{23}}$, $\mathbf{X_{33}}$, and $\mathbf{X_{43}}$ for each sector. We obtain the column sum of the value added, $\mathbf{V_3}$, subtracting the sum of intermediate input from the output value, $\mathbf{X_3}$.

Then we are able to acquire each sectoral input value from Japan, China, and the ROW, multiplying the regional purchasing ratio, which is calculated from the METI survey database, to the total intermediate input values by sector. They are the column sums of $\mathbf{X_{13}}$, $\mathbf{X_{c3}}$, $\mathbf{X_{43}}$, respectively. From the METI database, we are able to obtain the more detailed information on the purchasing intermediate input goods from Japanese or non-Japanese firm[5]. So using this information, we can divide the total purchasing value in China, $\mathbf{X_{c3}}$, into two parts; one from Japanese subsidiary, which is the column sum of $\mathbf{X_{33}}$, and the other from non-Japanese firm, the column sum of $\mathbf{X_{23}}$.

To estimate each cell value of input structure, we need more detail information. Here we use the elements of the actual input vector as reference indices to share the total value into each cell value. For example, each cell value of $\mathbf{X_{13}}$ is obtained by multiplying $a_{jc}/\sum_j a_{jc}$ to the column sum of $\mathbf{X_{13}}$, which is already estimated. Similarly, for each cell value of $\mathbf{X_{43}}$ is calculated by multiplying $a_{wc}/\sum_w a_{wc}$ to the column sum of $\mathbf{X_{43}}$, which is also estimated.

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[4] The difference between sales and product is change in inventory of product. However we are not able to acquire the information of the inventory on Japanese subsidiary. So we adopt the assumption that there is no change in inventory, which give that sales value is equal to product value. However, for "Wholesale and retail trades" sector, we set the product value as the difference between sales value and purchasing goods.

[5] This ratio is also value for 2009 survey data. So we apply similar modification as done for the ratio sold for Japanese subsidiary.

Returning to the row-wise aspect of demand-supply, we are able to acquire regional sales shares[6] by sector from the METI survey database. So using these shares, we estimate regional sales values to Japan, China, and the ROW, which are corresponding to the row-sum values of ($\mathbf{X}_{31}$ and $\mathbf{F}_{31}$), ($\mathbf{X}_{c3}$ and $\mathbf{F}_{32}$), and $\mathbf{E}_3$ respectively. METI database gives us the information on how much is the share of intermediate goods to the total output for each sector[7]. So we can divide the sum value of ($\mathbf{X}_{31}$ and $\mathbf{F}_{31}$) into the sum of intermediate demand $\mathbf{X}_{31}$ and the sum of final demand $\mathbf{F}_{31}$. Similarly, for the sales in China, we can set separate values $\mathbf{X}_{c3}$ and $\mathbf{F}_{32}$. More information how much Japanese subsidiary sells to Japanese subsidiary in China by sector is available from METI database[8]. So here we use these sales ratios to separate row-sum values of $\mathbf{X}_{32}$ and $\mathbf{X}_{33}$ from the row-sum value of $\mathbf{X}_{C3}$ by sector.

For each cell value, we have to estimate with more information or additional assumption. Here we calculate values for each cell of $\mathbf{X}_{31}$ by assuming the export pattern of intermediate goods from China to Japan has no difference between Japanese subsidiary and non-Japanese subsidiary. Also values for each cell of final goods $\mathbf{F}_{31}$, $\mathbf{F}_{32}$ are determined by assuming that shares of consumption and investment are same for any suppliers, Japanese subsidiary and non-Japanese subsidiary[9]. For $\mathbf{X}_{33}$, which is the transaction matrix of intermediate goods between Japanese subsidiaries in China, both column-sum and row-sum are independently estimated for each sector.

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6 There are firms that do not fill sales values by regions, though answer the value for total sales. We have calculated the regional sales ratio by excluding such firms.

7 The shares of intermediate goods and final goods are newly added items after 2008 survey and not found in both 2006 and 2007 surveys. We request to use micro data of 2008 and 2009 surveys. However we are not able to obtain the permission. Then we have to use published data in 2008 and 2009 survey report. These data are more aggregated by sector than that we define. So we use these data with some modifications. The published data on the share of intermediate goods and final goods are those of firms that produce mainly intermediate goods or final goods. So we had better to use these shares as weighted value with the product values as the weight, which are able to obtain only micro data are opened.

8 "Sales to Japanese subsidiary in China" is newly added as an item of 2009 questionnaire. This information is very important to estimate the transaction among Japanese subsidiaries in China. Unfortunately we are not able to acquire the permission to use the micro data of 2009 survey in spite of our request. So we have to use officially aggregated data in 2009 survey report with same modification.

9 Final demand parts, consumption and investment, of Japanese subsidiary sector are shared by using actual consumption and investment in Japan and China, and the change in inventory is assumed as zero principally. Final demand parts of non-Japanese subsidiary are obtained by subtracting the estimated value from the value in China.

So we apply RAS method[10] to acquire the cell values of the matrix, with corresponding input coefficients of original input-output table as initial values, after arranging both sum values so that their sum is equal to their average.

The other matrices to be estimated are obtained by subtraction like $X_{21}=X_{cj}-X_{31}$. However, such estimation gives inconsistent values in some sectors. In such cases, we make some modifications. For example, for import of Japan from Japanese subsidiary, we do not use METI survey's share information but actual share in the original input output table.

For value added sector, we estimate sectoral compensation of employee by multiplying the ratio of total salary of employee to sales value from METI survey database to the corresponding output value. Information on depreciation and indirect tax and subsidies are not available, so we estimate them by using actual ratio to output value for corresponding sector in China. And business surplus are estimated as the residual of the value added sectors, by subtracting item values above cited.

The reconstructed Japan-China input output tables, transaction table and input coefficient table, with one sector for each region and Japanese subsidiary are shown in Table 5. Transaction flow, output and value added, appears in Figure 3, where the output of Japan amounts to 8,190.0 billion US dollar, and value added is 4,197.4 billion US dollar, exporting final goods and intermediate goods to China except Japanese subsidiary are 29.9 billion US dollar and 89.4 billion US dollar respectively. Japan also imports final goods and intermediate goods, 63.1 billion US dollar and 40.2 billion US dollar respectively, from China except Japanese subsidiary. Export of intermediate goods of Japanese subsidiary in China to Japan amounts to 20.3 billion US dollar, and import of final goods and intermediate goods are 11.3 billion US dollar and 15.6 billion US dollar respectively.

The output of China except Japanese subsidiary is 10,705.5 billion US dollar, and the value added is 3,455.8 billion US dollar. On the other hand, the output of Japanese subsidiary is 141.3 billion US dollar, and its value added is 43.0 billion US

[10] Here we use the domestic input coefficient of China as initial value, just as applying same coefficient when we estimate the input coefficient of Japanese subsidiary in China.

dollar with purchase from Chinese firm by 50.7 billion US dollar, import from Japan by 20.3 billion US dollar, and import from the ROW by 10.1 billion US dollar. Japanese subsidiary supplies intermediate goods and final goods by 35.9 billion US dollar and 38.8 billion US dollar respectively to China, by 15.6 billion US dollar and 11.3 billion US dollar respectively to Japan, and by 228 billion US dollar to the ROW.

Table 5

Figure 3

Figure 4 shows final goods of Japanese subsidiary by 30 sectors, which is accumulated three components; sales to China market, export to Japan, and export to the ROW. And Figure 5 shows shares of them by sector. From the figures, we can observe the following characteristics. Firstly, "General machinery", "Household electronic equipment, Communications equipment", "Household electric and non-electric equipment", "Electronic component", "Industrial electric equipment", and "Motor vehicle" have large in values. Though "General machinery" and almost all sectors in electrical machinery industries supply almost equally to all regions: China, Japan, and the ROW, "Electronic component" sector sells only to the ROW because the products of this sector is mainly not final goods but intermediate goods. Contrarily, sales of "Motor vehicle", which is mainly final goods, concentrate in Chinese market. "Food" supplies mainly to Chinese market, and "Textiles, wearing apparels and leather products" sells mostly to Japan. "Chemical products" and "Steel, Non-Steel, metals, Metal products" does not supply to Japanese market but Chinese and the ROW market.

Figure 4

Figure 5

4. Contribution of Value Added and Import against One Unit Increase of Final

Demand

In this section, we discuss on the contribution of value added and import against one unit increase of final demand. It is well known that one unit increase of final demand in one sector induces direct and indirect product of each sector in the economies, and that the induced value added and import, if aggregated for all sectors of both countries, brings same value as the initial increase of final demand.

Figure 6 shows that the contribution of value added and import against one unit increase of final demand in Japan. Value added in Japan has dominant share for almost all sectors, as expected. The exception is "Petroleum and coal product" sector. Import from the ROW is largely induced against the increase of final demand in "Petroleum and coal products" sector. "Chemical products", "Steel, Non-Steel, metals, Metal products", "Household electronic equipment, Communications equipment", "Electronic computing equipment and accessories", and "Electricity, gas, water" sector also induce larger import demand from the ROW. Import from China, both Japanese subsidiary and non-Japanese subsidiary, is not induced so much as that from the ROW, because the import share from China is not dominant. However, looking each sector, there are several sectors that have relatively strong effect, as "Textiles, wearing apparels and leather products", "Household electronic equipment, Communications equipment", "Industrial electric equipment", "Electronic computing equipment and accessories", and "Motor vehicle", "Precision instruments".

Figure 6

Figure 7 shows that the contribution of value added and import against one unit increase of final demand in China except Japanese subsidiary. Value added in China except Japanese subsidiary has dominant share for almost all sectors with three exceptions, "Household electronic equipment, Communications equipment", "Electronic computing equipment and accessories", and "Precision instruments".

As China has much energy resource, especially coal, the induced import from the ROW is not so large as Japan in case of "Petroleum and coal product" sector. On the

other hand, import from the ROW is largely induced against the increase of final demand in several sector of manufacturing. Japanese contribution is also large for the case of manufacturing; “Precision instruments”, “Electronic computing equipment and accessories”, “Household electronic equipment, Communications equipment”, “Electronic component, “Motor vehicle”, “Other transportation equipment”, and “Plastic and rubber products”. Large contribution of Japanese subsidiary appears in the case of “Motor vehicle”, and “Motor vehicle parts”.

Figure 7

Figure 8 shows that the contribution of value added and import against one unit increase of final demand in Japanese subsidiary in China. Induced value added in Japanese subsidiary is dominant in the limited cases, “Agriculture, Forestry, Husbandry”, “Wholesale and retail trades”, and “Financial services, real estate”. However, adding the value added of both Japanese subsidiary and non-Japanese subsidiary in China, the effect seems similar to those of Chinese case. Of course, there are distinguished characteristics. Firstly, the relation between Japan and Japanese subsidiary is relatively strong. The induced import from Japan is large in case of “Precision instruments”, “Household electronic equipment, Communications equipment”, “Electronic component”, “Textiles, wearing apparels and leather products”, “Industrial electric equipment”, and “Electronic computing equipment and accessories” sector, in which the foreign direct investment from Japan is large. If foreign direct investment and overseas production is increased in the cases above stated, export from Japan to China would increase. However the output of the corresponding sector in Japan might be reduced at the same time, if some independent final demand does not appear in the same sector. In such case, reduced output migght offset the induced import, which we will discuss in the next section.

Figure 8

5. Simulation Analysis of Production shift to China

5.1 Motor vehicle

Firstly, we consider the effect of production shift in ”Motor vehicle” sector by comparing the reduction of value added, which stems from one unit reduction in final demand of this sector in Japan, and the increase of value added, which is induced by one unit increase in final demand of Japanese subsidiary in China.

Figure 9a shows the value added of Japan, China except Japanese subsidiary, and Japanese subsidiary, that is induced by one unit increase of final demand in “Motor vehicle”, Japan, according to the equation (7).

Augmentation in final demand of ”Motor vehicle” sector brings additional demand in “Motor vehicle parts”, “Steel, Non-Steel, metals, Metal products”, “Plastic and rubber products”, and “Electronic component”, as intermediate inputs. Inputs of “Wholesale and retail trades”, “Financial services, real estate”, “Services”, and “Transportation” are also relatively large in the Motor vehicle production in Japan. However, inputs from China, including Japanese subsidiary, are relatively small. Among imported intermediate inputs, relative large effects observed in “Mining”, “Steel, Non-Steel, metals, Metal products”, “Chemical products”, “Electronic component”, and “Industrial electric equipment”.

Figure 9b shows the induced value added and imports, brought by one unit increase of final demand in “Motor vehicle” sector in Japanese subsidiary in China, which is computed by equation (9). Intermediate inputs in this sector are large in sector “Motor vehicle” and “Motor vehicle parts”. The values in these two inputs differ relatively a little bit between in Japan and in China. However, the sum of them brings almost same values, and the pattern of the other inputs is also similar. Input of “Motor vehicle parts” is purchased from Japan and within Chinese market, and input of “Steel, Non-Steel, metals, Metal products” is also purchased within Chinese market. There is large supply of coal in China, so the share of domestic supply in this sector is large comparing Japanese case.

Figure 9a

Figure 9b

Figure 9c

Figure 9c shows the effect of the production shift of "Motor vehicle" sector from Japan to China, computed by equation (10). Naturally, one unit reduction of final demand in Japan's "Motor vehicle" sector brings basically negative impacts on Japan, especially on "Motor vehicle" and "Motor vehicle parts" sector. On the other hand, the increase of "Motor vehicle" final demand in Japanese subsidiary affects positive impacts on these sectors of Japanese subsidiary in China. Increased output of Motor vehicle in China affects positively the production in Japan through the intermediate import input. However negative impacts on Japanese production offset such positive effect because of decrease in Japanese final demand[11].

5.2 Household electric and non-electric equipment

Similar simulation is applied to "Household electric and non-electric equipment" sector, which brings Figure 10a, Figure 10b, and Figure 10c,

Figure 10a

Figure 10b

Figure10c

In Figure 10a, we are able to observe the impacts on value added by sector, brought by one unit increase of final demand in "Household electric and non-electric equipment" sector, Japan. Figure 10b gives similar impacts brought by one unit

[11] In 1980's, the export of motor vehicle from Japan to the US largely increased, and the share of Japanese motor vehicle in the US market was enlarged. At that time, Japanese automobile companies took voluntary control on exporting, and shifted to local production in the US. However, the export of "Motor vehicle" from Japan to China is not so much as that from Japan to the US. And the purpose of overseas production is mainly new expansion into China market of motor vehicle. So there is no evidence that the export of motor vehicle is directly affected by this expansion. Here our simulation might be considered to include the opportunity cost how much "Motor vehicle" in Japan loses the production opportunity if overseas production starts in China.

increase of final demand in the same sector in Japanese subsidiary, China. In both cases, production of "Household electric and non-electric equipment" sector receives the largest impact, and "Steel, Non-Steel, metals, Metal products", "Electronic component" follows then. Figure 10c shows the effect of production shift from Japan to China. In this case, Japanese value added decrease largely in "Household electric and non-electric equipment" sector, which are not able to be offset by the increasing effects brought by the sifted production in Japanese subsidiary, China.

5.3 Household electronic equipment, Communications equipment

Here, we discuss the effects of the production shift in "Household electronic equipment, Communications equipment" sector. Figure 11a shows the impacts on the value added by sector, brought by the change of Japanese final demand. The value added in "Household electronic equipment, Communications equipment", and "Electronic component" has large impacts. Especially, in "Electronic component" sector, the import from the ROW is almost same value to that from Japan, and input from Japanese subsidiary, China is small in both cases.

Figure 11a

Figure 11b

Figure 11c

Figure 11b shows the effects of Japanese subsidiary, China. Similarly, large increase of value added appears in "Household electric and non-electric equipment" and "Electronic component" sector. For "Electronic component" sector, we observe large effects in Japan and the ROW.

Figure 11c shows the effects of the production shift, in which "Household electronic equipment, Communications equipment" sector is affected largely in its value added. However, production shift has no effect on the value added in "Electronic component" sector. This means the main parts of the production in "Household electric and non-electric equipment" are stably supplied from both Japan and the ROW,

actually in Chinese Taipei or Korea, which seams be very interesting results.

5.4 Production shift in manufacturing sectors

So far we have discussed on the effects of production shift for three main sectors, in term of the change in value added and import by sector and regions. Aggregation by sector brings the effects on regions; Japan, China except Japanese subsidiary, Japanese subsidiary in China, and the ROW. Figure 12 shows the regional effects brought by the production shift from Japan to China in each sector[12].

Observing this figure, for the cases of "Household electric and non-electric equipment", "Electronic component", "Electronic computing equipment and accessories", and "Industrial electric equipment", Japanese decrease of value added is relatively small, though relatively large decrease appears in the case of "Motor vehicle" and "Motor vehicle parts".

Figure 13 shows the impacts on the compensation of employees for the production shift in each manufacturing sector. For almost all sectors except "Petroleum and coal products", decrease in Japanese compensation of employees is large in value comparing the Chinese increase in the compensation. This means that production shift to China makes room to save that cost. Actually, comparing each of sectors, "Motor vehicle" and "Motor vehicle parts" sector have large reduction effect on saving the labor cost. However, how much effect on employment should be investigated by the analysis using employment coefficient data in both countries, which is on our future research.

Figure 12

Figure 13

6. Concluding Remarks

The production shift of firms from one country to the other changes the pattern of trade

[12] Because total change of final demands is zero for each sector, the sum of the induced value added and induced import is also to be zero, when the induce change of international freight and insurance.

between them. There is increasing concerns on that such change in international trade structure between Japan and China might induce the hollowing of manufacturing industry. On the other hand, it is widely recognized that foreign direct investment takes important role for Chinese economic development. Input Output Analysis is one of the important tools to investigate such issues.

For the purpose stated above, we tried to reconstruct 2007 Japan-China international Input Output Table to new one, which include production activities of Japanese subsidiary in China as explicit sectors, by using information of METI overseas business survey database. The reconstructed table captures how Japanese firms contributes to Chinese economic development by supplying final goods to Chinese domestic market, exporting to overseas market, and by supplying intermediate goods to support the production of firms in China.

Continuous appreciation of Yen and rapid aging of Japanese population have force for Japanese firms to shrink domestic production and to enlarge overseas production, reducing production cost and seeking new market. According to our simulation on production shift from Japan to China, which is induced from pairwise assumption both one unit decrease of final goods in Japan and one unit increase of final goods produced by Japanese subsidiary in China, we are able to observe the followings; (1) reduction of Japanese value added happens in almost all sector in Japan and dominantly in the corresponding sector, (2) Increase of value added in China, both Japanese subsidiary and non-Japanese subsidiary, induced by the production shift is smaller than the reduction of value added in Japan, (3) change in compensation of employee is also similar to that of value added, which suggest that production shift might be related to the cost reduction.

The effect on employment brought by production shift is also import issue, which we have to plan to investigate after developing the employment table. It is important to capture the characteristics of input structure for Japanese overseas production. Is the cost structure similar to Japanese one or Chinese one? From where and how much do they purchase intermediate goods; Japan, China, and the ROW? METI “overseas business survey” is important to supply such detailed information. We

expect expansion and improvement in such survey statistics in both countries. Finally, because the economic development of China has regional inequality, we have to investigate on the production shift, using of Japan-China transnational interregional input output table, like IDE (2007).

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