

Overseas Production of Japanese Firms and Japan-US Interdependence: An Input-Output Analysis

By
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Abstract

This paper recompiles the Japan-US input-output table of 1995 to analyze the interdependence among Japanese firms, Japanese subsidiaries in the US, and the other US firms. We found the following. First, production of Japanese subsidiaries is hardly affected by the situation in Japan as a whole, but heavily depends on the US market. Second, additional final demand on Japanese subsidiaries increases the Japanese value added base by 13.4 percent, that of the US firms by 33.1 percent, and that of the Japanese subsidiaries by 46.0 percent. This reflects the fact that the local content ratio is increasing in the US market. Third, if manufacturing for export is completely replaced by overseas production in the machinery sector, which is the dominant export sector in Japan, Japan overall loses value added corresponding to 70 percent of initial overseas production, and the US as a whole gains almost the same value.

1. Introduction

The successive appreciation of the Japanese yen over the last twenty-five years has made overseas operations attractive for the Japanese manufacturing firms. After the Plaza Agreement in 1985, this tendency was strengthened. According to the statistics of the Ministry of Finance, the accumulated amount of direct investment from Japanese firms increased to about 725.8 billion yen in 1999, which is twenty times as much as in 1980 (see Figure 1-1).

Figure 1-2 shows the sales of overseas affiliated companies according to the statistics of Ministry of Economy, Trade and Industry (METI) on the overseas production of Japanese firms. In 1996, these sales amounted to 123 trillion yen; 47 trillion yen for the manufacturing sector and 76 trillion yen for non-manufacturing,

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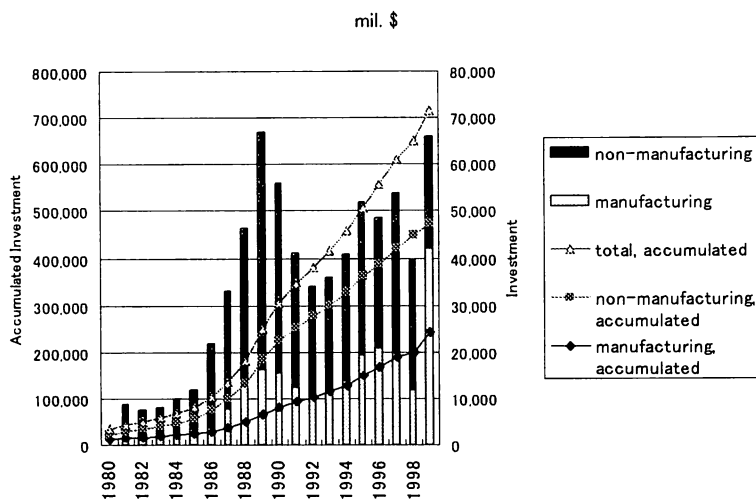


Figure 1-1 Change in Overseas Direct Investment of Japanese firms

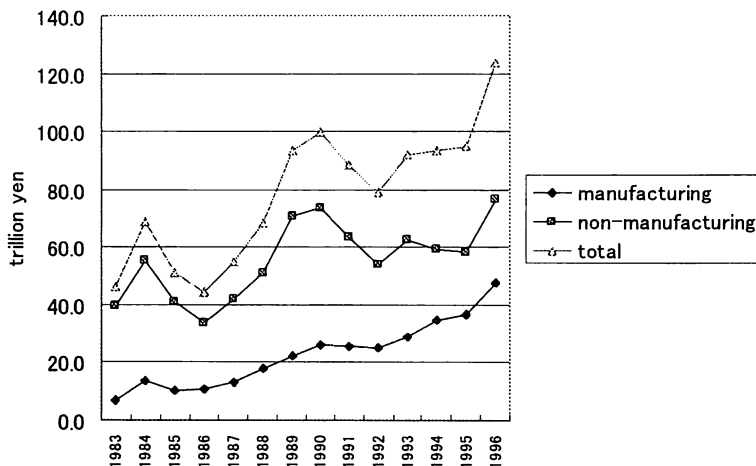


Figure 1-2 Sales of the Overseas Firms, Japan

which is about 13 percent of the Japanese gross output in the same year.

The inflow of direct investment is expected to induce technological transfer and industrialization, and increase the demand for labor in the country that accepts the direct investment, whereas there are some fears in the investing country that the restructuring in the production and labor markets will be required and the international competitiveness might deteriorate.

Many types of studies on direct investment has been done to date, both theoretical

and empirical. In this paper, we focus our attention to the scope of the input-output framework. According to Inaba (1999) who gives a brief survey of the related research from 1979 to 1995 in Japan, many studies commonly focus on the direction and magnitude of the effect of the direct investment on the international trade, and measure the effect of the change in international transactions on the production and labor demand, using the input-output analysis. Each study differs in the measured impact, because each estimates different trade changes and uses the input-output tables of different years. However, input-output analysis is thought to be a superior method for evaluating the impacts of direct investment on the internal production and labor demand.

Narita (1994) and Yamada and Asahi (1999) applied the model to the regional economy in Japan, and Muramatsu and Fujikawa (1998) and Fujikawa (1999) investigated the structural changes in international interdependency among counties as a result of the globalization of firms, by using the input-output model.

In this paper, we recompile the Japan-US Input-Output Table of 1995, to capture the interdependency between both countries, with a special focus on the relation between the overseas activity of Japanese firms and the economy of each country. In the next section, we show the framework of the input-output analysis, that we have adopted. Section 3 provides the method used to recompile the international input-output table, and in section 4 we analyze the interdependency of Japanese multinationals and the economies of Japan and the US.

2. Framework of the model

In this section, we present a model by recompiling the Japan-US international input-output table of METI to capture the relations among Japan, the US, and Japanese subsidiaries in the US. We use the following notation: x_1 as Japanese production, x_2 as the US production, in which the activities of Japanese subsidiaries in the US are excluded, and x_3 as the production of Japanese subsidiaries in the US. Then the equilibrium equation for the goods market in the international input-output model recompiled is then shown as:

$$\begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} F_{11} \\ F_{21} \\ F_{31} \end{bmatrix} + \begin{bmatrix} F_{12} \\ F_{22} \\ F_{32} \end{bmatrix} + \begin{bmatrix} E_1 \\ E_2 \\ E_3 \end{bmatrix} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} \quad (1)$$

where A_{ij} means input coefficient sub-matrix of j sector from i sectors, F_{i1} is the final demand vector of Japan from i sector, F_{i2} that of the US from i sector, and E_i export of i sector to the ROW.

Therefore $A_{31}x_1$ shows Japanese import of intermediate goods and services from Japanese subsidiaries in the US, and F_{31} that of final goods and services. These are

considered to be the so-called re-import effects. On the other hand, $A_{13}x_3$ denotes intermediate goods and services which Japan supplies to the Japanese subsidiaries in the US. This is regarded as the induced import effect.

Whereas $A_{32}x_2$ indicates the sales of intermediate goods and services supplied by Japanese subsidiaries in the US to US firms in the US market, and $A_{23}x_3$ is the intermediate goods and services purchased by Japanese subsidiaries from US firms. Also $A_{33}x_3$ indicates the purchase of intermediate goods and services of Japanese subsidiaries from each other.

Japanese subsidiaries supply final goods and services in the US market and in the ROW market, which are denoted as F_{32} and E_3 , respectively. These may partially substitute for the export demand from Japan, from which we can measure the export substitution effect. Import of capital goods such as machinery equipment, which Japanese subsidiaries in the US require to Japan, is included in F_{12} .

Solving the above equation by production vector x , we can induce the following equation.

$$\begin{aligned} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} &= \begin{bmatrix} I - A_{11} & -A_{12} & -A_{13} \\ -A_{21} & I - A_{22} & -A_{23} \\ -A_{31} & -A_{32} & I - A_{33} \end{bmatrix}^{-1} \left\{ \begin{bmatrix} F_{11} \\ F_{21} \\ F_{31} \end{bmatrix} + \begin{bmatrix} F_{12} \\ F_{22} \\ F_{32} \end{bmatrix} + \begin{bmatrix} E_1 \\ E_2 \\ E_3 \end{bmatrix} \right\} \\ \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} &= \begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{bmatrix} \left\{ \begin{bmatrix} F_{11} \\ F_{21} \\ F_{31} \end{bmatrix} + \begin{bmatrix} F_{12} \\ F_{22} \\ F_{32} \end{bmatrix} + \begin{bmatrix} E_1 \\ E_2 \\ E_3 \end{bmatrix} \right\} \end{aligned} \quad (2)$$

Using this equation, we can evaluate the induced demand effects of the increase in the final goods and services, which are produced by Japan, the US, and Japanese subsidiaries in the US. Here we arrange each final demand as follows,

$F_{11} + F_{12} + E_1 = F_J$: the demand for final goods and services for Japan,

$F_{21} + F_{22} + E_2 = F_U$: the demand for final goods and services for the US,

$F_{31} + F_{32} + E_3 = F_S$: the demand for final goods and service for Japanese subsidiaries located in the US.

Then we can decompose the equation as the following.

$$\begin{aligned}
 \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} &= \begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{bmatrix} \begin{bmatrix} F_J \\ F_U \\ F_S \end{bmatrix} \\
 &= \begin{bmatrix} B_{11}F_J \\ B_{21}F_J \\ B_{31}F_J \end{bmatrix} + \begin{bmatrix} B_{12}F_U \\ B_{22}F_U \\ B_{32}F_U \end{bmatrix} + \begin{bmatrix} B_{13}F_S \\ B_{23}F_S \\ B_{33}F_S \end{bmatrix}
 \end{aligned} \tag{3}$$

The first term of the right hand of the equation means production induced by the demand for final goods and services from Japan. The second and third terms are production induced by the demands for goods and services from the US firms and Japanese subsidiaries in the US, respectively.

Value added, that is induced by the additional final demand, is attained by multiplying a diagonal matrix consisting of value added ratios in its main diagonal parts, \hat{V} , to the induced production vector. That is,

$$\begin{aligned}
 \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} &= \begin{bmatrix} \hat{v}_1 & 0 & 0 \\ 0 & \hat{v}_2 & 0 \\ 0 & 0 & \hat{v}_3 \end{bmatrix} \begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{bmatrix} \begin{bmatrix} F_J \\ F_U \\ F_S \end{bmatrix} \\
 &= \begin{bmatrix} \hat{v}_1 B_{11} F_J \\ \hat{v}_2 B_{21} F_J \\ \hat{v}_3 B_{31} F_J \end{bmatrix} + \begin{bmatrix} \hat{v}_1 B_{12} F_U \\ \hat{v}_2 B_{22} F_U \\ \hat{v}_3 B_{32} F_U \end{bmatrix} + \begin{bmatrix} \hat{v}_1 B_{13} F_S \\ \hat{v}_2 B_{23} F_S \\ \hat{v}_3 B_{33} F_S \end{bmatrix}
 \end{aligned} \tag{4}$$

Furthermore, induced import from the ROW is obtained by multiplying an import ratio matrix to the induced production vector, which shows the following.

$$\begin{aligned}
 \begin{bmatrix} M_{R1} \\ M_{R2} \\ M_{R3} \end{bmatrix} &= \begin{bmatrix} A_{R1} & 0 & 0 \\ 0 & A_{R2} & 0 \\ 0 & 0 & A_{R3} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} \\
 &= \begin{bmatrix} A_{R1} & 0 & 0 \\ 0 & A_{R2} & 0 \\ 0 & 0 & A_{R3} \end{bmatrix} \begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{bmatrix} \begin{bmatrix} F_J \\ F_U \\ F_S \end{bmatrix} \\
 &= \begin{bmatrix} A_{R1} B_{11} F_J \\ A_{R2} B_{21} F_J \\ A_{R3} B_{31} F_J \end{bmatrix} + \begin{bmatrix} A_{R1} B_{12} F_U \\ A_{R2} B_{22} F_U \\ A_{R3} B_{32} F_U \end{bmatrix} + \begin{bmatrix} A_{R1} B_{13} F_S \\ A_{R2} B_{23} F_S \\ A_{R3} B_{33} F_S \end{bmatrix}
 \end{aligned} \tag{5}$$

Considering the cost components of the input-output model, we can induce the following relation,

$$\begin{aligned}
 & [I \quad I \quad I] \begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix} + [I \quad I \quad I] \begin{bmatrix} A_{R1} & 0 & 0 \\ 0 & A_{R2} & 0 \\ 0 & 0 & A_{R3} \end{bmatrix} \\
 & + [I \quad I \quad I] \begin{bmatrix} \hat{v}_1 & 0 & 0 \\ 0 & \hat{v}_2 & 0 \\ 0 & 0 & \hat{v}_3 \end{bmatrix} = [I \quad I \quad I]
 \end{aligned} \tag{6}$$

where I is a vector whose components are one. Therefore, the sum of the value added and import, both of them are induced, is expressed as follows:

$$\begin{aligned}
 & [I \quad I \quad I] \left\{ \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} + \begin{bmatrix} M_{R1} \\ M_{R2} \\ M_{R3} \end{bmatrix} \right\} \\
 & = [I \quad I \quad I] \left\{ \begin{bmatrix} \hat{v}_1 & 0 & 0 \\ 0 & \hat{v}_2 & 0 \\ 0 & 0 & \hat{v}_3 \end{bmatrix} + \begin{bmatrix} A_{R1} & 0 & 0 \\ 0 & A_{R2} & 0 \\ 0 & 0 & A_{R3} \end{bmatrix} \right\} \begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{22} \\ B_{31} & B_{32} & B_{33} \end{bmatrix} \begin{bmatrix} F_J \\ F_U \\ F_S \end{bmatrix} \\
 & = [I \quad I \quad I] \left\{ \begin{bmatrix} I & 0 & 0 \\ 0 & I & 0 \\ 0 & 0 & I \end{bmatrix} - \begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix} \right\} \begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{22} \\ B_{31} & B_{32} & B_{33} \end{bmatrix} \begin{bmatrix} F_J \\ F_U \\ F_S \end{bmatrix} \\
 & = [I \quad I \quad I] \begin{bmatrix} F_J \\ F_U \\ F_S \end{bmatrix}
 \end{aligned} \tag{7}$$

From these equations, we may confirm that the sum of value added and import, which is induced by the additional final demands, F_j , F_U , and F_S , equals the sum of the additional final demands. Therefore we can evaluate each country's contributions to the additional final demands by summing them up for Japan, the US, the Japanese subsidiaries in the US, and the ROW. From this model, Matsumura and Fujikawa (1998) and Fujikawa (1999) analyzed the changing industrial structures of each country, focusing on the domesticating production.

3. Recompilation of the international Input-output table

The Japan-US Input-Output table shows the international transactions between the Japanese economy and the US economy. From this table, we can observe the international relations between the two countries. In this paper, we recompile this table to one that divides the US sectors into two parts, to explicitly exhibit the activities of Japanese subsidiaries in the US. The new table consists of three parts: the sectors of Japanese economy, those of the US excluding the activities of Japanese subsidiaries in the US, and those of Japanese subsidiaries in the US. Using this new table, we can analyze the activity of the Japanese firms that moved into the US market, and the relations between Japanese subsidiaries in the US and both economies.

3.1 Method of Recompilation

There are three Japan-US input-output tables available for 1985, 1990, and 1995. To recompile the tables, we used the information from METI statistics, which is a basic survey of the overseas activities of Japanese firms. We obtained the sales values and purchasing costs by sector and region. For the 1985 table, however, we could not obtain sufficient data from the METI statistics. As the foreign direct investment of Japanese firms has increased remarkably in 1990's, we will conduct the analysis using the latest table in this paper.

Because of the limited data, the sector classification we adopt here contains the twenty sectors indicated in Table 3-1.

The basic idea of the recompilation is as follows (see Figure 3-1). First, we estimate the production of Japanese subsidiaries in the US for each sector, assuming that their production equals the sales estimated from the METI survey. Subtracting the values of this production from the US production by sector gives the production of the remaining firms in the US.

Second, we obtain the input value and value added for both Japanese subsidiaries and the other firms in the US, assuming that the input structure is the same for both by sector. The purchasing pattern of Japanese subsidiaries is also considered here. In this way, we can divide each production activity into two: that of Japanese subsidiaries and the other firms in the US.

Third, we divide Japanese intermediate inputs from the US into two parts: inputs from non-Japanese owned firms and those from Japanese subsidiaries. The regional sales pattern of Japanese subsidiaries is taken into account here. Also we separate the intermediate input of Japanese subsidiaries from the US market as a whole into two parts: that from non-Japanese owned firms and that from Japanese subsidiaries in the US. Unfortunately, we have no information as to how large a portion of sales is distributed within Japanese subsidiaries. Here we assume that this portion is the same as the ratio of their supply in the US market, which seems a little bit restrictive. The intermediate input of non-Japanese owned firms from the US market is divided into two parts in the same way.

Table3-1 Sector Classification

Code	Description
1	Agriculture
2	Mining
3	Construction
4	Food
5	Textile
6	Wood & Pulp
7	Chemical Industry
8	Iron & Steel
9	Non-Ferrous Metals
10	General Machinery
11	Electric Machinery
12	Transportation Equipment
13	Precision Instruments
14	Petroleum & Coal
15	Other Manufacturing
16	Wholesale and Retail Trade
17	Public Service
18	Other Service
19	Finance & Insurance
20	Other Industry

Japan-US linked Input-Output Table

		Intermediate Demand		Final Demand		Export	Output
		Japan	US	Japan	US	ROW	
Intermediate Input	Japan	Axij	Axju	Fdij	Fdju	Exir	Xj
	US	Axuj	Axuu	Fduj	Fduu	Exur	Xu
Import	ROW	Axrx	Axru	Fdrj	Fdru	-	-
Value Added		Vj	Vu				
Output		Xj	Xu				



Recompiled Input-Output Table

			Intermediate Demand			Final Demand		Export	Output
			Japan	US		Japan	US	ROW	
Intermediate Input	Japan	non-Japanese Firms	Axij	Axju	Axju*	Fdij	Fdju	Ejr	Xj
		Japanese Firms	Axuj	Axuj	Axuj	Fduj	Fduu	Eur	Xu
	US	non-Japanese firms	Axuj*	Axuj*	Axuj*	Fduj*	Fduu*	Exur*	Xu*
Import	Japanese Firms		Axuj*	Axuj*	Axuj*	Fduj*	Fduu*	Exur*	Xu*
	ROW		Axrx	Axru	Axru*	Fdrj	Fdru	-	-
Value Added			Vj	Vu	Vu*				
Output			Xj	Xu	Xu*				

Intermediate Goods exported from Japan (Induced Export Effect) → Axju*
 Purchase in the US market → Axju*
 Purchase from the ROW → Exur*
 Intermediate goods exported to Japan (Re-import Effect) → Axuj*
 Supply to the US and ROW markets, partly substituting Japanese export → Axuj*, Axuj*, Axuj*
 Final goods exported to Japan (Re-import Effect) → Fduj*, Fduu*, Exur*

Figure 3-1 Japan-US Input-Output Table, Original and Reconstructed

Finally, final demands, in Japan and the US respectively from Japanese subsidiaries are distinguished, with consideration of the estimated intermediate inputs and production of Japanese subsidiaries.

A more detailed description is presented in the Appendix. The recompiled input-output table, in which the activities of the Japanese subsidiaries in the US are described separately, is shown in Figure 3-1 below. In this figure, we confirm the re-import effect, which is the Japanese import of intermediate and final goods from the Japanese subsidiaries in the US, and the induced export effect, which indicates Japanese firms' export of intermediate goods to their subsidiaries. This table shows not only the purchasing of intermediate goods by Japanese subsidiaries in the US market, but also the sales in the US market and the export to the ROW by these companies. The export of capital goods from Japan to the US according to their direct investment can also be seen as the part of US final demand. Of course, we should pay attention to the fact that these effects are limited in considering the relations between Japan and the US, because our analysis depends on the Japan-US international input-output table and the other countries grouped as the ROW are treated exogenously.

3.2 Estimated Input-Output Table

Table 3-2 shows the estimated 1995 input-output table in summarized form. A more detailed table is provided in Table 3-3. We see that the amount of Japanese production is 9,140.50 billion dollars, that of the US is 12,401.79 billion dollars, and that of Japanese subsidiaries 198.64 billion dollars. The production of Japanese subsidiaries is not so large: about 2.1 percent of total US production.

Japanese exports to the US market are 112.14 billion dollars, of which final goods are 52.8 percent or 59.26 billion dollars. The rest are intermediate goods, and about half of which is for the Japanese subsidiaries, accounting for 25.87 billion dollars. This reflects as the induced export effect. On the other hand, Japanese import from the Japanese subsidiaries amounts to 3.03 billion dollars for intermediate and 2.04 billion dollars for final goods, which are very small compared to the production of Japanese subsidiaries. The sales in the US market are 84.00 billion dollars for the intermediates and 100.88 billion dollars for the final goods. Therefore, Japanese subsidiaries in the US are considered to have local market oriented activity.

The purchasing pattern of Japanese subsidiaries for intermediate goods has certain characteristics. First, the ratio of purchases from the US market is 67.7 percent, and that from Japan is 25.8 percent. According to the METI survey, the local content ratio of manufacturing firms in the US market, 60.1 percent in 1995, is higher than that in Asian market, 36.1 percent in the same year, which is comparable to our results. The ratio of purchasing among Japanese subsidiaries in the US is relatively low, which partly depends on the assumption of our estimation. The ratio of purchases from the ROW is also low, which means that the main supplier outside the US is Japan.

Table 3-3 Estimated Input-Output Table 1995, continued

	1995		Intermediate Demand			Final Demand of Japan		Final Demand of US		Output
	Japan	US	Japanese Subsidiary	Total	Domestic	Export	Domestic	Export		
ROW										
Agriculture	173045	145234	505	318784	64272	0	65790	0	448846	
Mining	519968	523955	344	1044267	3328	0	-1230	0	1046365	
Construction	0	0	0	0	0	0	0	0	0	
Food	123361	106680	552	230593	83993	0	136148	0	450734	
Textile	63241	120788	397	184426	181963	0	388092	0	754481	
Wood & Pulp	128687	274013	1502	404202	16108	0	89833	0	510143	
Chemical Industry	135245	310982	2225	448452	28907	0	130213	0	607572	
Iron & Steel	55985	137108	1940	195033	-316	0	576	0	195293	
Non-Ferrous Metals	152573	263534	4012	420119	19766	0	16259	0	456144	
General Machinery	24245	176421	2520	203186	48692	0	222180	0	474058	
Electric Machinery	155571	648900	22567	827038	170120	0	588091	0	1585249	
Transportation Equipment	17817	256009	2797	276623	82968	0	614111	0	973702	
Precision Instruments	19059	79752	633	99444	39157	0	94426	0	233027	
Petroleum & Coal	97626	63906	230	161762	11177	0	36315	0	209254	
Other Manufacturing	65275	251813	2691	319779	186468	0	426432	0	932679	
Wholesale and Retail Trade	14916	0	0	14916	1716	0	0	0	16632	
Public Service	9588	4488	20	14096	133	0	4519	0	18748	
Other Service	250887	35150	302	286339	213767	0	4071	0	504177	
Finance & Insurance	93985	9389	63	103437	15642	0	39446	0	158525	
Other Industry	224858	679307	6799	910964	113825	0	458893	0	1483682	
Intermediate Input, Japan	37874158	270112	258722	38402992	48618213	3791256	592583	0	91405044	
Intermediate Input, US	397011	47366020	655034	48418065	224053	0	69324284	6051505	124017906	
Intermediate Input, Jap. Sub.	30250	815465	24532	870247	20422	0	1008753	86998	1986421	
Intermediate Input	38301419	48451597	938288	87691304	48862688	3791256	70925620	6138503	217408371	
Import Duties & Import Sales Tax, Japan & US	12479	8151	6923	27553	35427	0	17326	0	80306	
International Freight & Insurance, Japan & US	43845	8446	7292	59583	18860	0	16115	0	94558	
Intermediate Input, ROW	2325932	4087430	50098	6463460	1281686	0	3314165	0	11059311	
Import Duties & Import Sales Tax, ROW	105587	58945	620	165152	47175	0	102036	0	314363	
Intermediate Input, Total	40789262	52614569	1003221	94407052	50245836	3791256	74375262	6138503	228957909	
Labor Compensation	29041095	41702757	593728	71337580	0	0	0	0	71337580	
Capital Income	18674897	24184695	317655	43177247	0	0	0	0	43177247	
Net Subsidies	2899790	5515886	71816	8487492	0	0	0	0	8487492	
Value Added	50615782	71403337	983200	123002319	0	0	0	0	123002319	
Output	91405044	124017906	1986421	217409371	50245836	3791256	74375262	6138503	351960228	

4. Some Simulation Analyses

In this section, we discuss some issues related to the interdependence of both countries and the role of Japanese subsidiaries in the US.

4.1 Production Induced by Unit Change in Final Goods

Japan and Japanese subsidiaries in US are mutually related through international trade. Japan imports intermediate goods and final goods from Japanese subsidiaries, and exports intermediate goods to them: the re-import effect and the induced export effect respectively. Furthermore, these affect the production of all other sectors, internally and internationally. We can observe such international interdependency from the column sum of each sector of the Leontief inverse matrix. There are three figures in Figure 4-1 for the induced effect of the change in Japanese final goods, US final goods, and the final goods supplied by Japanese subsidiaries, respectively.

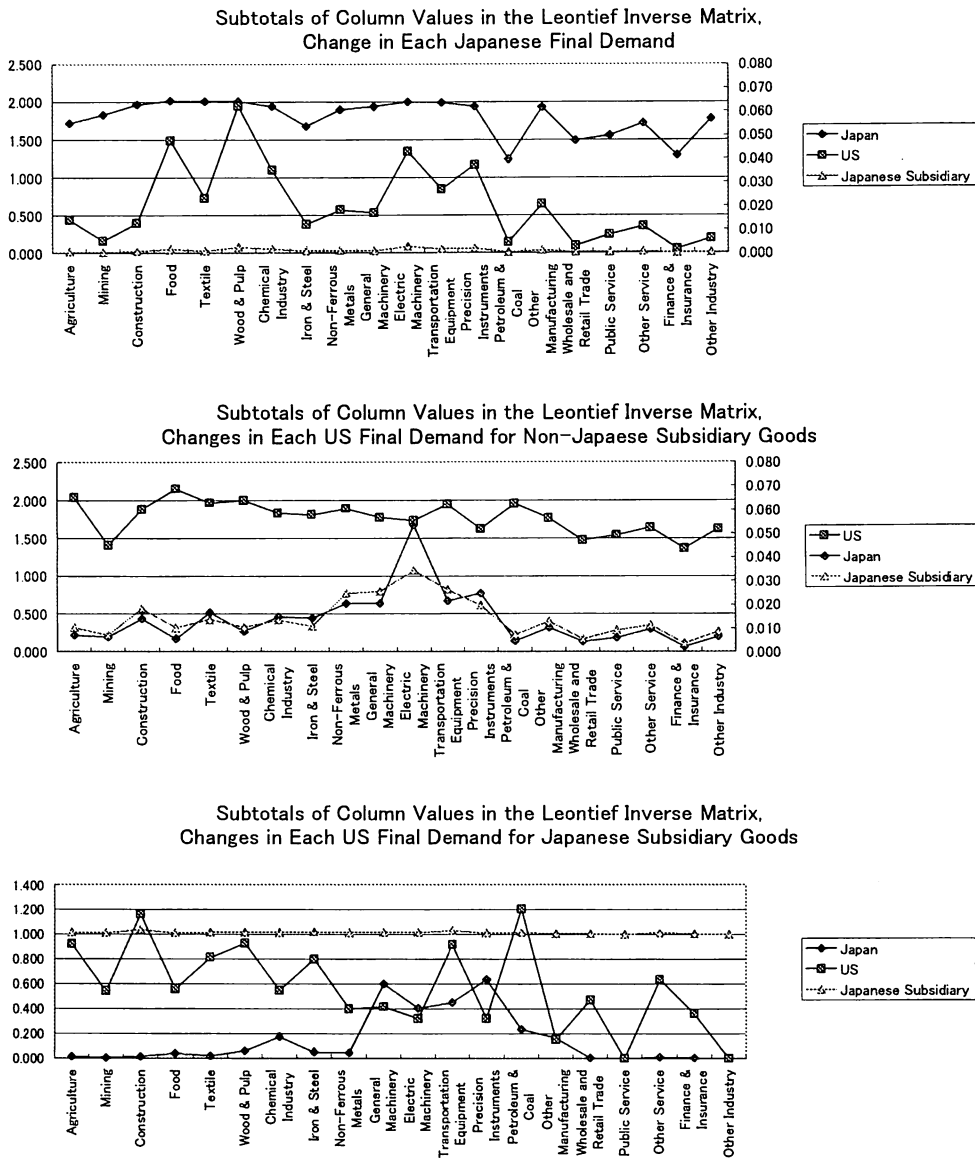


Figure 4-1 Production Induced by Unit Increase of Each Final Goods

The top figure shows the effect of the unit change in Japanese final goods on Japan, US, and Japanese subsidiaries in the US, respectively. The effect on Japan is dominant compared to the others, so the scales of the vertical axis are measured separately: the left axis for Japan, and the right axis for the other two. From this figure, we see that the impact on the US is relatively large in the Food sector and the Wood, Lumber and Pulp sector, whereas the effect on the Japanese subsidiaries is negligible. This implies that the re-import effect of intermediate goods is very small.

The middle figure shows effect of the changes in the US final demand by sector on each economy. In this case, final demand for the Japanese subsidiaries is assumed not to change. Though the dominant effect appears in the US production, the production of Japan and Japanese subsidiaries is affected almost to the same degree. A unit increase in the final demands brings the largest impact on the electric machinery sector in Japan and Japanese subsidiaries.

The bottom figure shows the case for the Japanese subsidiaries. Increase in the final demand for the products of Japanese subsidiaries induces larger production in the other US firms in almost all sectors. On the other hand, the effect on Japan is limited in some machinery sectors, because those effects occur through the exports from Japan to the US market, and because Japanese exports are concentrated in those machinery sectors. This effect is related to the so-called induced export effect.

4.2 Relative Contributions to Each Final Demand

Table 4-1 shows the effect of increase in the final goods in each sector, which appeared in the left side column of the table, on the values added to each economy, imports of the ROW, and the cost of freight and insurance. Because the sum of these terms is equal to the value of the original increase in the final demand, the relative effects can be calculated. From this table, we can observe the relative contributions to the increased final demands in terms of value added. Fujikawa (1999) calls these the international division ratios in terms of value added. Figure 4-2 presents those relations graphically.

The top figure in Figure 4-2 shows the case where each final demand from Japan is increased by one unit. In this figure, the effects on Japan and on the ROW are measured by the left-side axis, whereas the effects on the US and on Japanese subsidiaries are accumulatively measured by the right-side axis. For almost all sectors, the contributions of Japan are dominant with the exception of the petroleum and coal sector. On the other hand, US contributions are at most less than 4 percent. The largest is for the Wood, Timber and Pulp sector, followed by the Food sector, and then the Machinery sector. The contributions of Japanese subsidiaries in the US seem negligible.

The middle figure shows the case where final demand in the US increases by one unit. The effects on the US and the ROW are measured by the left-side axis, and the others by the right-side axis. The effects on Japan and Japanese subsidiaries are almost same in terms of influenced value added. Japan is connected to the US market strongly through exports of machinery goods and direct investment in the related firms.

The bottom figure presents the case of Japanese subsidiaries, which are drawn as an accumulative bar graph. The strong relations between Japan and Japanese subsidiaries are concentrated in the four machinery sectors. On the other hand, the effects on the US firms are observed in the Agriculture, the Construction, Food products, Textiles, Wood and Pulp, and the Other Services sectors. Also, the purchasing of intermediate goods and services in the US market is growing in the Transportation Equipment sector.

Table 4-1 Regional Contributions in Terms of Induced Value Added

		1995					Total
		Japan	US	Japanese Subsidiary	ROW	Dudies, Freight & Insurance	Total
Japan	Agriculture	94.92	0.67	0.03	4.01	0.37	100.00
	Mining	94.84	0.24	0.01	4.43	0.48	100.00
	Construction	94.05	0.62	0.04	4.99	0.30	100.00
	Food	89.59	2.26	0.09	7.08	0.97	100.00
	Textile	89.13	1.10	0.04	9.12	0.62	100.00
	Wood & Pulp	86.84	2.91	0.12	9.47	0.66	100.00
	Chemical Industry	87.59	1.72	0.10	9.87	0.73	100.00
	Iron & Steel	86.48	0.68	0.05	12.44	0.36	100.00
	Non-Ferrous Metals	87.87	0.94	0.06	10.85	0.27	100.00
	General Machinery	93.23	0.87	0.05	5.65	0.21	100.00
	Electric Machinery	89.64	2.13	0.15	7.76	0.32	100.00
	Transportation Equipment	93.20	1.29	0.08	5.17	0.26	100.00
	Precision Instruments	90.47	1.95	0.11	7.15	0.32	100.00
	Petroleum & Coal	63.94	0.20	0.01	30.55	5.31	100.00
	Other Manufacturing	92.48	1.02	0.07	6.01	0.41	100.00
	Wholesale and Retail Trade	97.55	0.14	0.01	2.17	0.12	100.00
	Public Service	96.78	0.39	0.02	2.63	0.18	100.00
	Other Service	95.50	0.54	0.04	3.58	0.34	100.00
	Finance & Insurance	97.92	0.08	0.01	1.94	0.06	100.00
	Other Industry	93.12	0.30	0.02	6.20	0.36	100.00
US	Agriculture	0.34	91.75	0.60	7.18	0.12	100.00
	Mining	0.30	90.11	0.37	9.12	0.09	100.00
	Construction	0.67	91.05	1.06	7.05	0.18	100.00
	Food	0.27	91.47	0.61	7.52	0.13	100.00
	Textile	0.78	86.11	0.79	11.40	0.91	100.00
	Wood & Pulp	0.41	88.45	0.61	10.38	0.15	100.00
	Chemical Industry	0.69	87.85	0.79	10.48	0.19	100.00
	Iron & Steel	0.71	84.95	0.62	13.42	0.29	100.00
	Non-Ferrous Metals	1.02	85.24	1.32	12.14	0.28	100.00
	General Machinery	0.99	88.96	1.37	8.45	0.24	100.00
	Electric Machinery	2.47	82.37	1.97	12.93	0.26	100.00
	Transportation Equipment	1.02	82.45	1.48	14.77	0.27	100.00
	Precision Instruments	1.15	89.82	1.13	7.71	0.19	100.00
	Petroleum & Coal	0.22	72.93	0.42	26.28	0.15	100.00
	Other Manufacturing	0.49	90.97	0.74	7.65	0.15	100.00
	Wholesale and Retail Trade	0.21	96.82	0.31	2.62	0.04	100.00
	Public Service	0.29	95.23	0.47	3.93	0.08	100.00
	Other Service	0.46	94.50	0.63	4.32	0.09	100.00
	Finance & Insurance	0.10	98.10	0.20	1.57	0.02	100.00
	Other Industry	0.30	91.99	0.44	7.19	0.07	100.00
Japanese Subsidiary	Agriculture	0.64	45.96	49.76	3.54	0.10	100.00
	Mining	0.21	29.21	68.03	2.51	0.04	100.00
	Construction	0.57	61.20	32.62	5.50	0.11	100.00
	Food	1.79	27.07	67.84	3.07	0.24	100.00
	Textile	0.91	40.40	54.44	3.95	0.30	100.00
	Wood & Pulp	2.74	46.52	46.04	4.38	0.33	100.00
	Chemical Industry	8.21	29.46	56.63	4.90	0.81	100.00
	Iron & Steel	2.67	45.18	47.36	4.41	0.38	100.00
	Non-Ferrous Metals	2.25	20.74	72.49	4.20	0.33	100.00
	General Machinery	29.20	21.70	37.58	9.31	2.22	100.00
	Electric Machinery	18.56	16.99	53.94	9.54	0.97	100.00
	Transportation Equipment	21.33	47.95	22.45	6.79	1.48	100.00
	Precision Instruments	29.89	16.88	46.88	4.44	1.92	100.00
	Petroleum & Coal	11.63	73.73	4.64	8.38	1.62	100.00
	Other Manufacturing	7.73	7.90	79.77	3.72	0.88	100.00
	Wholesale and Retail Trade	0.21	27.41	69.72	2.62	0.04	100.00
	Public Service	0.00	0.00	0.00	0.00	0.00	0.00
	Other Service	0.46	35.15	59.99	4.32	0.09	100.00
	Finance & Insurance	0.10	20.71	77.59	1.57	0.02	100.00
	Other Industry	0.00	0.00	0.00	0.00	0.00	0.00
Japan, Total	94.60	0.67	0.04	4.39	0.30	100.00	
US, Total	0.42	93.49	0.59	5.38	0.11	100.00	
Japanese Subsidiary, Total	13.92	33.06	45.96	6.10	0.95	100.00	

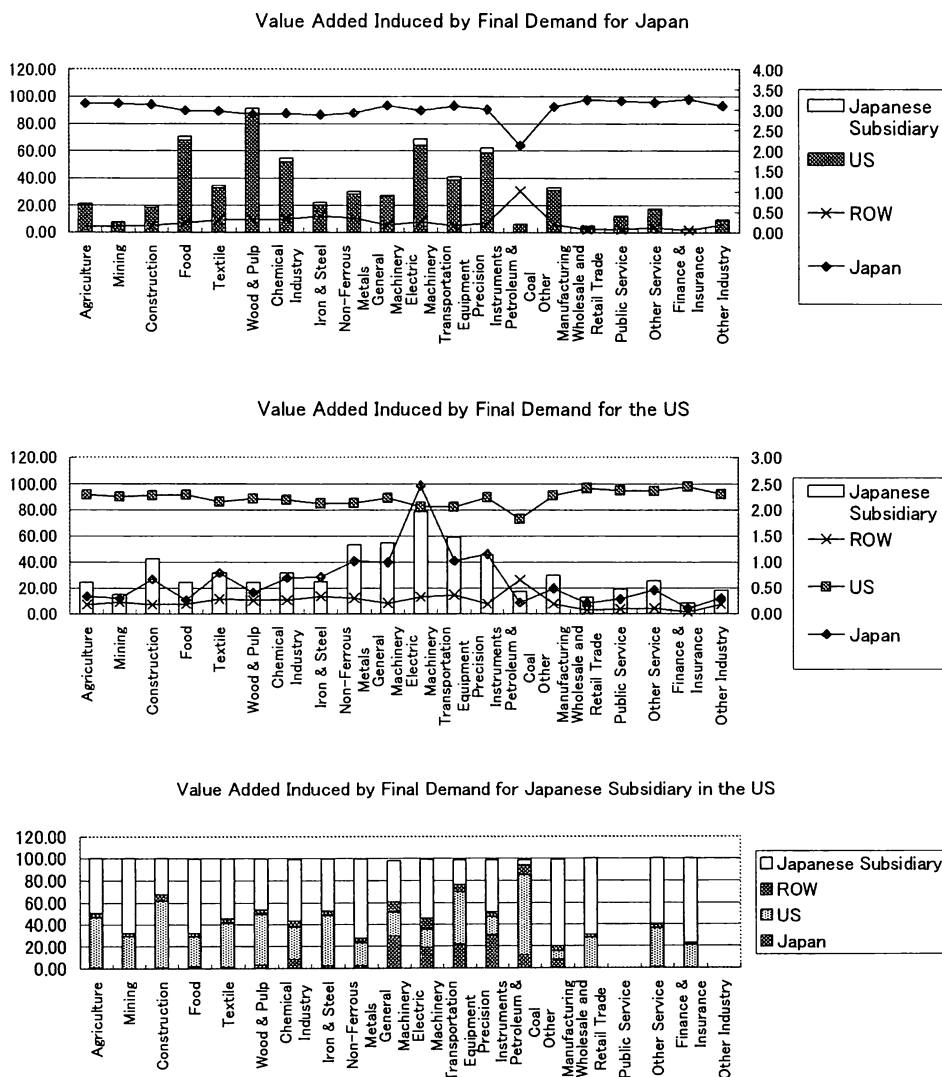


Figure 4-2 Regional Contributions to Final Demand Increase by Sector

4.3 Export Substitution through the Foreign Direct Investment

In general, the foreign direct investment of Japanese firms induces a reduction in the domestic production in the same sector. This is recognized as the hollowing out of the manufacturing production and called the export substitution effect. How much production is reduced by overseas operations depends on many factors. METI survey reports that manufacturing production of Japanese subsidiaries for all regions is about

37 trillion yen in 1995, and estimates that the export is substituted by about 8 trillion yen, which is 20 percent of the overseas production on average. This value might be different for each sector and each region.

In this section, we simulate the impacts of the overseas production and export substitution in the following two sectors: the Electric Machinery sector and the Transportation Equipment sector. They are considered as two main exporters and investors abroad in Japan.

We conduct the following four simulations for each sector.

Case-1: Increase final demand of Japanese subsidiaries in the sector by one unit.

Case-2: Decrease final demand of Japan in the sector by one unit.

Case-3: Increase final demand of Japanese subsidiaries in the sector by one unit, and decrease that of Japan by a half unit for the corresponding sector.

Case-4: Increase final demand of Japanese subsidiaries in the sector by one unit, and decrease that of Japan by one unit for the corresponding sector.

Table 4-2 shows the results, with values expressed as multiplies of one hundred. For Case 1, we analyze the effects, in terms of value added, of the increase in overseas production in certain sectors. For the electric machinery sector, increasing final demand of Japanese subsidiaries by one unit induces 0.5394 units of value added for Japanese subsidiaries as a whole, 0.1699 units for the remaining US firms, and 0.1856 units for Japan, respectively.

If export demand is decreased by one unit, then we observe a 0.8964 unit reduction of value added in Japan, a 0.0213 unit decline in the US, and a 0.0015 unit drop of Japanese subsidiaries. The dominant change has occurred in Japan. (See Case-2.)

Increase in overseas production is usually followed by reduction in export demand. Case 3 assumes that just half of the overseas production replaces export. In this case, a 0.5386 unit increase in Japanese subsidiaries as a whole, and a 0.1593 unit increment for the remaining US, produces a 0.2626 unit reduction in Japan.

If export is completely replaced by overseas production, Japanese subsidiaries gain 0.5379 units of value added, the US obtains 0.1486 units, and Japan loses 0.7108 units, as in Case 4. Though a one unit reduction in the final demand of Japan induces a 0.8964 unit decrease in Japanese value added, as shown in Case 2, import demand induced by overseas production weakens the effect to a 0.7108 unit reduction.

In cases of the Transportation Equipment, a one unit increase in the overseas production induces a 0.2245 unit increase in value added for Japanese subsidiaries overall, a 0.4795 unit increase for the remaining US, and a 0.2133 unit increase for Japan, as in Case 1, whereas a one unit decrease in Japanese export in the same sector induces mainly a 0.9320 unit decrease for Japan, as in Case 2.

If overseas production completely replaces Japanese export, Japanese subsidiaries gain 0.2237 units in value added, and remaining US a 0.4666 unit increase, while a 0.7187 unit reduction in value added is seen in Japan, as shown in Case 4. The effects on Japan as a whole are almost same as the case with electric machinery. The US gains in this case, however, are larger than with electric machinery. This reflects the difference in the purchasing share of Japanese subsidiaries in the US market.

Table 4-2 Overseas Production and Export Substitution

	Electric Machinery				Transportation Equipment				
	Case-1	Case-2	Case-3	Case-4	Case-1	Case-2	Case-3	Case-4	
Japan	Agriculture	0.06	-0.27	-0.08	-0.21	0.06	-0.25	-0.06	-0.19
	Mining	0.02	-0.10	-0.03	-0.08	0.03	-0.12	-0.03	-0.09
	construction	0.12	-0.59	-0.17	-0.46	0.14	-0.58	-0.15	-0.44
	Food	0.07	-0.33	-0.10	-0.26	0.07	-0.30	-0.08	-0.23
	Textile	0.06	-0.31	-0.09	-0.25	0.09	-0.32	-0.08	-0.24
	Wood & Pulp	0.19	-0.94	-0.28	-0.74	0.21	-0.76	-0.16	-0.54
	Chemical Industry	0.25	-1.16	-0.33	-0.91	0.32	-1.39	-0.37	-1.07
	Iron & Steel	0.42	-1.38	-0.28	-0.97	0.72	-3.37	-0.97	-2.65
	Non-Ferrous	0.62	-2.82	-0.79	-2.19	0.91	-3.15	-0.66	-2.24
	General Machinery	0.17	-0.65	-0.15	-0.48	1.12	-1.61	0.32	-0.49
	Electric machinery	8.70	-47.27	-14.94	-38.57	2.65	-3.71	0.80	-1.06
	Transportation Equipment	0.03	-0.13	-0.04	-0.10	5.78	-43.31	-15.87	-37.52
	Precise Instrument	0.06	-0.11	0.01	-0.05	0.09	-0.10	0.04	-0.01
	Petroleum & Coal	0.11	-0.50	-0.14	-0.39	0.13	-0.55	-0.14	-0.42
	The Other Manufacturing	0.91	-4.10	-1.14	-3.18	1.34	-5.18	-1.25	-3.84
	Wholesale and Retail Trade	2.20	-7.56	-1.58	-5.36	2.63	-7.84	-1.29	-5.21
	Public Service	0.14	-0.70	-0.21	-0.56	0.15	-0.65	-0.18	-0.50
	The other Service	1.62	-7.97	-2.36	-6.34	1.66	-6.96	-1.82	-5.31
	Finance & Insurance	1.00	-4.55	-1.28	-3.55	1.18	-4.86	-1.25	-3.68
	The Other Industry	1.79	-8.19	-2.31	-6.40	2.02	-8.17	-2.06	-6.14
US	Agriculture	0.09	-0.04	0.07	0.05	0.30	-0.03	0.28	0.26
	Mining	0.25	-0.04	0.23	0.21	0.87	-0.05	0.85	0.82
	construction	0.37	-0.02	0.36	0.34	0.82	-0.02	0.81	0.80
	Food	0.08	-0.02	0.07	0.06	0.23	-0.01	0.22	0.21
	Textile	0.02	0.00	0.02	0.02	0.92	-0.01	0.92	0.91
	Wood & Pulp	0.39	-0.04	0.37	0.35	1.22	-0.03	1.20	1.19
	Chemical Industry	0.42	-0.05	0.40	0.37	1.38	-0.09	1.34	1.30
	Iron & Steel	0.38	-0.02	0.36	0.35	1.73	-0.02	1.72	1.71
	Non-Ferrous	1.34	-0.12	1.28	1.22	5.24	-0.08	5.20	5.16
	General Machinery	0.33	-0.02	0.31	0.30	2.79	-0.04	2.77	2.75
	Electric machinery	2.51	-0.85	2.08	1.66	2.19	-0.12	2.13	2.07
	Transportation Equipment	0.03	0.00	0.02	0.02	0.13	-0.18	0.04	-0.05
	Precise Instrument	0.03	-0.01	0.03	0.03	0.28	-0.01	0.28	0.27
	Petroleum & Coal	0.04	0.00	0.04	0.03	0.11	0.00	0.11	0.11
	The Other Manufacturing	1.07	-0.08	1.03	0.99	3.70	-0.10	3.65	3.60
	Wholesale and Retail Trade	3.14	-0.37	2.95	2.76	7.80	-0.18	7.71	7.62
	Public Service	0.17	-0.01	0.16	0.16	0.36	-0.01	0.35	0.35
	The other Service	3.08	-0.19	2.98	2.89	8.98	-0.13	8.92	8.85
	Finance & Insurance	1.50	-0.10	1.45	1.40	3.41	-0.06	3.38	3.35
	The Other Industry	1.77	-0.15	1.70	1.62	5.49	-0.13	5.43	5.36
Japanese Subsidiary	Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Mining	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Food	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00
	Textile	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01
	Wood & Pulp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Chemical Industry	0.02	0.00	0.02	0.02	0.07	-0.01	0.07	0.06
	Iron & Steel	0.05	0.00	0.04	0.04	0.21	-0.01	0.21	0.20
	Non-Ferrous	0.02	-0.01	0.02	0.01	0.08	-0.01	0.08	0.07
	General Machinery	0.01	0.00	0.01	0.01	0.08	0.00	0.08	0.08
	Electric machinery	53.43	-0.09	53.38	53.34	0.41	-0.01	0.40	0.39
	Transportation Equipment	0.00	0.00	0.00	0.00	20.57	-0.01	20.57	20.56
	Precise Instrument	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Petroleum & Coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	The Other Manufacturing	0.05	-0.01	0.04	0.04	0.16	-0.02	0.15	0.14
	Wholesale and Retail Trade	0.33	-0.03	0.32	0.30	0.77	-0.01	0.76	0.76
	Public Service	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	The other Service	0.02	0.00	0.02	0.02	0.06	0.00	0.06	0.06
	Finance & Insurance	0.01	0.00	0.01	0.01	0.02	0.00	0.02	0.02
	The Other Industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Japan, Total	18.56	-89.64	-26.26	-71.08	21.33	-93.20	-25.27	-71.87	
US, Total	16.99	-2.13	15.93	14.86	47.95	-1.29	47.31	46.66	
Japanese Subsidiary, Total	53.94	-0.15	53.86	53.79	22.45	-0.08	22.41	22.37	
Import and others	10.51	-8.08	6.47	2.43	8.27	-5.43	5.56	2.84	
Total	100.00	-100.00	50.00	0.00	100.00	-100.00	50.00	0.00	

5. Concluding Remarks

In this paper, we recompile the Japan-US international input-output table to analyze the interdependence among Japanese firms, Japanese subsidiaries in US, and the other US firms. The activities of Japanese subsidiaries are extracted in the input-output table.

Overseas production through direct investment has many effects on the production and labor demand in both the Japan and US economies. For the Japanese economy, we decompose the effects through international trade: the export substitution effect, the export inducing effect, and the re-import effect. We can evaluate the impacts on overall production through changes in final demand by using the input-output model.

We analyze three aspects of the impacts. First, the impacts on production are evaluated. The production of Japanese subsidiaries in the US is hardly affected by the Japanese production, at least as a whole, but it heavily depends on the US market. The US change in final demand in the general machinery sector has almost the same impact on Japan and Japanese subsidiaries in the US.

Second, the contribution of each economy is also evaluated in terms of value added. The increase in final demand to the Japanese subsidiaries in the US induces both value added and import demand. Japanese contribution is 13.4 percent, that of the US firms 33.1 percent, that of the Japanese subsidiaries in US 46.0 percent, and that of the ROW 6.1 percent. The share of the US firms seems relatively high, which reflects the fact that the local content ratio is increasing in the US market: from 39.4 percent in 1985 to 60.1 percent in 1995, according to the METI survey.

Third, we analyze the effect of overseas production and export substitution for two large exporting sectors: the electric machinery sector and the transportation equipment sector. If manufacturing for export is completely replaced by overseas production, Japan overall loses value added corresponding to 70 percent of initial overseas production, and the US as a whole gains almost the same value. The ratio of the gain in Japanese subsidiaries to that of remaining US firms differs a little bit for both sectors.

According to the METI survey on Japanese overseas activity, Japanese overseas production accounts for as much about 10 percent of Japanese gross output in 1995. In this paper, we concentrate our attention to the Japanese overseas activity in the US economy, which covers only about 37 percent of the Japanese overseas production as a whole. We now need to extend our analysis to a wider area, including Asia and Europe, where Japanese firms have advanced. Such an expanded study may be expected to produce more interesting findings on the global network of Japanese overseas activity, and will be undertaken in our future research.

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Appendix

In this appendix, we describe the method used to reconstruct the Japan-US international input-output table step by step.

(1) Estimation of the Production Values of Japanese Subsidiaries in the US

Production values of Japanese subsidiaries in US are assumed to be equal to their sales values, which are estimated by METI survey statistics for the same year of the input-output table, although production is not the same as sales. In addition, we have made no adjustment for the difference in the year-bases in both statistics, or for the different price evaluations. These remain as difficult issues, simply because of data availability, to be resolved in future research.

For the Wholesale and Retail Trade sector, production should be defined as the sum of trade margins of sales in each sector. Therefore, we do not use the sales value as the production, but the sum of the sales cost, administration cost, and operation cost in the sector. This is estimated to be about 13.7 percent of the sales value of that sector.

(2) Estimation of Input values of Japanese Subsidiaries in the US

For Japanese subsidiaries in the US, input total and value added of each sector are estimated by multiplying the production value, which is estimated in the previous step, by the input coefficient of the corresponding sector of the US firms, including value added sectors.

Furthermore, we divided input total into three parts according to the regional groups: Japan, the US, and the ROW. The METI statistics supply information on the size of the portion of Japanese overseas firms purchase from each region. Then multiplying the input total by those ratios provides input values by region.

Thereafter, we divide those input values by region to values by sector assuming the input is proportional to the input of the US activity.

However, input values of the Wholesale and Retail Trade sector, the Other Service sector, and the Finance and Real Estate sector are estimated using the US input coefficients directly.

(3) Separation of Activities of Japanese Subsidiaries from US Activities

Subtraction each input and value added value of Japanese subsidiary activities from the corresponding values of the US activities induces those of non-Japanese subsidiary activities in the US.

(4) Separation of Input from Japanese Subsidiaries in Japanese Activities

Input from the US in Japanese firms' activity includes that from Japanese subsidiaries in the US, as a part which should be separated. For sectors from Agriculture to Other Manufacturing, we obtain each value separated as the following.

$$\begin{aligned}
 & \text{Input value from Japanese subsidiaries in Japan} \\
 & = \text{Intermediate input value from the US} \\
 & \quad \text{Sales value of Japanese subsidiaries to Japan} \\
 & \times \left(\frac{\hspace{10em}}{\text{Export value from US to Japan}} \right)
 \end{aligned}$$

Thereafter, we compute the sum of input values from the Japanese subsidiaries in US for each input category, and the ratio of this to the corresponding sum of the US. For sectors from Wholesale and Retail Trade to Other Services, we reduce each input value by multiplying this ratio to input demand of Japan from US.

The difference between input from the US and from Japanese subsidiaries gives us that of remaining firms in the US.

(5) Separation of Input from Japanese Subsidiaries in Non-Japanese Activities

The US activities are already divided into two, one for Japanese subsidiaries and the other for non-Japanese firms, up to the step (3). Input of non-Japanese firms, however, still includes that from Japanese subsidiaries in the US, which should be separated.

For the sectors from Agriculture to Other Manufacturing, we separate each value as follows,

$$\begin{aligned}
 & \text{Input value from Japanese subsidiaries in the remaining US activity} \\
 & = \text{Intermediate input of the remaining US from the US} \\
 & \quad \text{Sales of Japanese subsidiaries to the US market} \\
 & \times \left(\frac{\hspace{10em}}{\text{Input of the US}} \right)
 \end{aligned}$$

Thereafter, we can compute the sum of input values from Japanese subsidiaries in the remaining US for each input category, and the ratio of this to the corresponding sum of US. For sectors from Wholesale and Retail Trade to Other Services, we induce input values by multiplying the ratios to total input demands of the remaining US. The remaining input is that provided by non-Japanese firms in the US.

(6) Intermediate Input within Japanese Subsidiaries

From the METI statistics, we can obtain information on how much Japanese subsidiaries purchase within the US market, but not how much among the Japanese subsidiaries. We ought to, however, divide their input into two: that from the Japanese subsidiaries and from the remaining firms in the US.

For this separation in the Agriculture to the Other Manufacturing sectors, we use the supply ratio of Japanese subsidiaries to domestic demand in the US.

$$\begin{aligned}
 & \text{Input within Japanese subsidiaries} \\
 & = \text{Input of Japanese subsidiaries in the US market} \\
 & \quad \text{Sales of Japanese subsidiaries in the US market} \\
 & \times \left(\frac{\hspace{10em}}{\hspace{10em}} \right)
 \end{aligned}$$

Input of the US

Generally speaking, advance of Japanese auto assembly companies in the US market is followed by their parts and accessory firms. It might then be possible that transactions within Japanese subsidiaries are more frequent than that between Japanese subsidiaries and US firms, which is contradictory to our assumption. Nevertheless, we apply this procedure as the second best because of the data availability.

Thereafter, we compute the sum of input among Japanese subsidiaries for each input category, and the ratio of it to the corresponding sum. For sectors from Wholesale and Retail Trade to Other Services, we obtain input by multiplying this ratio. Input from the remaining firms is obtained by subtraction.

(7) Final Demand of Japan

Japanese final demand from US is divided into two: that from Japanese subsidiaries and from the remaining companies. For the Agriculture to the Other Manufacturing sectors, we use the ratio of sales from Japanese subsidiaries to Japan, after subtracting input goods, to the US sales of final goods in the Japanese market. We obtain final demand from Japanese subsidiaries by multiplying this ratio to the purchase in Japan from the US, for each sector. For the Wholesale and Retail Trade sector to the Other Service sector, we estimated the corresponding values by the same procedure as in step (4). Final demand from the remaining US is obtained by subtracting the value of Japanese subsidiaries from that of the US.

(8) Final Demand of the US

The US domestic final demand is also divided into two: that from Japanese subsidiaries and from the remaining US companies. Here we compute ratios of sales from Japanese subsidiaries in the US market, after subtracting input goods, to the US sales of final goods in the same market. Using those ratios, we obtain appropriate values in the same manner as in step (7).

(9) Export to the ROW

Export to the ROW is estimated, assuming that Japanese subsidiaries' sales to the region is equal to it. Export from the remaining firms in US is obtained by subtracting that of Japanese subsidiaries from the total export of the US.

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