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Chapter 4

AN INPUT-OUTPUT ANALYSIS OF INTERDEPENDENCE BETWEEN JAPANESE AND THE UNITED STATES ECONOMIES

Kōzō Ishida

I. INTRODUCTION

The purpose of this paper is to investigate and evaluate the economic interdependence through trade between Japan and the United States in 1970 from the viewpoint of production, value added and employment structures. The method of input-output analysis is, therefore, expanded from one country to two countries, Japan and U.S.A. The traditional econometric analysis of trade between Japan and U.S. has emphasized calculation of import and export functions on a macro level and of income and price elasticities on specific goods. These import and export functions are linked directly to a nation-wide macro model in order to measure their influences on such economic variables as national income, employment, etc. Such a macro analysis, however, is not sufficient to understand input-output relations between two countries as described below. For example, the level of export of iron and steel from Japan to the U.S., depends directly on the level of production in the relevant industries in the U.S., such as the general machinery and transportation equipment industries. Therefore, the expansion of demand in those sectors of U.S. will help to increase the export of iron and steel from Japan to U.S., which at the same time increases the import of coal from U.S. by the iron and steel sector in Japan, which depends heavily on U.S. coal as its intermediate raw material. Thus, the expansion of the final demand of machinery in U.S. generates output in the sector of coal in U.S., going through the sector of iron and steel in Japan. The viewpoint of analysis is, this time, focused on structural and inter-industry relations between two countries, so this paper uses the method of input-output analysis between the two countries; the input-output relations between Japan and U.S.A. are shown in Table 1. Using this method, the economic interdependence between the two countries in 1970 is quantitatively estimated.

The analysis basically requires the following two sets of data:

(1) national input-ouput tables of Japan and the U.S.A.

(2) trade statistics of Japan and the U.S.A.

The process of the analysis is to compile an input-output table between Japan and U.S. by linking the trade matrix to both national input-output tables, using the data sets (1) and (2), to make a static open Leontief model of the economy combining both countries, and then to evaluate directly and indirectly the magnitudes of production, value added and employment in each sector of both countries

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which will be determined by the final demands given exogeneously for Japan and the U.S.A.

This is a preliminary report of the joint research conducted over the last two and a half years at the Keio Economy Observatory (KEO) of Keio University and Institute of Developing Economies.

II. THE MODEL

Our models, drawing upon the Leontief static open model, are modified to make them capable of handling the interdependence of production and international trade between Japan and U.S. Table 1 shows the system of the 1970 Japan-U.S.A. International Input-Output Table. Every transaction between sectors in the system is evaluated at producer's price and market price in terms of U.S. dollars. Both the Japanese and the U.S. economies are divided into 45 sectors.

The transactions in Table 1 may be expressed in equations as follows:

1. The balance equations for Japanese sectors are

$$(1)\qquad \sum_j X_{ij}^{JJ}+\sum_j X_{ij}^{JU}+C_i^{JJ}+I_i^{JJ}+IV_i^{JJ}+G_i^{JJ}+C_i^{JU}+I_i^{JU}+IV_i^{JU}+G_i^{JU}$$
$$+E_i^{JA}+E_i^{JE}+E_i^{JR}+E_i^{JS}+E_i^{JD}=X_i^J \qquad (i=1,\cdots,45)$$

where

X_{ij}^{JJ}=output of the i-th Japanese sector used as intermediate input in the j-th Japanese sector,

X_{ij}^{JU}=output of the i-th Japanese sector used as intermediate input in the j-th U.S. sector,

C_i^{JJ}=output of the i-th Japanese sector used for Japanese private consumption expenditures,

I_i^{JJ}=output of the i-th Japanese sector used for Japanese gross private fixed capital formation,

IV_i^{JJ}=output of the i-th Japanese sector used for Japanese net inventory change,

G_i^{JJ}=output of the i-th Japanese sector used for Japanese government purchases,

C_i^{JU}=output of the i-th Japanese sector used for U.S. private consumption expenditures,

I_i^{JU}=output of the i-th Japanese sector used for U.S. gross private fixed capital formation,

G_i^{JU}=output of the i-th Japanese sector used for U.S. government purchases,

E_i^{JA}=exports of the i-th Japanese sector to Asia,

E_i^{JE}=exports of the i-th Japanese sector to EC (old EC),

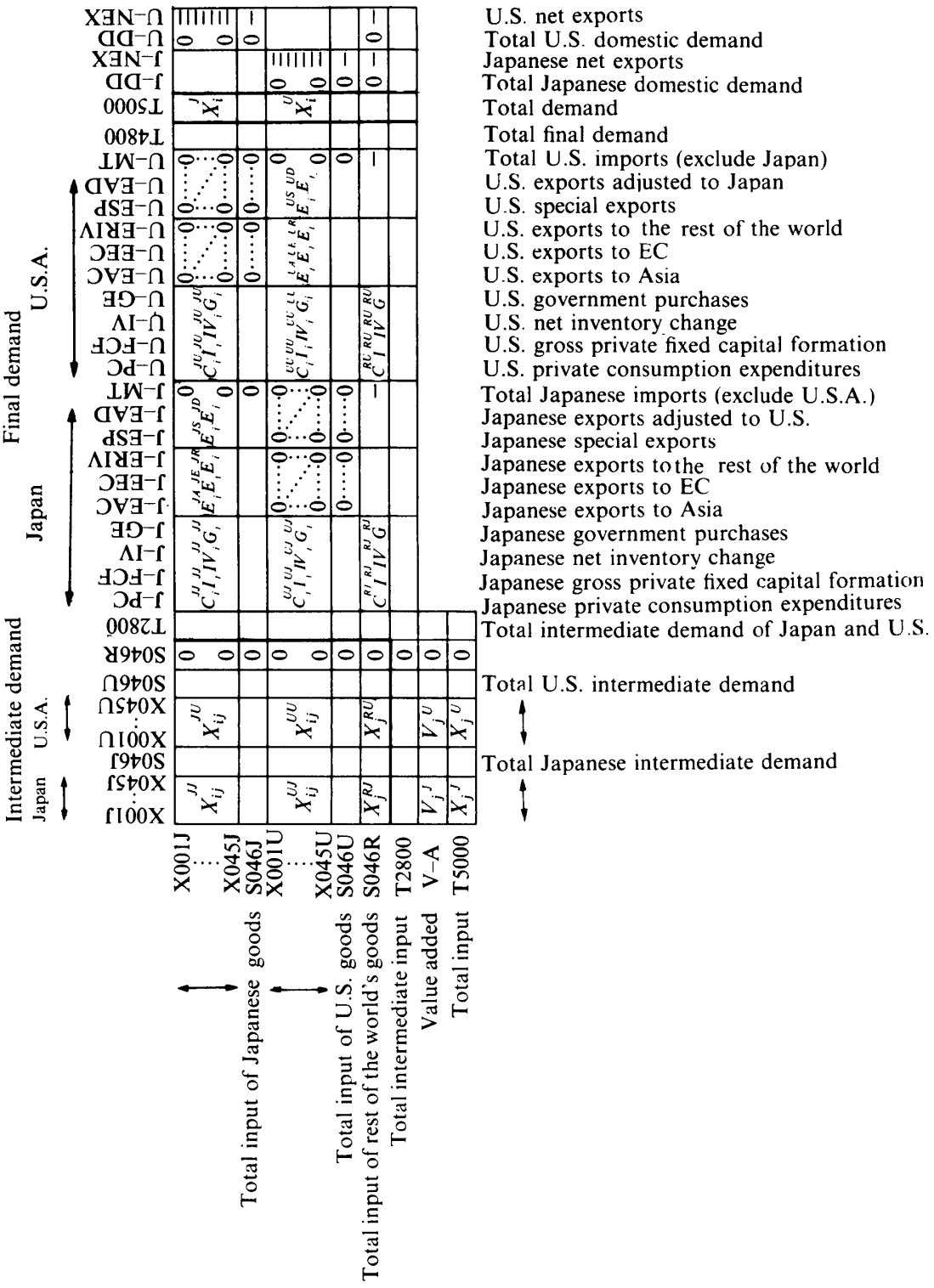
E_i^{JR}=exports of the i-th Japanese sector to the rest of the world,

E_i^{JS}=special exports of the i-th Japanese sector,

E_i^{JD}=adjusted exports of the i-th Japanese sector to the U.S.

X_i^J=total output of the i-th Japanese sector,

Table 1. THE 1970 JAPAN–U.S.A. INTERNATIONAL INPUT-OUTPUT TABLE (45 sectors)



2. The balance equations for U.S. sectors are

$$(2)\quad \sum_j X_{ij}^{UJ}+\sum_j X_{ij}^{UU}+C_i^{UJ}+I_i^{UJ}+IV_i^{UJ}+G_i^{UJ}+C_i^{UU}+I_i^{UU}+IV_i^{UU}+G_i^{UU}$$
$$+E_i^{UA}+E_i^{UE}+E_i^{UR}+E_i^{US}+E_i^{UD}=X_i^U \qquad (i=1, \cdots, 45)$$

where

X_{ij}^{UJ}=output of the i-th U.S. sector used as intermediate input to Japanese sector j,

X_{ij}^{UU}=output of the i-th U.S. sector used as intermediate input to U.S. sector j,

C_i^{UJ}=output of the i-th U.S. sector used for Japanese private consumption expenditures,

I_i^{UJ}=output of the i-th U.S. sector used for Japanese gross private fixed capital formation,

IV_i^{UJ}=output of the i-th U.S. sector used for Japanese net inventory change,

G_i^{UJ}=output of the i-th U.S. sector used for Japanese government purchases,

C_i^{UU}=output of the i-th U.S. sector used for U.S. private consumption expenditures,

I_i^{UU}=output of the i-th U.S. sector used for U.S. gross private fixed capital formation,

IV_i^{UU}=output of the i-th U.S. sector used for U.S. net inventory changes,

G_i^{UU}=output of the i-the U.S. sector used for U.S. government purchases,

E_i^{UA}=exports of the i-th U.S. sector to Asia,

E_i^{UE}=exports of the i-th U.S. sector to EC (old EC),

E_i^{UR}=exports of the i-th U.S. sector to the rest of the world,

E_i^{US}=special exports of the i-th U.S. sector,

E_i^{UD}=adjusted exports of the i-th U.S. sector to Japan,

X_i^U=total output of the i-th U.S. sector,

3. Total imports from the rest of the world required by both Japan and the U.S.

$$(3)\quad \sum_j X_j^{RJ}+\sum_j X_j^{RU}+C^{RJ}+I^{RJ}+IV^{RJ}+G^{RJ}+C^{RU}+I^{RU}+IV^{RU}+G^{RU}=M$$

where

X_j^{RJ}=total imports from the rest of the world used as input to the j-th Japanese sector,

X_j^{RU}=total imports from the rest of the world used as input to the j-th U.S. sector,

C^{RJ}=total imports from the rest of the world consumed for Japanese private consumption expenditures,

I^{RJ}=total imports from the rest of the world consumed for Japanese gross private fixed capital formation,

IV^{RJ}=total imports from the rest of the world consumed for Japanese net inventory changes,

G^{RU}=total imports from the rest of the world consumed for Japanese government purchases,

C^{RU}=total imports from the rest of the world consumed for U.S. private consumption expenditures,

I^{RU}=total imports from the rest of the world consumed for U.S. gross private fixed capital formation,

IV^{RU}=total imports from the rest of the world consumed for U.S. net inventory changes,

G^{RU}=total imports from the rest of the world consumed for U.S. government purchases,

M=total aggregate imports from the rest of the world of both Japan and U.S.,

Then, intermediate input coefficients for the combined international Input-Output Table of Japan and the U.S.A. are defined as follows:

(4) $a_{ij}^{JJ}=X_{ij}^{JJ}/X_j^J$=input from the i-th Japanese sector per unit output of the j-th Japanese sector,

$a_{ij}^{UJ}=X_{ij}^{UJ}/X_j^J$=input from the i-th U.S. sector per unit output of the j-th Japanese sector,

$a_j^{RJ}=X_j^{RJ}/X_j^J$=total imports from the rest of the world per unit output of the j-th Japanese sector,

$a_{ij}^{JU}=X_{ij}^{JU}/X_j^U$=input from the i-th Japanese sector per unit output of the j-th U.S. sector,

$a_{ij}^{UU}=X_{ij}^{UU}/X_j^U$=input from the i-th U.S. sector i per unit output of the j-th U.S. sector,

$a_j^{RU}=X_j^{RU}/X_j^U$=total imports from the rest of the world per unit output of the j-th U.S. sector,

We assume that these coefficients are constant.

Using assumption (4), equations (1) and (2) can be expressed in matrix form as follows:

(1)′ $A^{JJ}X^J+A^{JU}X^U+F^{JU}+E^J=X^J$

(2)′ $A^{UJ}X^J+A^{UU}X^U+F^{UJ}+E^U=X^U$

where

X^J=column vector with components X_i^J (45×1)

X^U=column vector with components X_i^U (45×1)

A^{JJ}=matrix with elements a_{ij}^{JJ} (45×45)

A^{JU}=matrix with elements a_{ij}^{JU} (45×45)

A^{UJ}=matrix with elements a_{ij}^{UJ} (45×45)

A^{UU}=matrix with elements a_{ij}^{UU} (45×45)

$F^{JJ}=[C_i^{JJ}+I_i^{JJ}+IV_i^{JJ}+G_i^{JJ}]$ = vector of Japanese domestic final demands for Japanese products

$F^{JU}=[C_i^{JU}+I_i^{JU}+IV_i^{JU}+G_i^{JU}]$ = vector of U.S. domestic final demands for

$F^{UJ}=[C_i^{UJ}+I_i^{UJ}+IV_i^{UJ}+G_i^{UJ}]$ = vector of Japanese domestic final demands for U.S. products

$F^{UU}=[C_i^{UU}+I_i^{UU}+IV_i^{UU}+G_i^{UU}]$ = vector of U.S. domestic final demands for U.S. products

$E^J=[E_i^{JA}+E_i^{JE}+E_i^{JR}+E_i^{JS}+E_i^{JD}]$ = vector of Japanese exports

$E^U=[E_i^{UA}+E_i^{UE}+E_i^{UR}+E_i^{US}+E_i^{UD}]$ = vector of U.S. exports

If we add equations (1)′ and (2)′ together, we get the following system:

$$\text{(5)}\qquad \begin{bmatrix} A^{JJ} & A^{JU} \\ A^{UJ} & A^{UU} \end{bmatrix}\begin{bmatrix} X^J \\ X^U \end{bmatrix}+\begin{bmatrix} F^{JJ} \\ F^{UJ} \end{bmatrix}+\begin{bmatrix} F^{JU} \\ F^{UU} \end{bmatrix}+\begin{bmatrix} E^J \\ E^U \end{bmatrix}=\begin{bmatrix} X^J \\ X^U \end{bmatrix}$$

Solving this system for X^J and X^U, we get

$$\text{(6)}\qquad \begin{bmatrix} X^J \\ X^U \end{bmatrix}=\begin{bmatrix} I-A^{JJ} & -A^{JU} \\ -A^{UJ} & I-A^{UU} \end{bmatrix}^{-1}\begin{bmatrix} F^{J*} \\ F^{U*} \end{bmatrix}$$

or

$$\text{(6)}'\qquad X=BF$$

where

$F^{J*}=[F^{JJ}+F^{JU}+E^J]$: vector of final demand for Japanese products (45×1)

$F^{U*}=[F^{UJ}+F^{UU}+E^U]$: vector of final demand for U.S. products (45×1)

Now let us partition the Leontief extended inverse matrix B into four submatrices as follows:

$$B=\begin{bmatrix} B^{JJ} & B^{JU} \\ B^{UJ} & B^{UU} \end{bmatrix}$$

where

B^{JJ} is a 45×45 submatrix of B, whose element b_{ij}^{JJ} stands for the amount of product of the i-th Japanese sector required directly and indirectly to deliver one unit of product of the j-th Japanese sector to final demand, and B^{UJ} is a 45×45 submatrix of B, whose element b_{ij}^{UJ} stands for the amount of product of the i-th U.S. sector required directly and indirectly to deliver one unit of product of the j-th Japanese sector to final demand. B^{JU} is a 45×45 submatrix of B, whose element b_{ij}^{JU} denotes the amount of product of the i-th Japanese sector required directly and indirectly to deliver one unit of product of the j-th U.S. sector to final demand, and B^{UU} is a 45×45 submatrix of B, whose element b_{ij}^{UU} denotes the amount of the product of the i-th U.S. sector required directly and indirectly to deliver one unit of product of the j-th U.S. sector to final demand.

1. *Total output requirements*

Multiplying the inverse coefficients along each row by a final demand vector of the given level and composition yields total output requirements. First, let us explain the difference between the output requirement for each Japanese sector

to deliver a bill of Japanese domestic final demand and that to deliver a bill of final demand for Japanese products. Then, the output in each Japanese sector generated by Japanese domestic final demand is computed by the following equation:

$$X^{*J}=[B^{JJ}\,|\,B^{JU}]\begin{bmatrix}F^{JJ}\\ \hdashline F^{UJ}\end{bmatrix}=B^{JJ}\cdot F^{JJ}+B^{JU}\cdot F^{UJ}$$

where $B^{JJ}\cdot F^{JJ}$ is generated by Japanese products, and $B^{JU}\cdot F^{UJ}$ is generated by U.S. products. The output of each Japanese sector generated by the final demand for Japanese products is calculated by the equation

$$X^{J*}=B^{JJ}\cdot F^{J*}=B^{JJ}\cdot(F^{JJ}+F^{JU}+E^{J}).$$

The total output requirements in the U.S. are computed in the same manner as in Japan.

2. *Induced value added*

V^{J} stands for a vector of value added coefficients in Japan. Each element v_j^J of this vector is the value added per dollar of output of the j-th Japanese sector. V^{U} stands for a vector of value added coefficients in the U.S. Each element v_j^U of this vector is the value added per dollar of output of the j-th U.S. sector.

The total induced value added in Japan and the U.S. to deliver a certain level of final demand for Japan and the U.S. are calculated. The Japanese total value added is expressed as

$$V^{J}=V^{J}(B^{JJ}\cdot F^{JJ}+B^{JU}\cdot F^{UJ})+V^{J}(B^{JJ}\cdot F^{JU}+B^{JU}\cdot F^{UU})+V^{J}(B^{JJ}\cdot E^{J}+B^{JU}\cdot E^{U}),$$

and the U.S. total value added is

$$V^{U}=V^{U}(B^{UJ}\cdot F^{JJ}+B^{UU}\cdot F^{UJ})+V^{U}(B^{UJ}\cdot F^{JU}+B^{UU}\cdot F^{UU})+V^{U}(B^{UJ}\cdot E^{J}+B^{UU}\cdot E^{U}).$$

3. *Total import requirements from the rest of the world*

First, let us consider the total import coefficients to deliver a unit of final demand. The vector of total import coefficients is

$$[A^{RJ}\,|\,A^{RU}]\begin{bmatrix}B^{JJ} & B^{JU}\\ \hdashline B^{UJ} & B^{UU}\end{bmatrix}=[A^{RJ}\cdot B^{JJ}+A^{RU}\cdot B^{UJ}\,|\,A^{RJ}\cdot B^{JU}+A^{RU}\cdot B^{UU}].$$

Each element of the subvector $A^{RJ}\cdot B^{JJ}+A^{RU}\cdot B^{UJ}$ denotes the total import requirement both for Japan and the U.S. to produce one unit of final demand for Japanese goods. $A^{RJ}\cdot B^{JJ}$ is for Japan, and $A^{RU}\cdot B^{UJ}$ for U.S. Each element of the subvector $A^{RJ}\cdot B^{JU}+A^{RU}\cdot B^{U}$ expresses total import requirements both for Japan and the U.S. to produce a unit final demand for U.S. goods.

The level of imports generated by the fixed final demand in Japanese and U.S. economy is calculated in a similar manner as induced value added, using import coefficients described above.

4. *Total labor requirements*

Total labor requirements are computed in the same way as total induced value added. Labor coefficients of Japan and U.S. are defined as follows:

l^J: vector of Japanese labor coefficients, whose element l_j^J denotes labor requirement to produce a unit output of the j-the Japanese sector. $(l^L=L_j^J/X_j^J)$

l^U: vector of U.S. labor coefficients, whose element l_j^U denotes the labor requirement to produce a unit output of the j-th U.S. sector. $(l_j^U=L_j^U/X_j^U)$

The Japanese total labor requirement is expressed as

$$L^J=l^J(B^{JJ}F^{JJ}+B^{JU}F^{UJ})+l^J(B^{JJ}F^{JU}+B^{JU}F^{UU})+l^J(B^{JJ}E^J+B^{JU}E^U),$$

and the U.S. total labor requirement is

$$L^U=l^U(B^{UJ}F^{JJ}+B^{UU}F^{UJ})+l^U(B^{UJ}F^{JU}+B^{UU}F^{UU})+l^U(B^{UJ}E^J+B^{UU}E^U).$$

We can understand a domestic total labor requirement generated through the trade and production network by a bill of final demand of the partner country as follows:

The Japanese total labor requirement to deliver a bill of U.S. final demand is $l^J(B^{JJ}F^{JU}+B^{JU}F^{UU}+B^{JU}E^U)$, while the U.S. total labor requirement to deliver a bill of Japanese final demand is $l^U(B^{UJ}F^{JJ}+B^{UU}F^{UU}+B^{UJ}E^J)$. Therefore, the balance in employment between Japan and U.S. is

$$B^L=l^J(B^{JJ}F^{JU}+B^{JU}F^{UU}+B^{JU}E^U)-l^U(B^{UJ}F^{JJ}+B^{UU}F^{UJ}+B^{UJ}E^J).$$

III. EMPIRICAL RESULTS

1. *Effect of changes in final demand*

Table 2 shows the column sums of submatrices (B^{JJ}, B^{UJ}) of the Leontief inverse matrix B for Japan. Column 1 represents the total (direct and indirect) impact on all outputs in Japan generated by a unit change in final demand for each Japanese product. Column 2 represents the total impact on all outputs in U.S. generated by a unit change in final demand for each Japanese product. Column 3 shows the total intermediate imports of Japan and the U.S. from the rest of the world generated by a unit change in final demand for each Japanese product. Each item of column 4 is the sum of corresponding items in column 1, 2 and 3. The figures in column 5, which give the ratios of column 2 to column 4 of all items, present the extent of U.S. production generated by a unit change in final demand in Japan, that is, the dependence of each Japanese sector on the U.S. economy. The outstanding sectors in column 5 are leather tanning and finishing (0.1354), nonferrous metal products (0.06356), primary nonferrous metals (0.05556), paper and sawmill products (0.04278), food, beverage and tobacco (0.03282), iron, steel and steel products (0.03282) and so on. Here it should be

noted that the values of column 5 are on the order of 10^{-2}. The Japanese sectors with a great total impact on production and import in both the Japanese and U.S. economies are iron, steel and steel products (3.1862), apparel products (2.8451), and transportation machinery (2.8216).

Table 3 shows the column sums of submatrices (B^{JU}, B^{UU}) of the Leontief inverse matrix B for the U.S. The values of column 5 in Table 3 are on the order of 10^{-3}, one-tenth of those of Japan. This shows that the effects of a unit change in Japanese final demand on the U.S. economy are larger than the effects of a unit change in U.S. final demand on the Japanese economy. In other words, the U.S. economy is more self-sustained relative to the Japanese economy. The Japanese economy is relatively sensitive to changes in final demand in U.S. sectors, such as iron, steel and steel products (0.01662), radio and T.V. sets (0.01622), transportation machinery (0.00932) and so on. Column 2 of Table 3 presents absolute values for these three sectors.

2. *The domestic total output generated by final demand in each sector of the partner country*

Table 2 and 3 present normalized final demand per unit for each sector of both the U.S. and Japan in order to investigate its effect on production for the partner country. The sector with a large amount of final demand may, however, have a great influence on the economy of the partner country in absolute terms, if the total output of the partner country generated by final demand per unit is small. Such effects are shown in Tables 4 and 5.

Column 1 of Table 4 presents the total output in the U.S. generated by the final demand for Japanese specific products. For example, the final demand of $4,139 million for Japanese building and constuction directly and indirectly generates a total output of approximately $1,342 million in the U.S. The final demand for Japanese food, beverage and tobacco generates a total output of about $1308 million in the U.S. These figures are calculated by multiplying each corresponding item of each column sum for the submatrix B^{UJ} by the final demand for specific Japanese products.

Column 2 of Table 4 represents the output of each sector in the U.S. generated by final demand for Japanese building and construction. The outstanding sectors in the U.S. are personal and business repair and maintenance services ($190 million), logging, nursery and other forest products (about $141 million), paper and sawmill products ($102 million) and so on.

Column 3 presents the output of each sector in the U.S. generated by the final demand for Japanese transportation machinery (motor vehicles). The total generated output of $340 million is small as compared with that of building and construction, and is not concentrated on any particular sector in the U.S. The figures for the metal products sector are relatively large among them.

Table 5 is computed by the same method as Table 4 to show that the total output in Japan is generated by a bill of final demand for U.S. specific goods.

TABLE 2. THE IMPACT OF A UNIT CHANGE IN FINAL DEMAND IN EACH JAPANESE SECTOR

45 sectors	① The total impact on production in Japan of a unit change in final demand in each Japanese sector	② The total impact on production in U.S. of a unit change in final demand in each Japanese sector	③ The total Japanese and U.S. intermediate imports from the rest of the world generated by a unit change in final demand in each Japanese sector	④ ①+②+③	⑤ ② / ④	⑥ ③ / ④
1. Building and construction	2.4047	.0325	.0700	2.5072	.01296	.02792
2. Concrete products, ammunition and explosives	2.2956	.0213	.0891	2.4060	.00885	.03703
3. Household refrigerators, freezers, laundry equipment and sewing machines	2.5031	.0334	.0638	2.6003	.01284	.02454
4. Construction and mining machinery	2.5835	.0586	.0781	2.7202	.02154	.02871
5. Transportation machinery	2.7034	.0146	.0766	2.8216	.01474	.02715
6. Other machinery and fabricated steel	2.5848	.0450	.0820	2.7117	.01659	.03024
7. Office machines	2.6600	.0493	.0747	2.7840	.01771	.02683
8. Radio and TV sets	2.5703	.0447	.0655	2.6805	.01668	.02444
9. Electric equipments and appliances	2.3873	.0562	.0783	2.5218	.02229	.03105
10. Arms, precision instruments, watches and cable	2.2070	.0709	.1630	2.4409	.02905	.06678
11. Furniture and daily necessities	2.3538	.0597	.1212	2.5348	.02355	.04781
12. Iron, steel and steel products	2.8925	.1046	.1896	3.1867	.03282	.05950
13. Nonferrous metal products	1.9736	.1526	.2748	2.4010	.06356	.11445
14. Primary nonferrous metals	1.6075	.1194	.4220	2.1489	.05556	.19638
15. Food, beverage and tobacco	2.1192	.0761	.0924	2.2876	.03327	.04039
16. Cement and ceramic products	1.8808	.0242	.0941	1.9990	.01211	.04707
17. Housefurnishing textile products	2.3663	.0497	.1440	2.5600	.01941	.05625
18. Textile goods	2.5753	.0488	.1467	2.7708	.07161	.05294
19. Yarn and spinning	2.0532	.0698	.2515	2.3745	.02940	.10592
20. Leather tanning and finishing	1.5871	.3083	.3814	2.2769	.13540	.16751
21. Paper and sawmill products	2.3708	.1146	.1935	2.6790	.04278	.07223
22. Paints and printing ink	2.5667	.0828	.0884	2.7379	.03024	.03229
23. Organic fibers, exc. cellulosic	2.2212	.0330	.0767	2.3310	.01416	.03290
24. Plastic materials and resins	2.4886	.0614	.0849	2.6349	.02330	.03222
25. Chemicals and fertilizers	2.4070	.0525	.1198	2.5793	.02035	.04645

Table 2. (continued)

26. Metal mining	1.6001	.0174	.0375	1.6550	.01051	.02266
27. Scrap metal	1.0000	.0000	.0000	1.0000	0	0
28. Forestry, fishery, livestock, vegetable and fruits	1.8536	.0667	.0588	1.9791	.03370	.02971
29. Feed grains	1.4254	.0081	.0212	1.4547	.00557	.01457
30. Dairy, tobacco leaf and other agricultural products	1.7433	.0284	.0481	1.8198	.01561	.02643
31. Stone and clay mining and quarrying	1.6377	.0093	.0513	1.6983	.00548	.03021
32. Logging, nursery and other forest products	2.2812	.0408	.0436	2.3657	.01725	.01843
33. Coal, chemical and fertilizer mineral mining	1.8897	.0153	.0610	1.9660	.00778	.03103
34. Sugar and sugar crops	1.3578	.0079	.5690	1.9346	.00408	.29412
35. Crude petroleum and natural gas	1.6065	.0071	.0312	1.6448	.00432	.01897
36. Electricity, gas and petroleum refinery products	1.3959	.0179	.2446	1.6584	.01079	.14749
37. Drugs	1.8829	.0319	.0618	1.9766	.01614	.03127
38. Apparel products	2.7094	.0329	.1028	2.8451	.01156	.03613
39. Other manufactured products	2.3322	.0487	.0963	2.4772	.01966	.03887
40. Personal and business repair and maintenance services	2.2326	.0250	.0518	2.3094	.01083	.02243
41. Wholesale trade	1.6328	.0075	.0372	1.6775	.00447	.02218
42. Retail trade and other services	1.5765	.0106	.0353	1.6224	.00653	.02176
43. Business consumption	2.7242	.0238	.0660	2.8140	.00846	.02345
44. Office supplies and not-classifiables	2.4136	.0290	.0635	2.5061	.01157	.02534
45. Directly allocated imports and other adjustments	1.0000	.0000	.0000	1.0000	0	0

U.S. building and construction has the greatest effect on the Japanese economy. While the output of U.S. logging industry generated by Japanese building and construction industries is large, as can be seen in Table 4, Japanese iron, steel, and steel products (about $378 million) stand out as the largest among outputs of the various Japanese sectors which are generated by the final demand for U.S. building and construction. It is observed that the final demand for U.S. transportation machinery in column 3 also generates a large output of Japanese iron, steel, and steel products as well as U.S. building and construction.

3. *Outputs and imports generated by each category of final demand in U.S. and Japan*

Table 6 shows outputs and imports generated by each category (private consumption expenditures, gross private fixed capital formation and so on) of final demand in the U.S. and Japan. Before going into details, it is necessary to

TABLE 3. THE IMPACT OF A UNIT CHANGE IN FINAL DEMAND IN EACH U.S. SECTOR

45 sectors	① The total impact on production in U.S. of a unit change in final demand in each U.S. sector	② The total impact on production in Japan of a unit change in final demand in each U.S. sector	③ The total Japanese and U.S. intermediate imports from the rest of the world generated by a unit change in final demand in each U.S. sector	④ ①+②+③	⑤ ② / ④	⑥ ③ / ④
1. Building and construction	2.1274	.0100	.0297	2.1671	.00461	.01370
2. Concrete products, ammunition and explosives	2.0710	.0087	.0292	2.1088	.00413	.01385
3. Household refrigerators, freezers, laundry equipment and sewing machines	2.2866	.0186	.0350	2.3402	.00795	.01496
4. Construction and mining machinery	2.2032	.0154	.0339	2.2524	.00684	.01505
5. Transportation machinery	2.4909	.0240	.0603	2.5752	.00932	.02343
6. Other machinery and fabricated steel	2.2107	.0189	.0355	2.2652	.00834	.01567
7. Office machines	1.7797	.0080	.0170	1.8047	.00443	.00942
8. Radio and TV sets	2.1685	.0363	.0336	2.2385	.01622	.01501
9. Electric equipments and appliances	2.0746	.0128	.0312	2.1187	.00604	.01473
10. Arms, precision instruments, watches and cable	2.1043	.0116	.0376	2.1535	.00539	.01746
11. Furniture and daily necessities	2.2380	.0122	.0466	2.2968	.00531	.02029
12. Iron, steel and steel products	2.2255	.0387	.0640	2.3282	.01662	.02749
13. Nonferrous metal products	2.5711	.0104	.1171	2.6986	.00385	.04339
14. Primary nonferrous metals	2.9417	.0085	.1488	3.0720	.00277	.04844
15. Food, beverage and tobacco	2.4437	.0037	.0497	2.4971	.00148	.01990
16. Cement and ceramic products	1.9328	.0045	.2626	1.9635	.00229	.01334
17. Housefurnishing textile products	2.6067	.0228	.0451	2.6747	.00852	.01686
19. Yarn and spinning	2.5370	.0127	.0393	2.5889	.00491	.01518
20. Leather tanning and finishing	2.5131	.0046	.0383	2.5559	.00180	.01498
21. Paper and sawmill products	2.2125	.0049	.0692	2.2866	.00214	.03026
22. Paints and printing ink	2.3862	.0099	.0521	2.4481	.00404	.02128
23. Organic fibers, exc. cellulosic	2.0741	.0069	.0314	2.1125	.00327	.01486
24. Plastic materials and !esins	2.5079	.0085	.0435	2.5600	.00332	.05699
25. Chemicals and fertilizers	2.2596	.0067	.0405	2.3068	.00290	.01756
26. Metal mining	1.9965	.0081	.0623	2.0669	.00392	.03014

Table 3. (continued)

27. Scrap metal	3.1947	.0180	.0532	3.2659	.00551	.01629
28. Forestry, fishery, livestock, vegetable and fruits	2.8943	.0028	.0264	2.9236	.00096	.00903
29. Feed grains	2.0770	.0027	.0220	2.1016	.00128	.01047
30. Dairy, tobacco leaf and other agricultural products	2.0253	.0023	.0164	2.0439	.00113	.00802
31. Stone and clay mining and	1.7691	.0055	.0186	1.7932	.00307	.01037
32. Logging, nursery and other forest products	2.0605	.0035	.0863	2.1503	.00163	.04013
33. Coal, chemical and fertilizer mineral mining	1.7663	.0057	.0158	1.7878	.00319	.00884
34. Sugar and sugar crops	2.1234	.0015	.1403	2.2652	.00066	.06194
35. Crude petroleum and natural gas	1.6412	.0033	.0135	1.6580	.00199	.00814
36. Electricity, gas and petroleum	2.0682	.0021	.0361	2.1064	.00100	.01714
37. Drugs	1.9423	.0039	.0222	1.9684	.00198	.01128
38. Apparel products	2.4507	.0161	.0362	2.5029	.00643	.01446
39. Other manufactured products	2.1572	.0142	.0449	2.2164	.00641	.02026
40. Personal and business repair and maintenance services	1.6979	.0073	.0164	1.7215	.00424	.00953
41. Wholesale trade	1.6045	.0017	.0086	1.6148	.00150	.00533
42. Retail trade and other services	1.4782	.0014	.0092	1.4888	.00094	.00618
43. Business consumption	2.8494	.0027	.0218	2.8739	.00094	.00758
44. Office supplies and not-classifiables	3.1602	.0147	.0467	3.2216	.00456	.01450
45. Directly allocated imports and other adjustments	1.0000	.0000	.0000	1.0000	0	0

decompose the Japanese final demand in order to evaluate the fianl demand for Japanese goods. For example, the vector $\begin{bmatrix} C^{JJ} \\ C^{UJ} \\ C^{RJ} \end{bmatrix}$ (91×1) stands for Japanese private consumption expenditures, where C^{JJ} (45×1) is a subvector for Japanese goods, C^{UJ} (45×1) for U.S. goods and C^{RJ} (scalar) for imports from the rest of the world. $[C^{JJ}+C^{UJ}](45\times 1)$ represents the vector of final demand for Japanese goods.

The value of \$187,934 million (row 1, column 1) in Table 6, the sum of elements of $B^{JJ}\cdot C^{JJ}$, shows the total output in Japan generated by Japanese final demand for Japanese goods. The value of \$3,105 million (row 2, column 1), the sum of elements of $B^{JJ}\cdot C^{JJ}$, shows the U.S. total output generated by Japanese final demand for Japanese goods.

Total outputs and imports required to deliver each category of final demand in the U.S. and Japan are calculated analogously. Column 1 to 4 show the total outputs and imports to produce a bill of Japanese final demand. Column 9 is the sum of column 1 to 4. Column 10 is the sum of column 5 to 8, which

TABLE 4. U.S. TOTAL OUTPUT GENERATED BY A PARTICULAR BILL OF FINAL DEMAND FOR JAPANESE GOODS

(one million US$)

		Building and construction	Transportation machinery
	①	②	③
1. Building and construction	1,342.5	0	0
2. Concrete products, ammunition and explosives	1.1	3.677	1.282
3. Household refrigerators, freezers, laundry equipment and sewing machines	23.1	0.909	0.376
4. Construction and mining machinery	339.3	13.715	4.601
5. Transportation machinery	340.0	8.923	4.184
6. Other machinery and fabricated steel	453.8	23.877	7.960
7. Office machines	32.2	0.661	0.172
8. Radio and TV sets	179.6	0.413	0.343
9. Electric equipments and appliances	402.3	32.428	15.298
10. Arms, precision instruments, watches and cable	132.7	16.482	8.867
11. Furniture and daily necessities	356.6	5.577	1.455
12. Iron, steel and steel products	221.2	39.326	15.167
13. Nonferrous metal products	10.4	10.451	4.388
14. Primary nonferrous metals	15.5	38.665	18.444
15. Food, beverage and tobacco	1,307.9	11.814	2.117
16. Cement and ceramic products	9.5	4.916	0.662
17. Housefurnishing textile products	24.9	0.578	0.172
18. Textile goods	137.5	7.312	2.492
19. Yarn and spinning	20.3	1.900	0.686
20. Leather tanning and finishing	7.1	0.537	0.163
21. Paper and sawmill products	24.9	102.198	7.624
22. Paints and printing ink	2.2	4.048	1.136
23. Organic fibers, exc. cellulosic	10.4	2.024	0.482
24. Plastic materials and resins	20.3	11.773	3.326
25. Chemicals and fertilizers	30.3	67.458	14.906
26. Metal mining	1.4	34.534	14.701
27. Scrap metal	—	58.700	27.973
28. Forestry, fishery, livestock, vegetable and fruits	388.9	62.955	6.726
29. Feed grains	0.7	23.381	2.844
30. Dairy, tobacco leaf and other agricultural products	6.8	27.718	3.040
31. Stone and clay mining and quarrying	0.0	7.683	0.809
32. Logging, nursery and other forest products	4.1	141.483	8.801
33. Coal, chemical and fertilizer mineral mining	0.7	77.248	25.578
34. Sugar and sugar crops	1.6	0.496	0.082
35. Crude petroleum and natural gas	0.0	18.878	3.751
36. Electricity, gas and petroleum refinery products	46.0	68.779	13.966
37. Drugs	33.2	3.635	0.637
38. Apparel products	96.8	0.909	0.262

Table 4. (continued)

39. Other manufactured products	306.1	103.644	35.156
40. Personal and business repair and maintenance services	82.1	37.467	8.916
41. Wholesale trade	88.3	66.136	19.278
42. Retail trade and other services	771.1	190.434	48.950
43. Business consumption	0	7.436	2.133
44. Office supplies and not-classifiables	34.0	1.239	0.335
45. Directly allocated imports and other adjustments	0	0	0
	7,307.5		

presents total outputs and imports to produce a bill of U.S. final demand.

The value of $14,379 million (row 17, column 10) in Table 6 shows the Japanese total output generated by the total U.S. final demand, while $9,656 million (row 18, column 9) is the total U.S. output generated by the total Japanese final demand. This shows that the direct and indirect dependence of Japanese outputs on U.S. final demand is also greater in absolute terms than the dependence of U.S. outputs on Japanese final demand. The value of relative dependence may be computed by dividing generated production by total output. The Japanese relative dependence on U.S., 3.14%, is much larger than the U.S. relative dependence on Japan, 0.52%.

4. *Value added generated by each category of final demand*

Table 7 shows value added for the U.S. and Japan generated by each category of final demand. The total Japanese value added generated by the total U.S. final demand is $5,007 million (row 13, column 10), while the total U.S. value added generated by the total Japanese final demand is $4,380 million (row 14, column 9). There is not so much difference between the U.S. and Japan in terms of value added as in the case of output. The relative dependence seen from the aspect of value added is 2.48% in Japan and 0.45% in the U.S.

5. *Total labor requirement*

Table 8 shows total labor requirement in both U.S. and Japan to deliver each category of final demand of both countries. It is found that the Japanese total labor requirement to deliver a fixed U.S. final demand is 1,178,000 man-year, while the U.S. total labor requirement to produce a fixed Japanese demand is 346,000 man-year. As much as 2.14% of Japanese total employment is dependent on a bill of U.S. final demand whereas only 0.43% of U.S. total employment is dependent on a bill of Japanese final demand. These ratios are approximately the same as that of value added. It is obvious in Table 6 that the unbalance in employment between Japan and the U.S. is much larger than that in the trades in 1970; $5,873 million worth of Japanese exports to the U.S. in contrast to $4,876 million worth of U.S., exports to Japan).

TABLE 5. JAPANESE TOTAL OUTPUT GENERATED BY A PARTICULAR BILL OF FINAL DEMAND FOR U.S. GOODS

(one million US$)

		Building and construction	Transportation machinery
	①	②	③
1. Building and construction	976.4	0	0
2. Concrete products, ammunition and explosives	21.5	2.246	0.292
3. Household refrigerators, freezers, laundry equipment and sewing machines	39.7	0.098	0.065
4. Construction and mining machinery	373.6	2.441	11.102
5. Transportation machinery	778.2	2.636	57.551
6. Other machinery and fabricated steel	425.2	20.211	11.705
7. Office machines	14.0	1.269	0.551
8. Radio and TV sets	86.0	2.539	34.530
9. Electric equipments and appliances	343.3	23.237	20.783
10. Arms, precision instruments, watches and cable	148.5	21.187	6.549
11. Furniture and daily necessities	270.8	30.951	8.333
12. Iron, steel and steel products	58.7	378.340	272.775
13. Nonferrous metal products	6.4	16.110	11.672
14. Primary nonferrous metals	15.3	15.426	9.759
15. Food, beverage and tobacco	246.7	4.198	3.145
16. Cement and ceramic products	1.4	19.332	0.778
17. Housefurnishing textile products	94.6	0.293	0.259
18. Textile goods	19.9	14.255	11.478
19. Yarn and spinning	1.9	7.127	5.090
20. Leather tanning and finishing	0.2	0.683	0.195
21. Paper and sawmill products	6.7	18.941	13.812
22. Paints and printing ink	1.4	1.269	1.329
23. Organic fibers, exc. cellulosic	1.5	4.784	3.567
24. Plastic materials and resins	4.6	9.373	6.874
25. Chemicals and fertilizers	25.3	30.267	18.287
26. Metal mining	1.9	1.172	0.778
27. Scrap metal	—	8.201	5.155
28. Forestry, fishery, livestock, vegetable and fruits	59.6	5.565	3.826
29. Feed grains	3.9	1.172	0.875
30. Dairy, tobacco leaf and other agricultural products	2.1	0.391	0.259
31. Stone and clay mining and quarrying	0.3	2.246	0.746
32. Logging, nursery and other forest products	3.0	3.710	2.594
33. Coal, chemical and fertilizer mineral mining	4.8	2.636	1.783
34. Sugar and sugar crops	1.1	0.195	0.130
35. Crude petroleum and natural gas	0.3	0.195	0.130
36. Electricity, gas and petroleum refinery products	65.3	26.264	18.124
37. Drugs	16.4	1.367	1.005
38. Apparel products	289.3	1.074	0.746

Table 5. (continued)

39. Other manufactured products	379.9	119.506	105.569
40. Personal and business repair and maintenance services	293.2	17.184	12.710
41. Wholesale trade	80.9	46.670	38.713
42. Retail trade and other services	664.5	68.150	51.747
43. Business consumption	—	14.645	11.478
44. Office supplies and not-classifiables	8.7	29.584	21.075
45. Directly allocated imports and other adjustments	—	0	0
	5,837		

6. *Dependence of specific Japanese sectors on total U.S. final demand*

Table 9 shows the output in each Japanese sector generated by total U.S. final demand. The values respectively stand for dependence of each Japanese sector on the U.S. in absolute terms. Column 1 persents the output in each Japanese sector generated by U.S. final demand for Japanese goods (each element of $B^{JJ} \cdot F^{JU}$). The figures in column 2 are estimates of Japanese output levels generated by U.S. final demand for U.S. goods (each element of $B^{JU} \cdot (F^{UU} + E^{U})$). Column 3 is the sum of column 1 and 2.

An examination of the figures in this table indicates the following points; the total Japanese output generated by the U.S. final demand for Japanese goods ($8,584 million) exceeds that for U.S. goods ($5,802 million) since Japanese final goods exported to the U.S. are generally greater in volume than exported intermediate goods with one exception; namely, Japanese iron, steel, and steel products generated by the U.S. final demand for U.S. goods exceeds considerably that for Japanese goods.

7. *Dependence of specific U.S. sectors on total Japanese final demand*

Table 10 shows the output in each U.S. sector generated by Japanese final demand. The values respectively stands for dependence of each U.S. sector on Japan in absolute terms. Column 1 presents the output in each U.S. sector generated by Japanese final demand for Japanese goods (each element of $B^{UJ} \cdot (F^{JJ} + E^{J})$). The figures in column 2 are estimates of U.S. output levels generated by Japanese final demand for U.S. goods (each element of $B^{UU} \cdot F^{UJ}$). Column 3 is the sum of columns 1 and 2.

The fact observed in this table is the opposite of that observed in Table 9: U.S. total output generated by Japanese final demand for Japanese goods ($7,140 million) exceeds that for U.S. goods ($2,542 million). It is formulated as follows: for Table 9, $B^{JJ} \cdot F^{JU} > B^{JU} \cdot (F^{UU} + E^{U})$, for Table 10, $B^{UU} \cdot F^{UJ} < B^{UJ} \cdot (F^{JJ} + E^{J})$.

A large U.S. output generated by Japanese goods is concentrated on sectors of raw materials such as metal mining, scrap metal, forestry, fishery, livestock,

TABLE 6. OUTPUTS AND IMPORTS OF U.S. AND JAPAN GENERATED BY EACH CATEGORY OF FINAL DEMAND

(one million US$)

		Japan				U.S.A.				⑨ Japan ①+②+③+④	⑩ U.S.A. ⑤+⑥+⑦+⑧	⑪
		① C^{JJ}	② I^{JJ}	③ IV^{JJ}	④ G^{JJ}	⑤ C^{JU}	⑥ I^{JU}	⑦ IV^{JU}	⑧ G^{JU}			
①	*J*	187,934	124,912	14,997	74,712	6,297	1,605	106	581	402,555	8,589	
②	*U*	3,105	1,934	323	915	117	28	0	12	6,277	157	
③	*R*	6,441	3,759	625	2,090	219	53	6	23	12,915	301	
④	Sub-total	197,480	130,605	15,945	77,717	6,633	1,686	212	616	421,747	9,047	
		C^{UJ}	I^{UJ}	IV^{UJ}	G^{UU}	C^{UU}	I^{UU}	IV^{UU}	G^{UU}			
⑤	*J*	1	6	0	2	2,558	1,558	106	1,111	9	5,333	
⑥	*U*	643	1,256	102	537	1,070,382	273,110	14,413	366,044	2,538	1,723,949	
⑦	*R*	11	19	1	8	12,584	4,108	428	3,903	39	21,023	
⑧	Sub-total	655	1,281	103	547	1,085)524	278)776	14)947	371)058	2)586	1,750,305	
		E^{JA}	E^{JE}	E^{JR}	E^{JS}	E^{UA}	E^{UE}	E^{UR}	E^{US}			
⑨	*J*	12,397	3,100	17,171	7,660	34	85	328	9	40,328	456	
⑩	*U*	301	73	400	67	8,319	18,732	58,120	19,680	841	104,851	
⑪	*R*	599	147	741	210	141	341	1,026	72	1,697	1,580	
⑫	Sub-total	13,297	3,320	18,312	7,937	8,494	19,158	59,474	19,761	42,866	106,887	
		E^{JD}				E^{UD}						
⑬	*J*	161				1				161	1	
⑭	*U*	0				359				0	359	
⑮	*R*	4				7				4	7	
⑯	Sub-total	165				367				165	367	
⑰	Total X^J									443,053	14,379	457,432
⑱	Total X^U									9,656	1,829,316	1,838,972
⑲	*M*									14,655	22,911	37,566
⑳										467,364	1,866,606	2,333,970

TABLE 7. VALUE ADDED OF U.S. AND JAPAN GENERATED BY EACH CATEGORY OF FINAL DEMAND

(one million US$)

		Japan				U.S.A.				⑨ Japan ①+②+③+④	⑩ U.S.A. ⑤+⑥+⑦+⑧	⑪
		① C^{JJ}	② I^{JJ}	③ IV^{JJ}	④ G^{JJ}	⑤ C^{JU}	⑥ I^{JU}	⑦ IV^{JU}	⑧ G^{JU}			
①	J	94,678	47,489	5,635	33,840	2,347	567	35	208	181,642	3,157	
②	U	1,448	861	142	412	50	8	0	2	2,863	60	
③	Sub-total	96,126	48,350	5,777	34,252	2,397	575	35	210	184,505	3,217	
		C^{UJ}	I^{UJ}	IV^{UJ}	G^{UJ}	C^{UU}	I^{UU}	IV^{UU}	G^{UU}			
④	J	0	1	0	0	843	493	30	351	1	1,717	
⑤	U	279	571	48	239	579,985	126,961	2,688	207,756	1,137	917,390	
⑤	Sub-total	279	572	48	239	580,828	127,454	2,718	208,107	1,138	919,107	
		E^{JA}	E^{JE}	E^{JR}	E^{JS}	E^{UA}	E^{UE}	E^{UR}	E^{US}			
⑦	J	4,342	1,107	5,957	5,172	8	21	101	3	15,578	133	
⑧	U	130	35	181	34	3,635	8,196	25,512	15,799	380	53,142	
⑨	Sub-total	4,472	1,142	6,138	4,206	3,643	8,217	25,613	15,802	15,958	53,275	
		E^{JD}				E^{UD}						
⑩	J	58				0				58	0	
⑪	U	0				150				0	150	
⑫	Sub-total	58				150				58	150	
⑬	Total V^J									197,279	5,007	202,286
⑭	Total V^U									4,380	970,742	975,122
⑮										201,659	975,749	

TABLE 8. TOTAL LABOR REQUIREMENT IN U.S. AND JAPAN

(1,000 of man-years)

		Japan				U.S.A.				⑨ Japan ①+②+③+④	⑩ U.S.A. ⑤+⑥+⑦+⑧	⑪
		① C^{JJ}	② I^{JJ}	③ IV^{JJ}	④ G^{JJ}	⑤ C^{JU}	⑥ I^{JU}	⑦ VI^{JU}	⑧ G^{JU}			
①	J	29,294	11,198	1,346	8,336	610	114	4	44	50,174	772	
②	U	120	62	10	31	1	0	0	0	223	1	
③ Sub-total		29,414 C^{UJ}	11,260 I^{UJ}	1,356 IV^{UJ}	8,367 C^{UJ}	611 C^{UU}	114 I^{UU}	4 IV^{UU}	44 G^{UU}	50,397	773	
④	J	0	0	0	0	191	94	4	70	0	359	
⑤	U	21	40	1	17	48,421	9,811	665	17,157	79	76,054	
⑥ Sub-total		21 E^{JA}	40 E^{JE}	1 E^{JR}	17 E^{JS}	48,612 E^{UA}	9,905 E^{UE}	669 E^{UR}	17,227 E^{US}	79	76,413	
⑦	J	1,005	261	1,359	1,016	0	4	15	0	3,641	16	
⑧	U	8	1	12	1	281	625	1,931	593	22	3,430	
⑨ Sub-total		1,013 E^{JD}	262	1,371	1,017	281 E^{UD}	629	1,946	593	3,663	3,449	
⑩	J	11				0				11	0	
⑪	U	0				13				0	13	
⑫ Sub-total		11				13				11	13	
⑬ Total L^J										53,826	1,150	54,976
										(53,835)	(1,178)	(55,013)
⑭ Total L^U										324	79,498	79,822
										(346)	(79,515)	(79,861)
⑮										54,150	80,648	

TABLE 9. THE OUTPUT IN EACH JAPANESE SECTOR GENERATED BY U.S. FINAL DEMAND

(one million US$)

	Japanese sectors	① The output in each Japanese sector generated by U.S. final demand for Japanese goods	② The output in each Japanese sector generated by U.S. final demand for U.S. goods	③ ①+②
X 0 1 J	Building and construction	0	0	0
X 0 2 J	Concrete products, ammunition and explosives	8	4	12
X 0 3 J	Household refrigerators, freezers, laundry equipment and sewing machines	65	2	67
X 0 4 J	Construction and mining machinery	343	45	488
X 0 5 J	Transportation machinery	690	80	770
X 0 6 J	Other machinery and fabricated steel	185	85	270
X 0 7 J	Office machines	116	22	138
X 0 8 J	Radio and TV sets	896	94	990
X 0 9 J	Electric equipments and appliances	535	181	716
X 1 0 J	Arms, precision instruments, watches and cable	223	103	326
X 1 1 J	Furniture and daily necessities	525	104	629
X 1 2 J	Iron, steel and steel products	704	2,068	2,772
X 1 3 J	Nônferrous metal products	108	90	198
X 1 4 J	Primary noferrous metals	88	93	181
X 1 5 J	Food, beverage and tobacco	160	31	191
X 1 6 J	Cement and ceramic products	81	29	111
X 1 7 J	Housefurnishing textile products	36	2	38
X 1 8 J	Textile goods	158	209	367
X 1 9 J	Yarn and spinning	80	87	167
X 2 0 J	Leather tanning and finishing	10	5	15
X 2 1 J	Paper and sawmill products	150	99	249
X 2 2 J	Paints and printing ink	26	8	34
X 2 3 J	Organic fibers, exc. cellulosic	40	63	103
X 2 4 J	Plastic materials and resins	61	60	121
X 2 5 J	Chemicals and fertilizers	126	215	341
X 2 6 J	Metal mining	6	7	13
X 2 7 J	Scrap metal	14	44	58
X 2 8 J	Forestry, fishery, livestock, vegetable and fruits	72	56	128
X 2 9 J	Feed grains	38	8	46
X 3 0 J	Dairy, tobacco leaf and other agricultural products	10	3	13
X 3 1 J	Stone and clay mining and quarrying	10	7	17
X 3 2 J	Logging, nursery and other forest products	30	19	49
X 3 3 J	Coal, chemical and fertilizer mineral mining	10	16	26

Table 9. (continued)

X 3 4 J	Sugar and sugar crops	5	1	6
X 3 5 J	Crude petroleum and natural gas	1	1	2
X 3 6 J	Electricity, gas and petroleum refinery products	172	152	324
X 3 7 J	Drugs	18	10	28
X 3 8 J	Apparel products	170	6	176
X 3 9 J	Other manufactured products	803	656	1,459
X 4 0 J	Personal and business repair and maintenance services	146	100	246
X 4 1 J	Wholesale trade	597	279	876
X 4 2 J	Retail trade and other services	688	400	1,088
X 4 3 J	Business consumption	151	87	238
X 4 4 J	Office supplies and not-classifiables	228	171	399
X 4 5 J	Directly allocated imports and other adjustments	0	0	0
S 4 6 J	Total	8,584	5,802	14,386

vegetable and fruits, dairy, tobacco leaf and other agricultural products, feed grains, and logging nursery and other forest products. If U.S. exports to Japan are changing from intermediate goods to final goods, the values of final goods sectors (from sector 2 to sector 11) can be larger than those of raw material sectors in column 1.

IV. THE COMPILATION OF THE 1970 JAPAN-U.S.A. INTERNATIONAL INPUT–OUTPUT TABLE AND THE DATA

For compiling the input-output table, we require both comparable national input–output tables of Japan and U.S.A. and trade statistics. I will summarize in this section the procedures for the compilation of the 1970 Japan–U.S. international table with 216 uniform sector classification and the particular statistics used in its compilation. Figure 1 shows the system of the 1970 Japan–U.S. International Input–Output Table.

1. *Estimation of 1970 U.S. Input–Output Table*

The most recent table available for U.S. is for 1967. Thus, the bench year was set at 1970, the year of Japan's most recent input–output table. Therefore, the 1970 input–output table of U.S.A. had to be estimated based on the table for 1967. The procedure is as follows: first we estimated total output (control totals) of each sector, sectoral final demand, value added, import and export trades and so on for 1970. Next, the intermediate demands were calculated by multiplying the estimated control total by the 1967 input coefficients. The estimates for value added and final demand were then substituted to compute the first approximation table, which was at this stage not yet balanced. The unbalance was then adjusted for the rows and then for the columns. After repeating these procedures several

TABLE 10. THE OUTPUT IN EACH U.S. SECTOR GENERATED BY JAPANESE FINAL DEMAND

(one million US$)

U.S. sectors		① The output in each U.S. sector generated by Japanese final demand for Japanese goods	② The output in each U.S. sector generated by Japanese final demand for U.S. goods	③ ①+②
X 0 1 U	Building and constuction	0	0	0
X 0 2 U	Concrete products, ammunition and explosives	16	3	19
X 0 3 U	Household refrigerators, freezers, laundry equipment and sewing machines	5	9	14
X 0 4 U	Construction and mining machinery	144	317	461
X 0 5 U	Transportation machinery	45	48	93
X 0 6 U	Other machinery and fabricated steel	126	296	422
X 0 7 U	Office machines	5	31	36
X 0 8 U	Radio and TV sets	3	6	9
X 0 9 U	Electric equipments and appliances	242	342	584
X 1 0 U	Arms, precision instruments, watches and cable	91	87	178
X 1 1 U	Furniture and daily necessities	24	88	112
X 1 2 U	Iron, steel and steel products	190	112	302
X 1 3 U	Nonferrous metal products	55	29	84
X 1 4 U	Primary nonferrous metals	207	30	237
X 1 5 U	Food, beverage and tobacco	95	53	148
X 1 6 U	Cement and ceramic products	12	4	16
X 1 7 U	Housefurnishing textile products	3	3	6
X 1 8 U	Textile goods	35	21	56
X 1 9 U	Yarn and spinning	9	7	16
X 2 0 U	Leather tanning and finishing	3	2	5
X 2 1 U	Paper and sawmill products	220	28	248
2 2 U	Paints and printing ink	17	5	22
X 2 3 U	Organic fibers, exc. cellulosic	10	5	15
X 2 4 U	Plastic materials and resins	57	10	67
X 2 5 U	Chemicals and fertilizers	417	35	452
X 2 6 U	Metal mining	162	11	173
X 2 7 U	Scrap metal	275	11	286
X 2 8 U	Forestry, fishery, livestock, vegetable and fruits	374	77	451
X 2 9 U	Feed grains	546	14	560
X 3 0 U	Dairy, tobacco leaf and other agricultural products	399	18	417
X 3 1 U	Stone and clay mining and quarrying	22	2	24
X 3 2 U	Logging, nursery and other forest products	342	7	349
X 3 3 U	Coal, chemical and fertilizer mineral mining	312	20	332

Table 10. (continued)

X 3 4 U	Sugar and sugar crops	6	1	7
X 3 5 U	Crude petroleum and natural gas	97	16	113
X 3 6 U	Electricity, gas and petroleum refinery products	349	68	417
X 3 7 U	Drugs	35	16	51
X 3 8 U	Apparel products	4	7	11
X 3 9 U	Other manufactured products	489	238	727
X 4 0 U	Personal and business repair and maintenance	221	60	281
X 4 1 U	Wholesale trade	371	145	516
X 4 2 U	Retail trade and other services	1,057	235	1,292
X 4 3 U	Business consumption	41	22	63
X 4 4 U	Office supplies and not-classifiables	7	3	10
X 4 5 U	Directly allocated imports and other adjustements	0	0	0
S 4 6 U	Total	7,140	2,542	9,682

times, the 1970 U.S. Input–Output Table with 484 order was compiled.

The following were used as data sources to estimate each control total; *Annual Survey of Manufacturing 1970* for manufacturing, *Statistical Abstract of the United States* for mining, *Agricultural Statistics* for agriculture and *National Income and Product Accounts* for services. The original statistical source used for estimation of personal consumption expenditures is Table 2-5, "Personal Consumption Expenditures by Type of Product" in the PCE category of *National Income and Product Accounts*, which gives the data of personal consumption expenditures of 83 categories on the purchaser's price basis. In order to convert these data into the categories of the input-output table, the items had to be converted into the I-0 sector basis and also the purchaser's prices had to be conevrted to producer's prices. Concepts from Table B, "Industrial Composition of Personal Consumption Expenditures", by PCE category in Producer's and Purchaser's Prices, 1967 (Survey of Current Business, February 1974, pp. 32–33) were used for converting the data. Like personal consumption expenditures, the figures of gross private fixed capital formation are estimated from the data of Table 5-2, "Purchases of Structures by Type" and Table 5-4, "Private Purchases of Producer's Durable Equipment by Type" in *National Income and Product Accounts*. Concepts contained in the paper by Simon and Ritz, "Producers Durable Equipment in 1963 and 1967" (*Survey of Current Business*, February 1975) were used for converting the data to the input–output format. Government expenditures and net inventory changes were estimated from the data in *National Income and Product Accounts*. Gross exports from the United States include exports of commodities and of direct services. For commodities exports, the statistics were obtained from the tape of "United States Exports of Domestic and Foreign Marchandise", which uses the Schedule B classification. Two conversion procedures had to be undertaken to convert these statistics to the estimates of

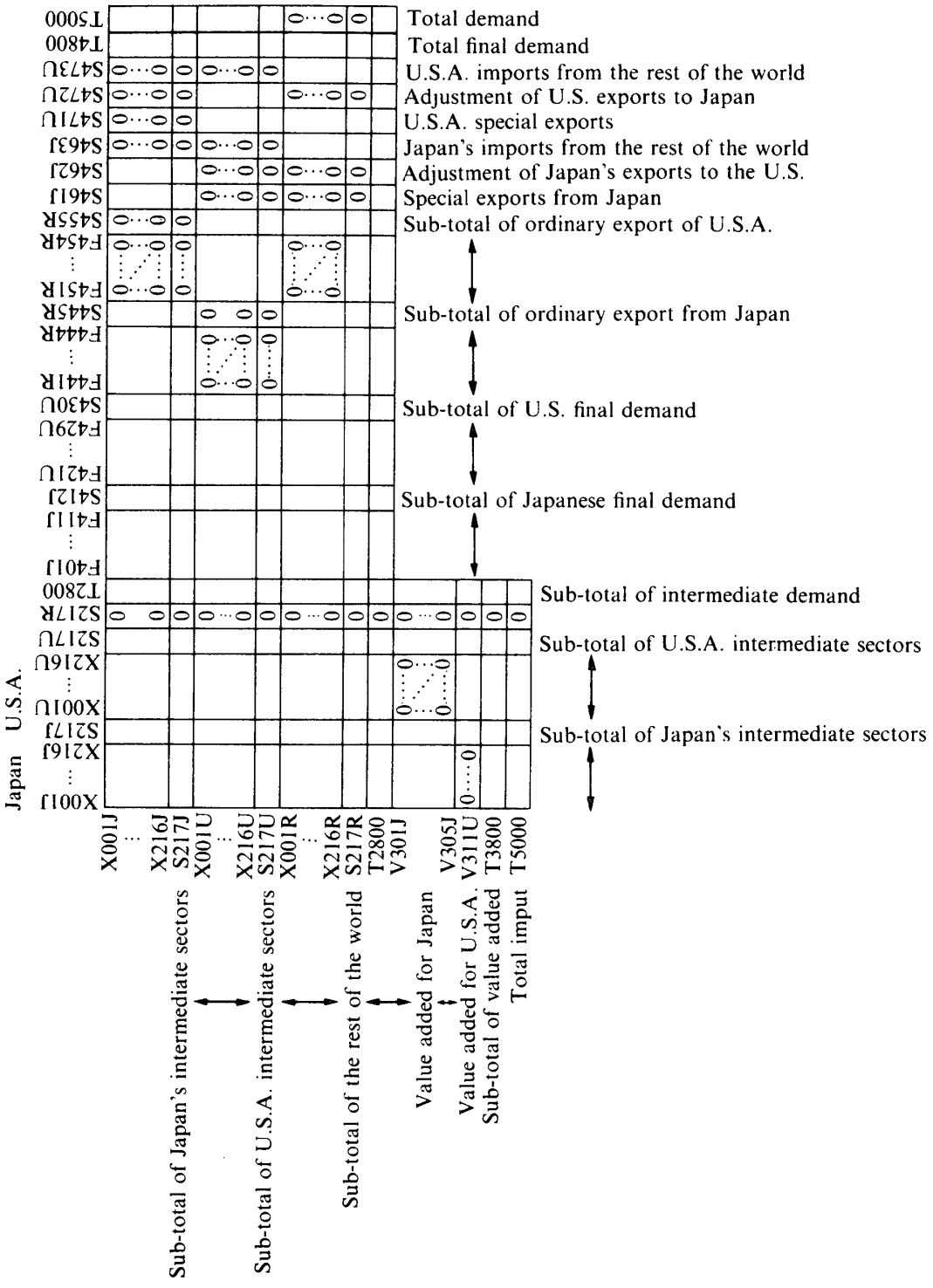


Fig. 1. Layout of 1970 Japan-U.S.A. International Input-Output Table (216 sectors).

gross exports in an input–output category; (1) the Schedule B classification was adjusted to fit the input–output sector classification and (2) f.o.b. prices were converted to producer's prices.

Procedure (1): The Schedule B classification was converted to the U.S. SIC classification by OBE, the U.S. Department of Commerce, and was then converted to the input–output sector classification.

Procedure (2): Exports were valued at producers' prices by using the rate of domestic freight and other trade margins in the 1967 U.S.A. Table. Merchandise exports, then, are separately presented by 25 regions. Exports of direct services including interest receipts and repatriated profits from American investment abroad were estimated from the relevant items in national income and international balance of payments accounts.

Imports are separated into two categories in the U.S.A. input–output table: (1) the transferred imports and (2) the directly allocated imports. The transferred imports, which are substitutable for domestically produced goods, are added to the output of domestic industries producing the similar goods and are then distributed to the consuming sectors together with the domestic outputs. For example, transferred imports include such competitive imports as iron, steel and steel products. The directly allocated imports, which are not substitutable for domestically produced goods, are shown as purchased directly by the consuming industries and recorded in a separate row. For example, the directly allocated imports cover non-competitive goods like coffee beans as intermediate goods, and final goods purchased by the consuming sector. The statistical sources used for estimating U.S. imports are *U.S. Commodity Exports and Imports as Related to Output 1968 and 1967, 1971 and 1970* and items in the national income and balance of payment.

In order to estimate an international input–output table, the national input–output table of each partner country should be separated into two transaction tables, i.e. the transaction table for domestic products and the transaction table of imported goods and services. For this purpose, the import matrix or the transaction table for imported goods and services was prepared. The Japanese import matrix for 1970 is available but the U.S. import matrix is not available either for 1967 or for 1970. Therefore, the import matrix with 484 sectors for U.S.A. had to be estimated. By using the composition ratios obtained from the estimated U.S. 1970 import matrix, the U.S. imports from Japan are divided into two parts, imports for intermediate demands and those for final demands.

2. *Estimation of Japanese exports to the U.S. and U.S. exports to Japan*

Estimations of Japanese exports to the U.S. were made using the magnetic tape. Two conversion procedures had to be undertaken to adjust the trade classification to the input–output sector classification and to convert f.o.b. prices to producer's prices, assuming that trade margin ratios in Japanese exports to U.S. are equal to those in Japanese total exports. Furthermore, Japanese exports

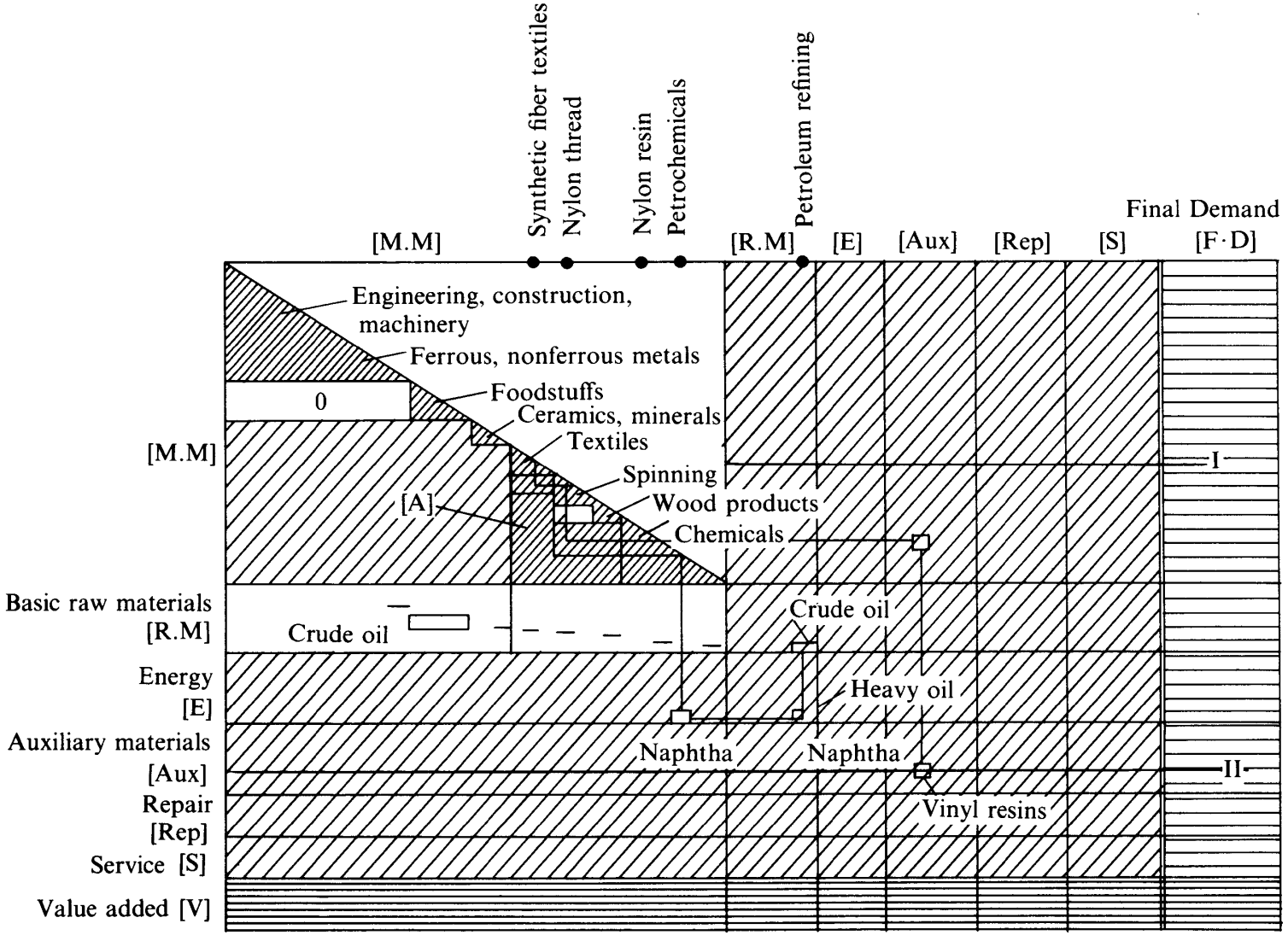


Fig. 2. Summary Diagram of the Basic Economic Structure.

are broken down into 25 destination regions. U.S. exports to Japan based on the U.S. input–output classifications were compiled in the 1970 U.S. estimated table.

3. *Compilation of Japan and U.S. Input–Output Tables with uniform sectors*

The 1970 Japanese Input–Output Table is available at 541×407, while the estimated U.S.A. I–O Table is at 484×484. Both classifications are based on different criterion so that a uniform sector classification is required for the precise international comparison. However, a uniform classification, on the other hand, should meet the purpose of triangular international input–output analysis which aims at pursuing the related industry by a main raw material and the interdependence among the sets of related industries. Figure 2 shows a summary diagram of the triangulated I–O table. The sector order in the triangular I–O table is different from that in the ordinary I–O table. Both Japan and U.S. original I–O tables are aggregated to the triangular tables with 216 sectors, using the converter of the uniform sector classification. The tables with 45 sectors used for this study are aggregated from the tables with 216 sectors and are also triangulated. The official exchange rate \$1=¥360 is used in the Japanese table for comparison between Japan and the U.S.

4. *Estimation of X^{JU}, F^{JU}, X^{UJ} and F^{UJ}*

For both Japan and U.S. I–O tables with 216 sectors, the vector of Japan exports to U.S. and the vector of U.S. exports to Japan on a I–O basis were prepared as the result of steps 1, 2 and 3. The next step was to divide each vector of exports to the partner country into intermediate demands and final demands. For example, Japanese exports to the U.S. had to be separated into X^{JU} used for U.S. intermediate demands and F^{JU} for U.S. final demands. The composition ratios obtained from the U.S. 1970 import matrix were usually divided into two parts, assuming that there was no difference in composition between Japan and the rest of the world. The composition ratios are, however, adjusted by additional information, for the above assumption is not always effective. The similar procedure is required for U.S. exports to Japan (X^{JU}, F^{UJ}).

5. *Linkage of Japan and U.S. Input–Output Tables*

The final step is to compile the international Input–Output table by linking both national input–output tables of Japan and U.S. using trade matricies, i.e., the Japan's import matrix, the U.S.A. import matrix, the Japan's import matrix from U.S.A. and the U.S.A. import matrix from Japan. Japan's import matrix from the rest of the world is estimated by deducting the matrix of the Japan's import from U.S.A. from the Japan's import matrix, and the U.S.A. import matrix from the rest of the world can be similarly estimated. Figure 1 shows the layout of the International Input–Output Table. For example, the total input of the j-th Japanese sector seen columnwise is composed of four categories: (1) the domestic intermediate input (X_{ij}^{JJ}), (2) the imported intermediate input from U.S. (X_{ij}^{UJ}), (3) the imported intermediate input from the rest of the world (X_{ij}^{RJ}) and (4) the

TABLE II. 1970 JAPAN–U.S. INTERNATIONAL INPUT-OUTPUT TABLE (45 sectors)

	X001J……X045J	S046J	X001U……X045U	S046U	S046R	T2800	J-PC	J-FCF	J-IV	J-GE	J-EAC	J-EEC	J-ERW	J-ESP	J-EAD	J-MT	U-PC	U-FCF	U-IV	U-GE	U-EAC	U-EEC	U-ERW	U-ESP	U-EAD	U-MT	T4800	T5000	J-DD	J-NEX	U-DO	U-NEX
X001J……X045J					0……0											0……0					0	⋱	0	0	⋱	0					0……0	
S046J		①		②	0	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	0	⑬	⑭	⑮	⑯	0	……	0	0	……	0	⑰	⑱	⑲	⑳	0	㉑
X001U……X045U					0……0						0	⋱	0	0	⋱	0										0……0			0……0			
S046U		㉒		㉓	0	㉔	㉕	㉖	㉗	㉘	0	……	0	0	……	0	㉙	㉚	㉛	㉜	㉝	㉞	㉟	㊱	㊲	0	㊳	㊴	0	㊵	㊶	㊷
S046R		㊸		㊹	0	㊺	㊻	㊼	㊽	㊾						㊿	(51)	(52)	(53)	(54)	0	……	0	(55)		(56)	(57)	(58)	0	(59)	0	(60)
T2800		(61)		(62)	0		(63)	(64)	(65)	(66)							(67)	(68)	(69)	(70)				(71)			(72)	(73)		(74)		(75)
V-A		(76)		(77)	0																											
T5000					0																											

(one million US$)

① 236,499	⑮ 44	㉙ 593,424	㊸ 15,107	(57) −37,567	(71) 19,908
② 2,321	⑯ 243	㉚ 131,576	㊹ 22,460	(58) 0	(72) 1,177,461
③ 238,819	⑰ 218,629	㉛ 3,150	㊺ 37,567	(59) −18,126	(73) 2,296,451
④ 102,605	⑱ 457,449	㉜ 212,025	㊻ 1,914	(60) −53,466	(74) 894
⑤ 51,884	⑲ 433,712	㉝ 3,791	㊼ 776	(61) 255,133	(75) 4,442
⑥ 6,433	⑳ 23,737	㉞ 8,565	㊽ 70	(62) 863,858	(76) 202,316
⑦ 36,291	㉑ −5,873	㉟ 26,641	㊾ 259	(63) 104,812	(77) 975,145
⑧ 5,131	㉒ 3,527	㊱ 15,876	㊿ −18,126	(64) 53,255	
⑨ 1,303	㉓ 839,077	㊲ 159	(51) 18,663	(65) 6,554	
⑩ 6,939	㉔ 842,604	㊳ 996,399	(52) 2,013	(66) 36,802	
⑪ 4,423	㉕ 292	㊴ 1,839,003	(53) 248	(67) 614,720	
⑫ 68	㉖ 596	㊵ −4,717	(54) 6,045	(68) 134,227	
⑬ 2,627	㉗ 51	㊶ 1,779,252	(55) 4,032	(69) 3,441	
⑭ 638	㉘ 251	㊷ 63,781	(56) −53,466	(70) 218,313	

value added (V_j^J). Japanese imports from U.S.A. valued at c.i.f. include U.S. domestic trade margin and transportation charges, and maritime freight and insurance. The former is settled in the course of conversion of f.o.b. prices to producers' prices to be included in the category (2). The latter is unsettled for lack of data and was included not in category (2) but in category (3), which is left for a future study. Table 11 is the international Input–Output table with 45 sectors aggregated from that with 216 sectors. The figures indicate important points of transactions in the international Input–Output table.

V. CONCLUSION

The purpose of this report is to investigate interdependence between the Japanese and U.S. economies from the viewpoint of structural analysis how the final demands of both countries are directly and indirectly influenced each other by linking economic structures of both Japan and U.S. to trade patterns, and to determine it quantitatively. The results are as follows:

i) In absolute terms the dependence of the Japanese economy on the U.S. is larger in production, value added and employment than the dependence of the U.S. economy on Japan.

ii) As for the relative dependence, when comparative size of production, value added and employment in both Japan and U.S. are taken into consideration, the dependence of the Japanese economy on the U.S. is far larger than the dependence of the U.S. economy on Japan.

iii) The following unbalance arises: Japanese employment of 1,178,000 (man-years) is finally dependent on U.S. final demand, whereas U.S. employment of only 346,000 is dependent on Japanese final demand. In fact, the unbalance in employment exceeds that in trade.

iv) Japanese output generated by U.S. final demand for Japanese goods is larger than that for U.S. goods. For one exception, the Japanese generated output of iron and steel, which is much more dependent on U.S. goods than on Japanese goods.

v) U.S. output generated by Japanese final demand for Japanese goods is larger than U.S. output generated by Japanese final demand for U.S. goods. The U.S. raw materials sector is prominently dependent on Japan.

vi) Using the method of Japan–U.S. international input–output analysis to evaluate the vertical relation in the economic interdependence between Japan and U.S., it was shown that Japan generally exports final goods to U.S., while U.S. supplies raw materials to Japan.

The above analysis does not deal with the analysis of by what factor a trade pattern between two countries is changed, for it emphasizes the discovery of facts on the interdependence of the economies between the two countries by fixing economic structures of both countries and trade patterns in 1970. It was, however, observed that the change in final demand in a specific sector has a direct and indirect effect not only on other sectors in the domestic country, but also on whole sectors in both countries. The present unbalance of trade between Japan and the U.S. and the voluntary export restraint on the sale of color television sets and iron and steel as a commercial policy are, therefore, not a mere problem in a particular sector, but a serious problem concerned with the structure of the entire Japanese economy. To carry out this quantitative analysis in the furture, we must collect the relevant data more systematically in order to construct models where changes in trade patterns are built in more appropriately.

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