Estimation Technique of International Input-Output Model by Non-survey Method

Nobuhiro Okamoto[1], Takao Sano[2] and Satoshi Inomata[3]

Abstract

The Asian International Input-Output (IO) Table that is compiled by Institute of Developing Economies –JETRO (IDE), was constructed in Isard type form. Thus, it required a lot of time to publish. In order to avoid this time-lag problem and establish a more simple compilation technique, this paper concentrates on verifying the possibility of using the Chenery-Moses type estimation technique. If possible, applying the Chenery-Moses instead of the Isard type would be effective for both impact and linkage analysis (except for some countries such as Malaysia and Singapore and some primary sectors. Using Chenery-Moses estimation method, production of the Asian International IO table can be reduced by two years. And more, this method might have the possibilities to be applied for updating exercise of Asian IO table.

Keywords: International Input-Output, non-survey, Chenery-Moses, compilation

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[1] Institute of Developing Economies-JETRO, 3-2-2, Wakaba, Mihamaku, Chibashi, Chiba, Japan
[2] Gifu Shotoku Gakuen University, 1-38, Nakauzura, Gifushi, Gifu, Japan
[3] Institute of Developing Economies-JETRO, 3-2-2, Wakaba, Mihamaku, Chibashi, Chiba, Japan

1. Introduction

The Institute of Developing Economies – JETRO (IDE) has compiled the Asian International Input-Output Tables for the years, 1975, 1985, 1990 and 1995 (Institute of Developing Economies 1982,1992,1998,2001). It is now compiling the table for the year 2000 in the form of non-competitive import or so called Isard type (Isard 1951). This shows the commodity of transaction by country of origin.

Compilation of the Asian International IO tables needs a lot of time, work, and personnel. In the compilation procedure (Tamamura 1994), there are many estimation steps such as updating or estimating country's national table, conducting the survey of import commodity inputs, compiling an import matrix, dividing it by country of origin, linking each economy's table, and conducting a number of balancing exercises by IO specialists. The survey and primary data provided by each statistical organization in each country is especially important in the construction of the international IO table. Such construction work is done after the collection and evaluation of results of survey and primary data. Since this important information is included in the table, the Asian international IO table has been regarded as a survey based table so far.

When survey based tables are planed to be constructed, a lot of data must be collected such as production outputs and intermediate inputs. Further more, the survey must be conducted to capture purchase and sales of imported commodities. Although the ideal is to conduct such a detailed survey, there is generally not enough time and money to allow this kind of data gathering. Even if this kind of survey can be conducted, the data of inputs from sectors (countries) for production and those of outputs to sectors (other countries) may be inconsistent. Row-wise and column –wise information must be reconciled for constructing input-output data; this adjustment must be faced.

One of the most frequent criticisms of the Asian international IO table may be the "time-lag problem." As seen earlier, a lot of estimation work goes into the construction of the Asian international IO table. Thus, six or seven years have passed after the reference year when the table is published. The user of this table may do analysis based on the assumption of a constant input coefficient and that the data are updated when they want to apply the table to an understanding of current economic issues such as the economic integration of the East Asia or the environmental impact of China on other countries.

Okamoto and Arakawa (2003) tested the stability of the input coefficient. They concluded that the input coefficient was relatively stable but that the input coefficient of the economy with a large relation to the international market and primary sectors were not so stable. They also mentioned that the RAS method was useful in updating the international IO table. Okuda (2003) also proposed the entropy method for updating the interregional IO table of Japan. Takagawa and Okada (2004) collected exogenous data and trade statistics; they then updated the Asian international IO table by using the RAS method in consideration of trade data.

The RAS method is commonly used for updating[4]. The entropy method is also one of the RAS family. However, these techniques require more information than other methodologies. For example, intermediate demand (total output minus final demand) and intermediate input (total input minus value added) must be considered. Regional or international economists usually cannot collect these exogenous data by country and by sector. In such cases, other estimation technique under time and data constraints muste be considered.

Based on the above, the Chenery-Moses (column) model (Chenery 1953; Moses 1955) is proposed in the paper for updating or estimating the international IO table. Additionally, accuracy of its technique is assessed and clarified.

This paper consists of four parts: (1) the compilation procedure of the Asian International IO table, (2) the Chenery-Mose model and a proposed estimation technique, (3) the result of the estimation and a discussion of model accuracy, and (4) final conclusions and discussion on the future works.

2. Compilation Procedure of the Asian International Input-Output Table in IDE

The compilation procedure of the Asian international IO table in IDE has four steps as follows (a detailed explanation is provided in the Annex):

Step 1: Preparation of a national input-output table in non-competitive import type format.

First, national input-output tables are prepared for the same referential year. While the Japanese table is compiled in the year with its last digit being either 5 or 0 (1995 or 2000, for example), the Chinese table is compiled in years where the last digit is 2 or 7 (such as 1997 or 2002). Thus, tables of some countries relative to the same referential year must be extrapolated. Second, tables are produced in the form of the non-competitive import type. If some tables do not have an import matrix, then with the

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[4] However RAS method has been criticized. For example, see Polenske (1997).

collaborating organization/agency in each country, a sample survey is conducted to collect effective information about the input/output structure of imported goods. This is done to single out the import matrix.

Step 2: Making of import matrices by countries of origin

First, data on duties and the import commodity tax are collected, and these amounts are removed from the import matrix. Then, the vector for duties and the import commodity tax is compiled. Second, the country of origin's import shares for each commodity is computed, and the import matrix of goods is split by the country of origin using import share. Finally, a reconciliation of import matrices by country of origin can be reconciled if more reliable information on the input structure of imported goods by country of origin can be obtained. Since there is no information on country of origin for service trades, the import of services is added to the import from the rest of the world.

Step 3: Conversion of import matrices into CIF and the producer's price

So far, all import matrices are valued at CIF, net of duties and import commodity taxes. Import matrices from the member countries should be made FOB by removing international freight and insurance from each country of origin. All the matrices of international freight and insurance are aggregated column-wise into a single row vector, and this is placed below the matrices from the member countries. The data on international freight and insurance is provided by the collaborating organization/agency in each country. When there is no such data, estimation may be based on the existing information.

After import matrices are converted from CIF to FOB, they can be further converted into producer's price. Rates of domestic transportation costs and trade margins (TTMs) on the export of the countries of origin are computed. Then, TTMs are removed from import matrices country by country. The TTM matrices thus derived are aggregated in a column-wise direction country by country in order to obtain TTM vectors (rows) for the countries of origin. Finally, the derived TTM vectors are added to the corresponding sectors of import matrices as imports of trade and transportation services.

Step 4: Linking and Balancing

Through the above steps, all components, including domestic transaction or import matrices by country of origin, can be prepared and made ready for linking. After due aggregation into the Asian IO sector classification, all the parts are linked within the

Asian IO framework. It should be noted that export vectors to member countries are not used, in order to avoid double-counting with corresponding import matrices.
In principal, figures are balanced in a column-wise direction since they are expanded from a single country's data. The row-wise direction, however, is not balanced since the export data of one country is replaced by the import data of its trade partner. Row-wise discrepancies occur primarily because of the data inconsistency among the trade statistics of the countries concerned. In balancing work, sectors with the error ratios of over 5% are checked. Assuming that these errors come from the misclassification of items at the HS coding level, "bad" trade figures moved from one sector to another. This is based on the coding correspondence of the export country. If the error is due to other reasons, the primary data source may be checked and revised to reduce the discrepancy using the opinion of experts.

Past experience in this compilation work indicates that step 1 and step 2 take almost four years. Step 3 and 4 are executed in 1 or 2 years. Thus, this kind of survey-based table requires 5 or 6 years to complete.

3. A Proposed Methodology of an International Input-Output Model

3.1 Discussion on model

The Asian international IO table is compiled using the non-competitive import or Isard type. This is sometimes called the "interregional IO model." For estimating the Isard type international IO table, a lot of information is required concerning distribution or input structure of imported goods by country of origin. Unlike the interregional model, the multi-regional model has also been developed. It requires less information than the interregional model and needs only the national IO table in competitive import type and the trade coefficient. In addition, separation of a country's technical structure from its trade structure allows updates to model to be made more easily. Among the various kinds of multi-regional model, Hioki (2003) compared (1) a column coefficient model, (2) a row coefficient model, (3) a gravity model and (4) a linear programming model, concluded that the column coefficient model (Chenery-Moses model) is best.

> The reasons are: (1) non-negativity of Leontief inverse matrix is secured only in the column coefficient model. It is possible that negative entries might happen in a Leontief inverse matrix when we utilize the latter two models. This is especially the case of the row coefficient model, sometimes even leading to

negative projection of outputs (Polenske 1980, Bon 1984, Toyomane 1988 etc). (2) Performance of the column coefficient model is known to be fairly good. Polenske (1970) used sets of Japanese interregional input-output table to check the accuracy of these three models. From the comparison between the estimated outputs and interregional trade flows by the models and the real data listed in the table, she showed that the accuracy of the row coefficient model is considerably worse than those of the other two models, and that the column coefficient model is almost as accurate as the Leontief-Strout gravity model. In Polenske's MRIO model for the United States, 44regions-78sectors tables of several years were estimated based on the regional technical structure and the interregional trade structure in 1963. In the work, although they used the Leontief-Strout gravity model at first, they could not get the convergence solution and finally changed to use the column coefficient model (Polenske 1980). (3) The amount of data necessary for the estimation of these 3 models is almost indifferent. (Hioki 2003, pp.68-69)

In the case of international trade, it is easy to get trade data, so the gravity model does not need to be considered. As Hioki (2003) showed in empirical research, the column model is better than the row model (see Polenske 1970).

3.2 Estimation Model

It is generally impossible for a general economist to construct the international input-output table for Asia using a full-survey base or to collect the exogenous data required for RAS updating because this work needs a large amount of time, funds, and manpower. These are usually far beyond the capacity of a general economist. It is easier to use the existing IO table for each country along with trade statistics. Even though a country's IO table has been provided a few years later, trade statistics have usually been available after one year.

Consider the column model of the multi-regional IO model. Assume that there are two countries, country one and country two in Asia. Further assume that the country's value added, final demand, total output, technical coefficient, and trade coefficient are given. The column input-output model can be represented as follows (Miller and Blair 1985, pp.69-85):

$$\begin{bmatrix} \hat{C}^{11} & \hat{C}^{12} \\ \hat{C}^{21} & \hat{C}^{22} \end{bmatrix} \begin{bmatrix} A^{1} & 0 \\ 0 & A^{2} \end{bmatrix} \begin{bmatrix} X^{1} \\ X^{2} \end{bmatrix} + \begin{bmatrix} \hat{C}^{11} & \hat{C}^{12} \\ \hat{C}^{21} & \hat{C}^{22} \end{bmatrix} \begin{bmatrix} F^{1} \\ F^{2} \end{bmatrix} + \begin{bmatrix} E^{1} \\ E^{2} \end{bmatrix} = \begin{bmatrix} X^{1} \\ X^{2} \end{bmatrix} \qquad (1)$$

Where

X^R = Total output in country R

F^R = Final Demand in country R

E^R = Export to the Rest of the World of country R

A^R = Technical coefficient matrix of country R

$\hat{C}^{RS}$ = Trade coefficient matrix from country R to country S. (a diagonal matrix of coefficients).

(R, S = 1 and 2 respectively)

In this model, import from the rest of the world is not considered and will be treated it later.

The elements of the trade coefficient matrix, denoted by c_i^{RS}, show the proportion of goods i used in S that comes from country R. Trade coefficients are derived from the transactions going from R to S divided by the total imports of S. This is defined as:

$$c_i^{RS} = \frac{t_i^{RS}}{\sum_n t_i^{nS}} \qquad \text{(n=1,2)}$$

where t_i^{RS} is the amount of goods i moved from country R to country S. With this as a background, it is assumed that each sector in the country purchases commodities and services from the other country in the same ratio.

From equation (1), we can derive the followings:

$$\begin{bmatrix} X^1 \\ X^2 \end{bmatrix} = \left\{ \begin{bmatrix} I & 0 \\ 0 & I \end{bmatrix} - \begin{bmatrix} \hat{C}^{11} & \hat{C}^{12} \\ \hat{C}^{21} & \hat{C}^{22} \end{bmatrix} \begin{bmatrix} A^1 & 0 \\ 0 & A^2 \end{bmatrix} \right\}^{-1} \left\{ \begin{bmatrix} \hat{C}^{11} & \hat{C}^{12} \\ \hat{C}^{21} & \hat{C}^{22} \end{bmatrix} \begin{bmatrix} F^1 \\ F^2 \end{bmatrix} + \begin{bmatrix} E^1 \\ E^2 \end{bmatrix} \right\}$$

In this model, the trade coefficient plays an important role on the impact of each country's final demand.

4. Empirical Study

4.1 Data and methodology

As discussed above, a multi-regional IO model can be constructed on the assumption that only the technical coefficient, trade coefficient and final demand are available. Considering the circumstances of the general economist's research, it is easier to get

Figure 1 Estimating Trade Coefficient (Case of 3 countries)

Step 1 Compiling trade matrix

Import data

	A	B	C
A	s^A	m^{AB}	m^{AC}
B	m^{BA}	s^B	m^{BC}
C	m^{CA}	m^{CB}	s^C
ROW	m^{RA}	m^{RB}	m^{RC}
Total	m^{0A}	m^{0B}	m^{0C}

Note: Singapore's total export consists of domestic exports and re-exports.

Step 2 Estimating the Self-sufficient ratio (Diagonal cell)

s = 1-(imports/intermediate and final demand)
:::estimated from IO data

Step 3 Calculation of column trade coefficient

column coeffient calculation

	A	B	C
A	s^A	$m^{AB}/m^{0B}*(1-s^B)$	$m^{AC}/m^{0C}*(1-s^C)$
B	$m^{BA}/m^{0A}*(1-s^A)$	s^B	$m^{BC}/m^{0C}*(1-s^C)$
C	$m^{CA}/m^{0A}*(1-s^A)$	$m^{CB}/m^{0B}*(1-s^B)$	s^C
ROW	$m^{RA}/m^{0A}*(1-s^A)$	$m^{RB}/m^{0B}*(1-s^B)$	$m^{RC}/m^{0C}*(1-s^C)$
Total	1	1	1

Trade coefficient

	A	B	C
A	c^{AA}	c^{AB}	c^{AC}
B	c^{BA}	c^{BB}	c^{BC}
C	c^{CA}	c^{CB}	c^{CC}
ROW	c^{RA}	c^{RB}	c^{RC}
Total	1	1	1

these kinds of data. However, there are some difficulties in estimating the trade coefficient. A methodology for estimating the trade coefficient must be established. Here, it is assumed that only the input-output table (competitive import type) and total trade (import) statistics by country of origin are available. In the trade statistics, only one total is used, not commodity. Although the estimate might be better estimates if trade statistics by commodity were used, the bad condition of data must be considered. Model accuracy may be verified under the worst data limitation. Import statistics are used because this is regarded as more reliable than export data. Import data is carefully collected for custom duties in each country.

The following steps are made to estimate the trade coefficient. First, a trade matrix is made by using total import data. Second, a self-sufficient ratio is estimated using each country's IO table by commodity or sector. Finally, the trade (column) coefficient of each commodity or sector is calculated according to the self-sufficient ratio of commodity. A detail procedure may be shown in Figure 1.

Two points must be mentioned regarding estimation of the trade coefficient. First, Singapore does not have a figure for imports from Indonesia, so the figure for export to Singapore from Indonesia is used as an alternative. Second, except for the trade and transport sector, it was assumed that no transaction would be occurred in the non-commodity sectors of countries[5]. For estimating trade and transport sector, a total commodity self-sufficient ratio was calculated for the country, then a weighted average of commodity imports data by country of origin was used for estimating trade coefficients of this sector. Here, it was implicitly assumed that trade and transport transactions among countries would increase with the increase of the commodity transactions.

After estimating the trade coefficient, the international input coefficient $\tilde{A}$ can be estimated from the equation (1) as follows:

$$\begin{bmatrix} \tilde{A}^{11} & \tilde{A}^{12} \\ \tilde{A}^{21} & \tilde{A}^{22} \end{bmatrix} = \begin{bmatrix} \hat{C}^{11} & \hat{C}^{12} \\ \hat{C}^{21} & \hat{C}^{22} \end{bmatrix} \begin{bmatrix} A^{1} & 0 \\ 0 & A^{2} \end{bmatrix}$$

In this paper, only the coefficient matrix is estimated. After obtaining the data of the international input coefficient matrix, the Leontief multiplier can be calculated. In the input-output model, impact analysis or linkage analysis is the most commonly used approach. The Leontief multiplier is derived from the input coefficient. It plays a more important role in model accuracy.

To verify the model accuracy, several comparison methods are used. For impact analysis, the Leontief-Carter method (Leontief 1953; Carter 1970) is applied as in Okamoto and Arakawa (2003). The total output is calculated by using the estimated international input coefficient multiplied by original final demand. This is then compared it with original output. Two error indices, the Overall Percentage Error (OPE) and Correlation Coefficient (CC), are used.

For linkage analysis, the estimated input coefficient is compared with the original. Many kinds of comparison methods have been developed, and Lahr (2001) discusses the characteristics of each. Since each index has its own character, all indices are used as

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[5] When we compile Asian table, we also make no international transaction in non-commodity sectors among countries because of lack of service trade direction data.

follows:

【Standardized total percentage error (STPE) 】

$$100 \frac{\sum_j \sum_i \left| a_{ij} - a_{ij}^0 \right|}{\sum_j \sum_i a_{ij}}$$

【Mean Absolute Difference (MAD) 】

$$100 \frac{\sum_j \sum_i \left| a_{ij} - a_{ij}^0 \right|}{mn}$$

【Index of inequality (Theil's U)】

$$\left[\frac{\sum_j \sum_i \left(a_{ij} - a_{ij}^0 \right)^2}{\sum_j \sum_i a_{ij}^2} \right]^{0.5}$$

【Root mean squared error (RSME) 】

$$\frac{\left[\sum \sum \left(a_{ij} - a_{ij}^0 \right)^2 \right]^{0.5}}{mn}$$

【Weighted absolute difference (WAD) 】

$$\frac{\sum_j \sum_i \left(a_{ij} + a_{ij}^0 \right) \left| a_{ij} - a_{ij}^0 \right|}{\sum_j \sum_i \left(a_{ij} + a_{ij}^0 \right)}$$

Lahr (2001) recommends the WAD. Considering holistic accuracy (Jensen 1980), the original error index is proposed as follows:

【Weighted total percentage error (WTPE) 】

$$100 \frac{\sum_j \sum_i \left| a_{ij} - a_{ij}^0 \right| \bullet a_{ij}}{\sum_j \sum_i a_{ij}}$$

4.2 Result

In conducting empirical research, the international input coefficient was estimated with 10 countries and 24 sectors for the year 1995. First, input-output tables are collected from ten countries using competitive import type with 24 sectors for the year 1995. These are re-compiled from the Asian IO table, and then various kinds of trade coefficients are estimated by using 1995 trade data[6] as follows:

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[6] Trade statistics comes from Noda ed. (2003). They are compiled from the data of

Case 1. Total import data

Case 2. Total import data adjusted with international freight and insurance

Case 3. Import data by sectors

Case 4. Import data by sectors adjusted with international freight and insurance

As seen in the previous section, under usual circumstances, it is easy for an economist to get total import statistics from the IMF or OECD. Case 1 shows the worst data condition. Since import data is valued at CIF prices, including international freight and insurance, trade among countries may be overestimated. Therefore total import data must be adjusted by the formulae CIF/(1+r), where r is international freight and insurance rate; r is assumed to be 0.06 according to experience in compilation of the Asian international IO table. This is seen in Case 2.

The international transaction of primary goods seems to be different from that of manufacturing goods. Resources of agriculture, forestry, fishery and mining are located in relatively unbalanced fashion in Asian countries. This may lead to some bias or errors in estimation when only total import data is used. Thus, in Case 3 the import figures by sector (only commodity) are collected. In Case 4, the trade coefficient is estimated from import figures by sector and adjusted with international freight and insurance.

Table 1. OPE and CC by country

	OPE				CC			
	Case 1	Case 2	Case 3	Case 4	Case 1	Case 2	Case 3	Case 4
Indonesia	0.63%	-0.05%	1.95%	1.20%	0.9988	0.9962	0.9986	0.9987
Malaysia	6.38%	3.90%	5.22%	2.83%	0.9780	0.9780	0.9949	0.9957
Philippine	3.16%	2.40%	1.81%	1.14%	0.9923	0.9923	0.9899	0.9899
Singapore	11.98%	9.40%	9.84%	7.40%	0.9859	0.9859	0.9974	0.9982
Thailand	1.60%	0.77%	0.71%	-0.05%	0.9955	0.9955	0.9976	0.9976
China	5.27%	4.61%	4.66%	4.03%	0.9988	0.9988	0.9961	0.9964
Taiwan	8.85%	7.46%	-0.02%	-0.78%	0.9977	0.9977	0.9987	0.9985
Korea	2.56%	1.89%	2.65%	1.98%	0.9989	0.9989	0.9995	0.9995
Japan	1.01%	0.72%	0.82%	0.55%	0.9999	0.9999	0.9999	0.9999
US	-0.88%	-1.03%	-1.07%	-1.20%	0.9998	0.9998	0.9998	0.9998
Overall/Average	0.66%	0.35%	0.30%	0.01%	0.9945	0.9943	0.9972	0.9974

United Nations and OECD.

4.3 Total Output

Table 1 reports the overall percentage error (OPE) of the model in the four cases. The original output is compared with the estimated output derived from the estimated Leontief multiplier. This is calculated from the international input coefficient, with the original final demand of each country.

This table shows that OPEs of all countries tend to decrease with increases in availability of trade data and international freight and insurance. In Case 1, this is 0.66%, and it decrease to 0.35% in Case 2, to 0.30% in Case 3, and to 0.01% in Case 4. At the country level, Singapore, Malaysia, and China have relatively large OPE in all cases. Singapore and Malaysia are some of the most open economies, and their re-exports also should be higher than other regions. Thus, the trade coefficient might be relatively difficult to estimate by using only import data. This also implies that the trade structure by sector may be different from the whole trade direction in this region. China has implemented an open door policy for two decades and has had remarkably very high economic development by exporting to other countries. Hong Kong played an important role in China's exports as a trade port. Thus, trade statistics may be problematic relative to other countries such as Japan and the USA. Using only import data may not give good fit to the estimates. Taiwan also has a relatively large OPE in both Case 1 and Case 2. However, this OPE becomes almost 0% in Case 3 and Case 4.

The correlation coefficient (CC) is also shown in Table 1. In Case 1 and Case 2, this is estimated from total import data only. Here, the CCs of Malaysia and Singapore are relatively low, the same as the tendency of OPE. On the other hand, the CCs of China and Taiwan are high. It seems that the trade structure of Malaysia and Singapore may be different from the direction of total imports. Further, China and Taiwan may have been totally over or under estimated by sector. Case 3 and Case 4 indicate that total output by country may be better estimated if import data by sector is used.

In order to clarify the estimation errors of output by sector level and by country, the percentage error of total output by countries is checked and shown in Table 2. It can be seen that the primary sector, especially crude oil and other mining, does not show good results when total import data is used. Errors of total output by sector in Malaysia and Singapore show that the trade structure by sector is different from the total import data. Therefore, this does not provide such good estimates at the sector level. On the other hand, outputs of China and Taiwan are totally overestimated at the sector level, so, the CC index becomes high as OPE is high.

Table 2 shows the percentage error by sector (Case 4). On the whole, estimated results improved by sector level. Singapore, however, showed small improvement at this level.

Table 2. Percentage error of Total Output by Sector and Economy

Case 1

	Indonesia	Malaysia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	USA
Paddy	1.3%	-1.1%	1.1%	na	-8.2%	3.0%	-0.4%	4.2%	4.1%	na
Other agricultural products	3.0%	46.1%	6.7%	750.3%	4.6%	5.0%	39.2%	17.8%	15.7%	-6.9%
Livestock	2.0%	6.9%	1.4%	162.9%	-4.5%	3.6%	3.0%	3.5%	5.7%	0.8%
Forestry	-10.7%	-54.4%	21.5%	na	48.2%	12.6%	158.4%	45.1%	22.1%	-3.1%
Fishery	2.4%	15.9%	-2.2%	75.7%	2.2%	2.5%	9.1%	0.3%	4.5%	4.6%
Crude petroleum and natural gas	-35.1%	10.6%	737.0%	na	229.1%	54.1%	1047.6%	na	1626.4%	20.2%
Other mining	-6.1%	180.0%	11.0%	1495.0%	26.4%	9.0%	81.5%	27.7%	17.4%	10.6%
Food, beverage and natural gas	1.2%	-4.8%	1.0%	41.3%	-8.8%	4.2%	0.3%	4.2%	4.6%	0.9%
textile, leather and such products	12.7%	67.2%	32.3%	164.4%	5.2%	8.1%	19.0%	3.7%	1.2%	-5.3%
Timber and wooden products	-25.9%	-48.6%	9.0%	120.8%	22.9%	10.1%	55.8%	21.3%	6.0%	0.7%
Pulp, paper and printing	4.9%	58.7%	45.0%	49.9%	13.2%	12.9%	21.4%	8.8%	3.8%	-0.6%
Chemical products	26.7%	69.5%	41.5%	42.5%	50.6%	11.5%	33.9%	7.4%	4.3%	0.1%
Petroleum and petro products	-4.8%	24.9%	2.1%	-53.4%	13.0%	10.2%	29.4%	2.7%	6.3%	1.1%
Rubber products	-11.1%	-15.6%	0.6%	133.4%	-34.1%	11.0%	29.3%	1.4%	1.2%	-3.7%
Non-metallic mineral products	6.4%	7.7%	13.7%	34.1%	-0.5%	1.6%	3.8%	0.6%	1.3%	-0.8%
Metal products	27.4%	64.2%	9.2%	102.0%	44.7%	4.7%	8.7%	-0.7%	2.9%	3.8%
Machinery	19.7%	-10.4%	29.3%	-9.5%	-3.5%	2.4%	4.0%	-7.1%	0.6%	0.0%
Transport equipment	10.1%	49.4%	72.8%	54.6%	11.7%	9.6%	23.5%	8.5%	0.0%	-0.2%
Other manufacturing products	19.9%	30.4%	48.4%	50.9%	10.6%	7.8%	8.8%	-0.3%	-1.3%	-2.4%
Electricity, gas, and water supply	2.5%	6.9%	0.3%	7.1%	2.8%	5.5%	6.7%	1.5%	1.0%	-0.4%
Construction	0.0%	-0.1%	-0.2%	1.0%	0.0%	0.3%	0.8%	0.1%	0.1%	-0.1%
Trade and transport	-4.2%	-3.2%	-16.8%	2.4%	-9.9%	1.7%	-1.2%	2.7%	-2.2%	-6.9%
Service	0.5%	-2.6%	-3.2%	5.3%	-1.4%	5.1%	5.6%	1.8%	0.7%	-0.3%
Public administration	0.0%	0.9%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Overall error	0.6%	6.4%	3.2%	12.0%	1.6%	5.3%	8.8%	2.6%	1.0%	-0.9%

Case 4

	Indonesia	Malaysia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	USA
Paddy	0.4%	-4.5%	1.3%	na	-3.8%	3.0%	-3.8%	1.7%	3.0%	na
Other agricultural products	1.4%	2.4%	8.5%	36.2%	1.1%	4.8%	17.1%	12.3%	8.9%	-2.1%
Livestock	0.7%	7.8%	1.0%	15.9%	-3.0%	5.1%	-2.3%	0.1%	2.2%	0.8%
Forestry	12.5%	14.8%	-9.9%	na	21.8%	5.5%	43.0%	7.7%	10.9%	-1.9%
Fishery	5.5%	0.6%	-1.1%	2.1%	25.5%	1.0%	8.9%	-1.4%	1.0%	-10.8%
Crude petroleum and natural gas	9.5%	11.6%	65.0%	na	6.9%	6.9%	2.0%	na	3.3%	-1.0%
Other mining	3.8%	-2.9%	28.0%	79.4%	0.6%	5.0%	-9.4%	-3.1%	-0.5%	0.4%
Food, beverage and natural gas	0.4%	-7.1%	1.3%	5.1%	-3.6%	3.7%	-2.5%	1.7%	3.4%	1.2%
textile, leather and such products	17.8%	24.9%	42.0%	25.9%	6.1%	17.4%	6.3%	15.5%	-4.9%	-9.4%
Timber and wooden products	16.5%	-0.9%	8.3%	21.9%	20.3%	7.5%	36.7%	6.5%	1.0%	-0.9%
Pulp, paper and printing	2.2%	3.9%	9.2%	19.0%	-9.7%	4.7%	-3.5%	3.0%	0.8%	0.1%
Chemical products	7.0%	0.3%	12.1%	13.6%	17.6%	8.5%	-11.6%	8.2%	1.9%	0.5%
Petroleum and petro products	-0.8%	17.8%	-3.2%	34.9%	1.2%	4.3%	0.4%	6.1%	2.5%	-1.0%
Rubber products	17.0%	11.7%	-8.9%	31.9%	27.0%	3.9%	5.8%	-1.4%	2.0%	-5.5%
Non-metallic mineral products	1.3%	-2.5%	4.4%	-1.9%	0.5%	1.9%	-3.4%	-0.4%	1.5%	-1.9%
Metal products	4.9%	0.1%	-4.9%	19.7%	9.1%	2.9%	-4.6%	2.6%	2.1%	0.3%
Machinery	-20.6%	7.2%	56.1%	10.1%	2.4%	-2.1%	-2.0%	-3.2%	3.6%	0.8%
Transport equipment	-0.3%	7.6%	14.5%	-6.7%	2.7%	-0.4%	5.2%	4.0%	1.9%	0.2%
Other manufacturing products	3.0%	19.2%	34.5%	22.4%	12.4%	13.4%	0.3%	-4.4%	-2.1%	-2.1%
Electricity, gas, and water supply	0.9%	1.1%	-0.8%	6.7%	0.2%	3.5%	-1.9%	1.6%	0.4%	-0.8%
Construction	0.0%	-0.5%	-0.2%	0.5%	0.0%	0.2%	0.2%	0.1%	0.0%	-0.2%
Trade and transport	-5.5%	-6.2%	-18.2%	-1.0%	-10.7%	0.3%	-7.9%	2.0%	-2.5%	-7.1%
Service	0.6%	-4.0%	-3.8%	3.6%	-2.7%	4.4%	2.8%	1.6%	0.5%	-0.3%
Public administration	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Overall error	1.2%	2.8%	1.1%	7.4%	-0.1%	4.0%	-0.8%	2.0%	0.5%	-1.2%

4.4 International Input Coefficient

In input-output analysis, the input coefficient plays a key role in calculating the Leontief inverse matrix. Its accuracy determines the reliability of the input-output model.

Table 3 shows error indices of the international input coefficient. From this table, it can be seen that every index has the same tendency. So emphasis is placed on the STPE and WTPE. For both indices, Case 1 and Case 2 show these to be relatively large, but in Case 3 and Case 4, they are rather small. Using import data by sector may produce better results than using total import data. In Case 2 and Case 4, such improves the result. It is very important to adjust trade data by the international freight and insurance ratio. The WTPE in Case 4 is somewhat larger than in Case 3. This implies that using the same freight and insurance ratio may influence relatively important cells. As a whole, this information shows us that the Chenery-Moses model is effective even if total import data is used.

Table 3. Error indices of the international input coefficient

	Case 1	Case 2	Case 3	Case 4
STPE	30.3562	29.6680	25.4097	24.9337
MAD	0.0585	0.0572	0.0490	0.0480
Theil's U	0.2810	0.2780	0.2459	0.2449
RSME	0.0000	0.0000	0.0000	0.0000
WAD	0.0149	0.0149	0.0142	0.0142
WTPE	1.4685	1.4725	1.3947	1.3973

5. Conclusion

Okamoto and Arakawa (2003) have questioned the stability of the input coefficient of the Asian International IO table and arguer for the use of the Leontief-Carter method to quantify the stability of the input coefficient. Compared with their result, the model estimated by the Chenery-Moses type seems to give us better estimates than in using the previous or old table. It can also be concluded that this estimation method would be useful for an economist. In short,

(1) Applying the Chenery-Moses instead of the Isard type appears to be effective in both impact and linkage analysis. Even total import data is only used, the estimation may be better.
(2) As in the conclusions of Okamoto and Arakawa (2003), economies with large relations to the international market, such as Singapore and Malaysia may not provide better estimates.
(3) In the case of the Asian IO model, the structure of the primary sector may provide worse results.
(4) Gathering more data (here gathering trade data by sector), makes a contribution to the higher accuracy of the international IO model.
(5) In the Asian IO, the 24 sector classification includes many primary sectors (7 sectors), and service sector is highly aggregated. This affects model accuracy because only total trade statistics is used. The model might give better results if

sector classification is changed with the inclusion of more manufacturing sectors. With experience in the compilation of the Asian international IO table, it appears that at least two years is necessary for estimating the import matrix by country of origin for each country, linking these matrices, and balancing. Based on empirical work presented here, more than two years can be saved getting the Asian international IO model when the Chenery-Moses estimation method is used. This method may also be applied in updating the Asian IO model. Trade data is revised annually, so the trade coefficient can be updated every year. If the technical coefficient is assumed to be stable in each country, a new Asian international IO model estimated annually by using updated trade coefficient[7].

In estimating the international input-output model, the worst situation was considered in which no survey can be conducted, and only national IO table and trade statistics can be obtained. Considering this worst situation, the worst limitation of this methodology can be understood. If even a, partial and crucial, survey can be conducted, or superior data from some agency can be obtained, it is obvious that the accuracy of the estimated model will be better.

[7] The problem of how to update the self-sufficient ratio of each country remains. Trade statistics do not provide the information on the transaction volume in each country.

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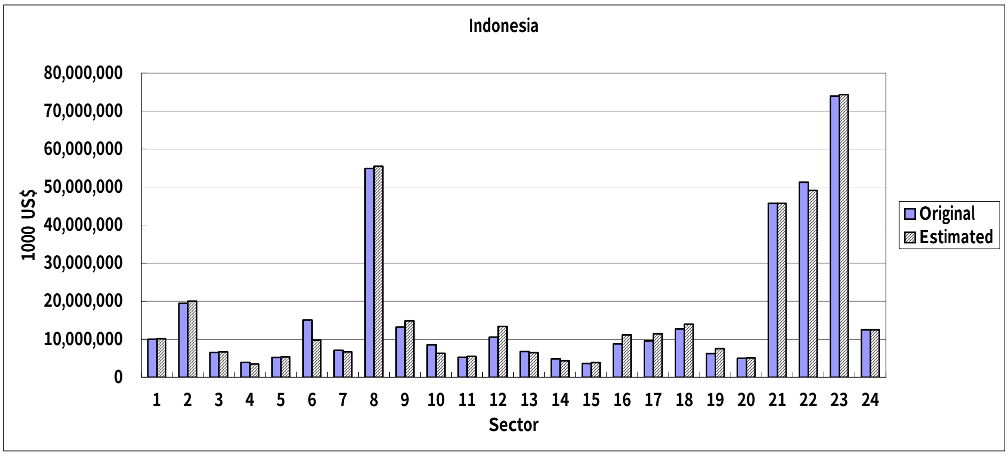
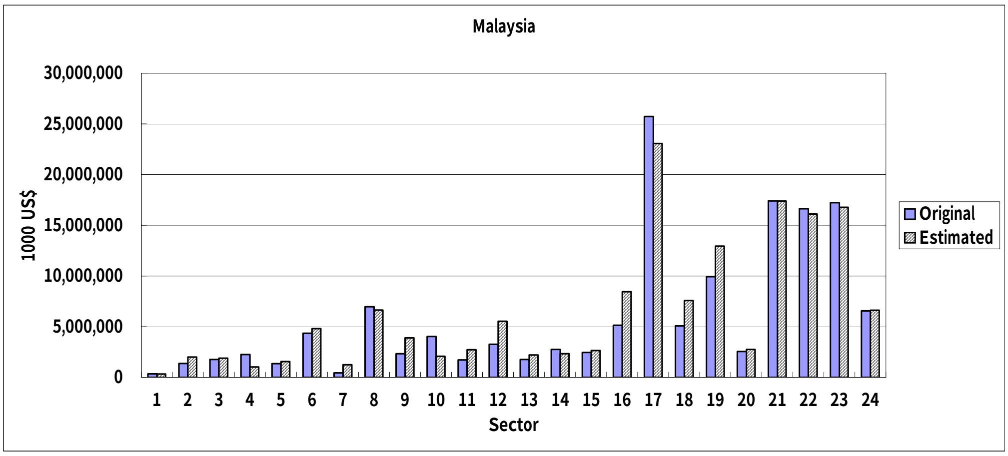
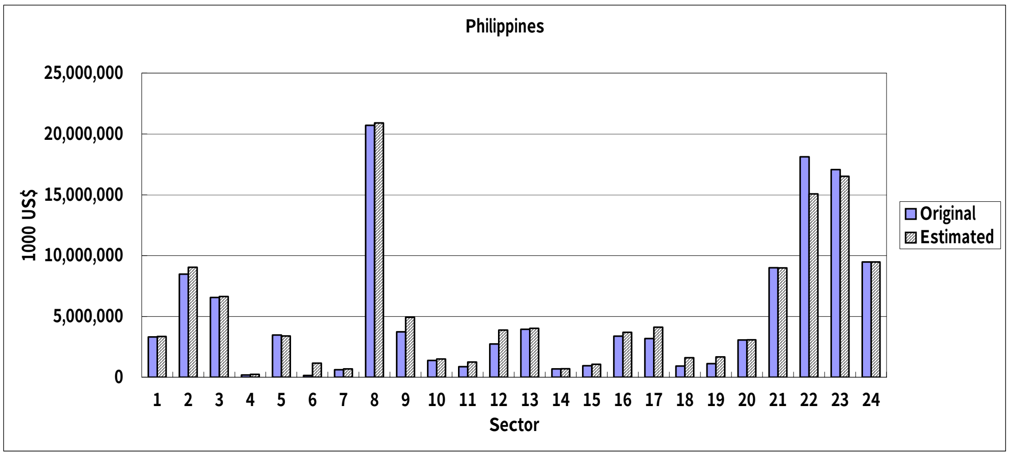
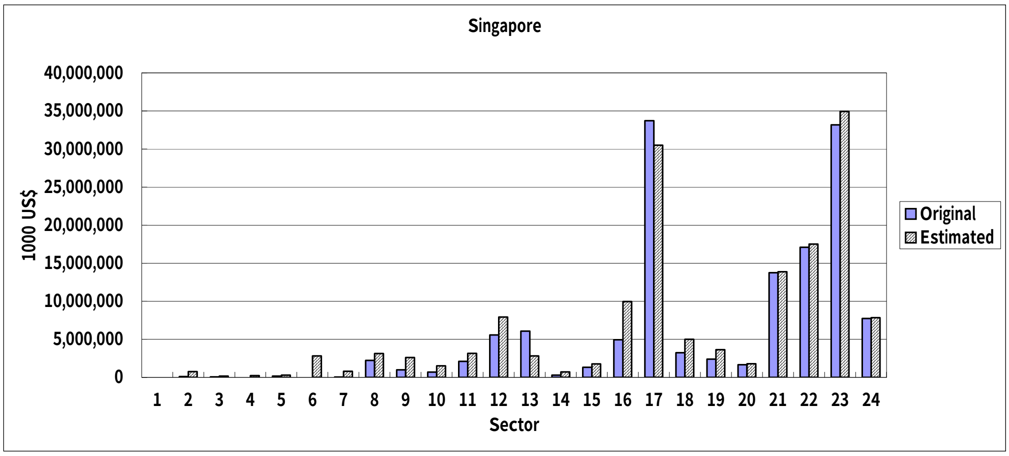
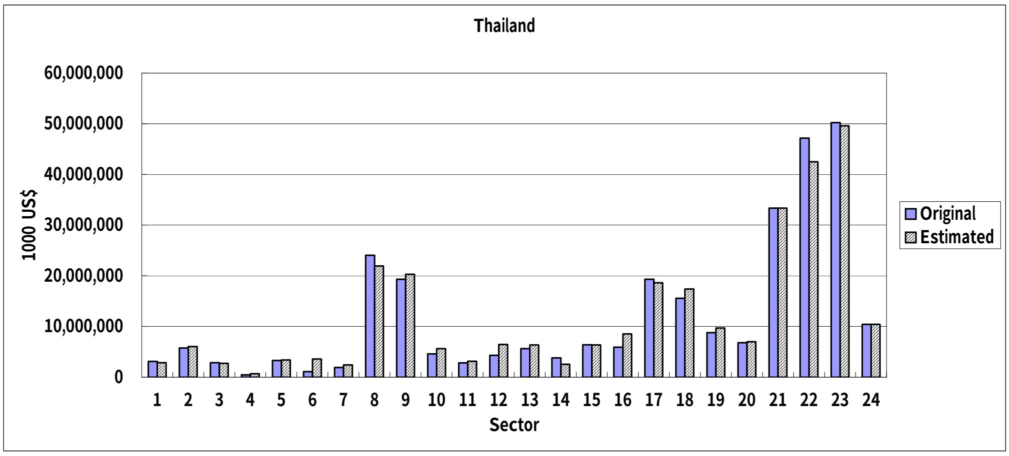
Appendix Table: Comparison of estimated and original output by country in Case 1

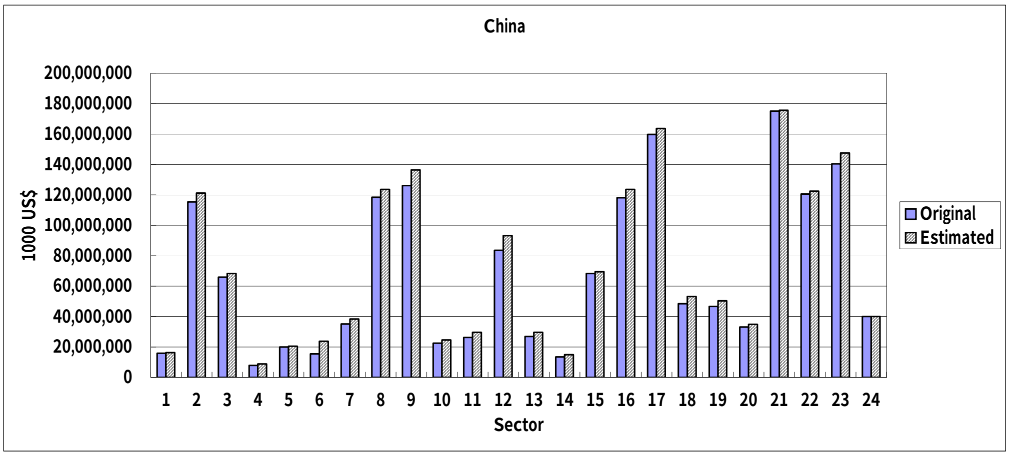


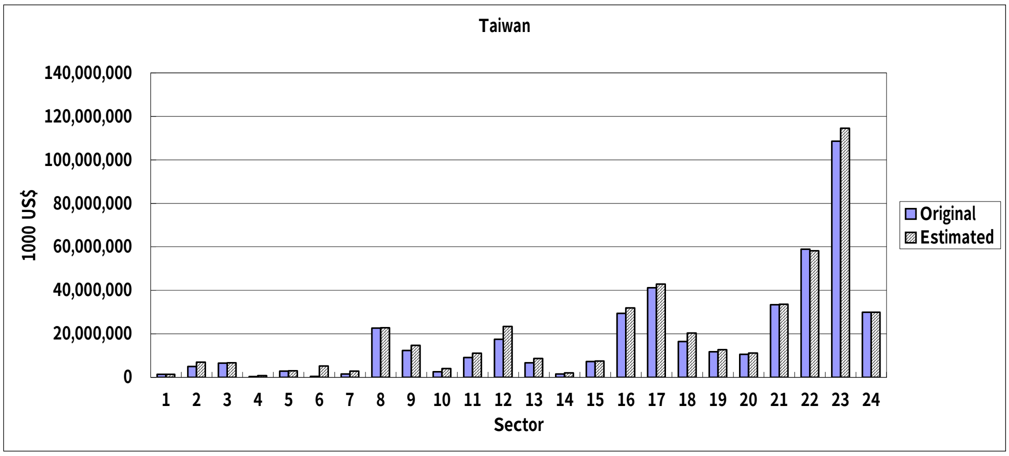


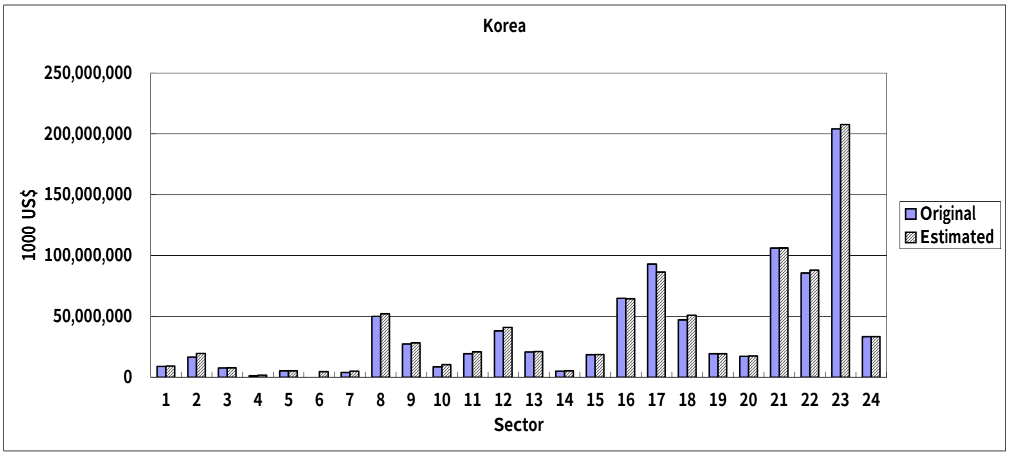


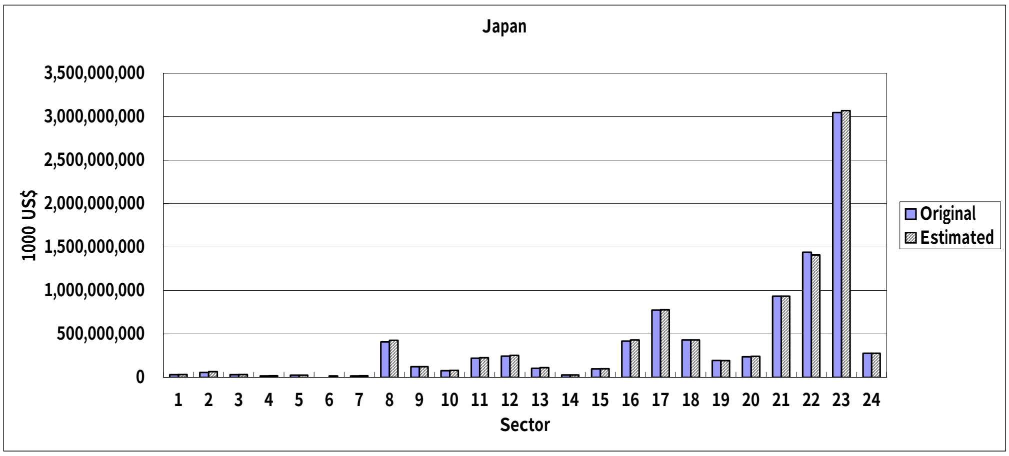

Singapore
1000 US$
40,000,000
35,000,000
30,000,000
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Sector
Original
Estimated

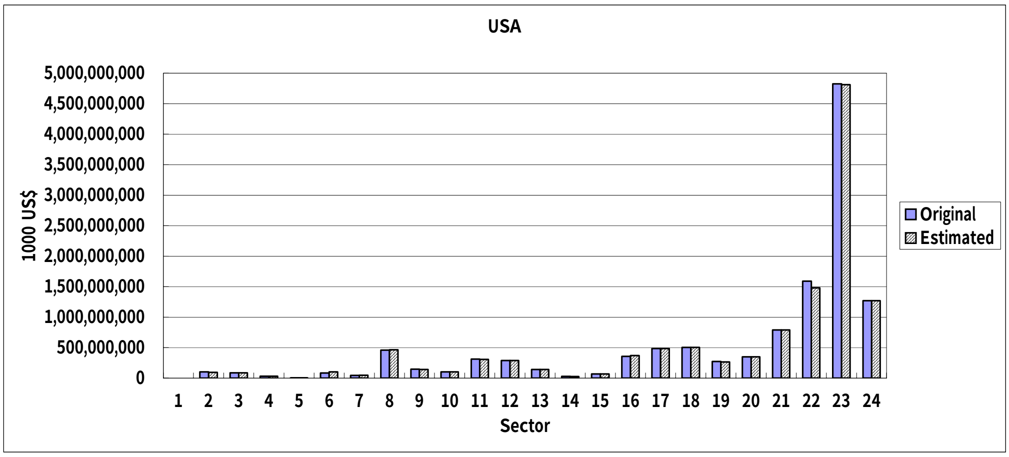

Thailand
1000 US$
60,000,000
50,000,000
40,000,000
30,000,000
20,000,000
10,000,000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Sector
Original
Estimated


China
1000 US$
200,000,000
180,000,000
160,000,000
140,000,000
120,000,000
100,000,000
80,000,000
60,000,000
40,000,000
20,000,000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Sector
Original
Estimated


Taiwan
140,000,000
120,000,000
100,000,000
80,000,000
60,000,000
40,000,000
20,000,000
0
1000 US$
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Sector
Original
Estimated


Korea
250,000,000
200,000,000
150,000,000
100,000,000
50,000,000
0
1000 US$
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Sector
Original
Estimated


Japan
3,500,000,000
3,000,000,000
2,500,000,000
2,000,000,000
1,500,000,000
1,000,000,000
500,000,000
0
1000 US$
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Sector
Original
Estimated


USA
5,000,000,000
4,500,000,000
4,000,000,000
3,500,000,000
3,000,000,000
2,500,000,000
2,000,000,000
1,500,000,000
1,000,000,000
500,000,000
0
1000 US$
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Sector
Original
Estimated

Annex

Compilation Procedure of Asian International Input-Output Table

JOB 1: MAKING OF IMPORT MATRICES by countries of origin

<STEP 1>
Compute duties and import commodity taxes ratios.

<STEP 2>
Remove duties and import commodity taxes.

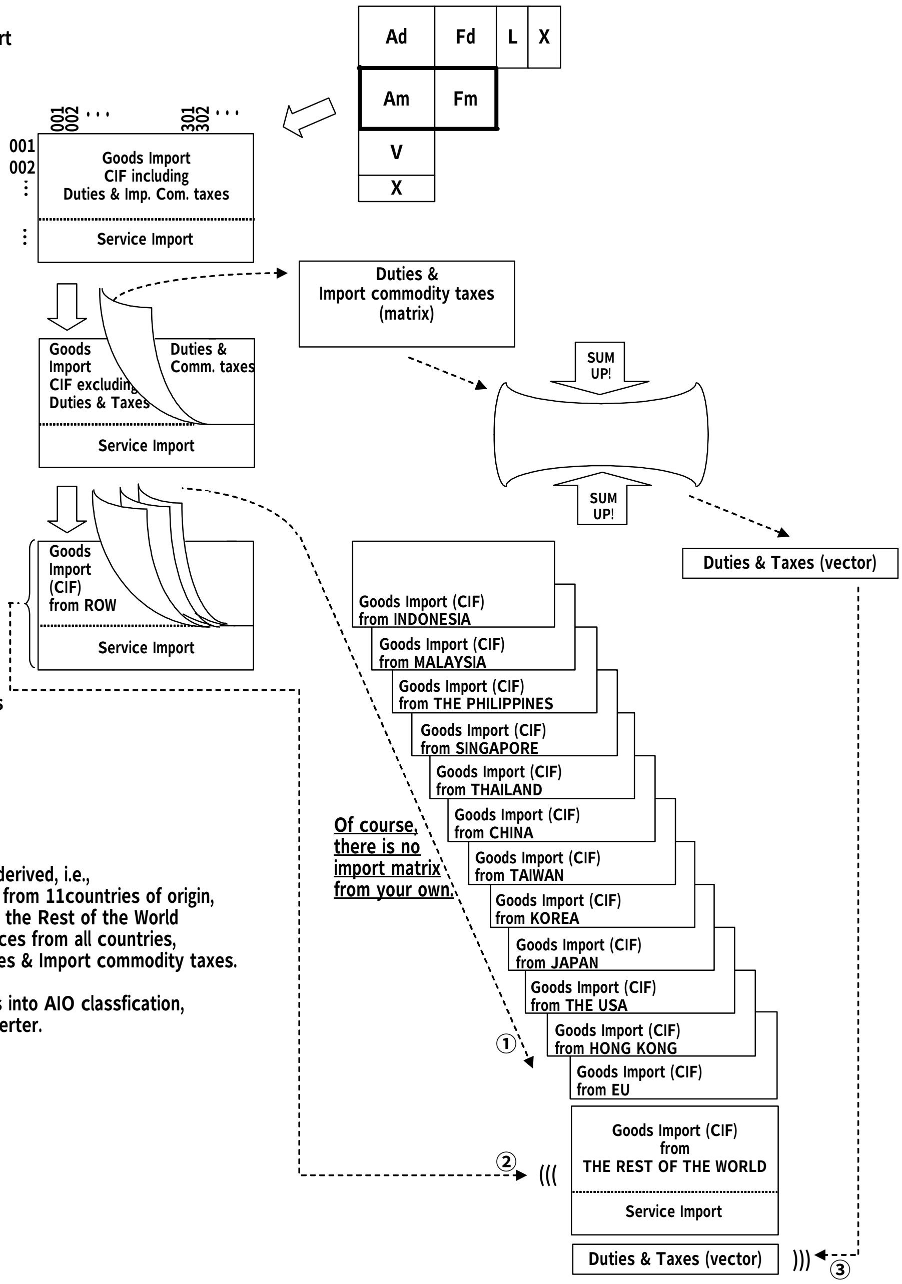
<STEP 3>
Aggregate the duties and import commodity taxes matrix into a single row vector.

<STEP 4>
Compute country-of-origin's import shares for each commodity.

<STEP 5>
Split the import matrix of goods into 11 countries of origin plus the Rest of the World, using the import shares derived in the STEP 4.

<STEP 6>
Assemble the parts thus derived, i.e.,
① goods import matrices from 11countries of origin,
② the import matrix from the Rest of the World embracing import of services from all countries,
③ and the vector of Duties & Import commodity taxes.

Then, convert these parts into AIO classfication, using the NIO - AIO converter.

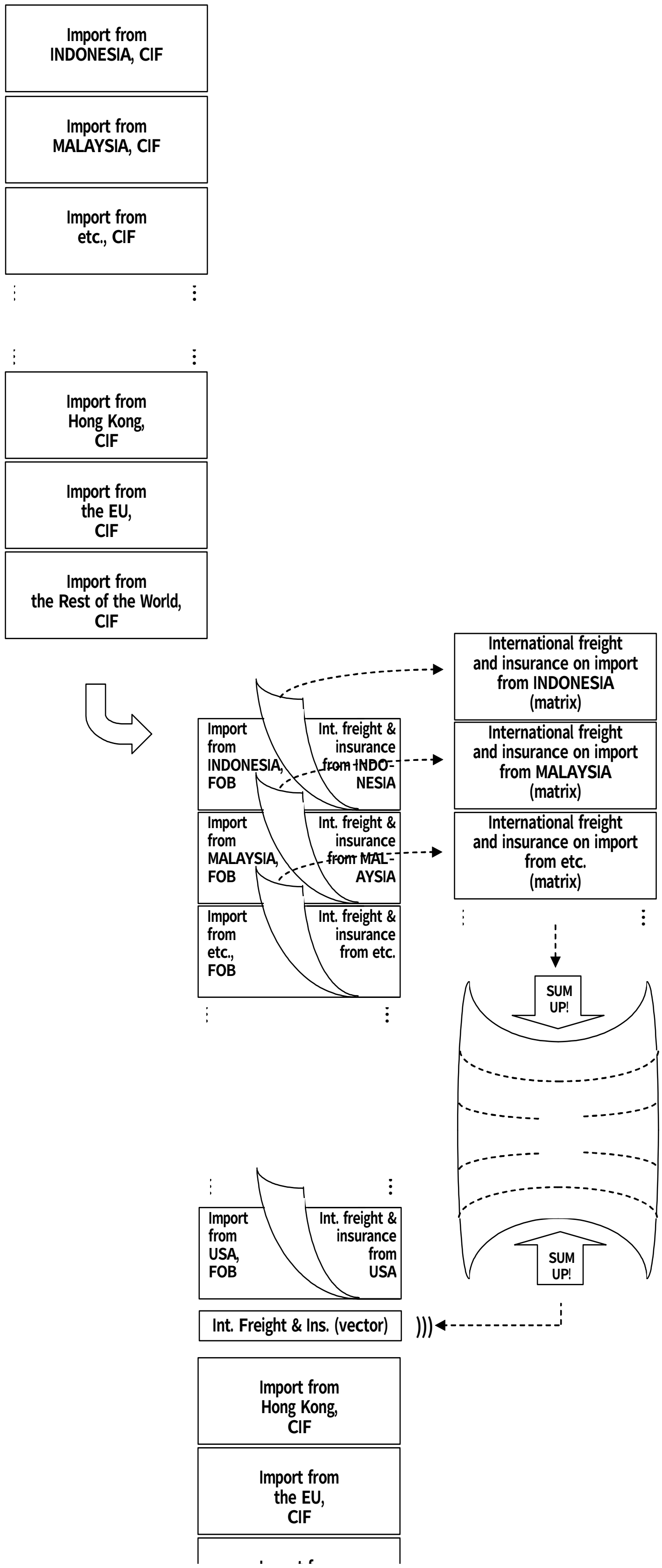


JOB 2: CONVERSION OF IMPORT MATRICIES into FOB

So far, all the import matrices are valued at CIF, net of duties and import commodity taxes

<STEP 1>
Import matrices from the member countries should be made FOB, by removing international freight and insurance from each country of origin.

<STEP 2>
All the matrices of international freight and insurance are aggregated columnwise into a single row vector, which is to be placed below the import matrix from the USA.



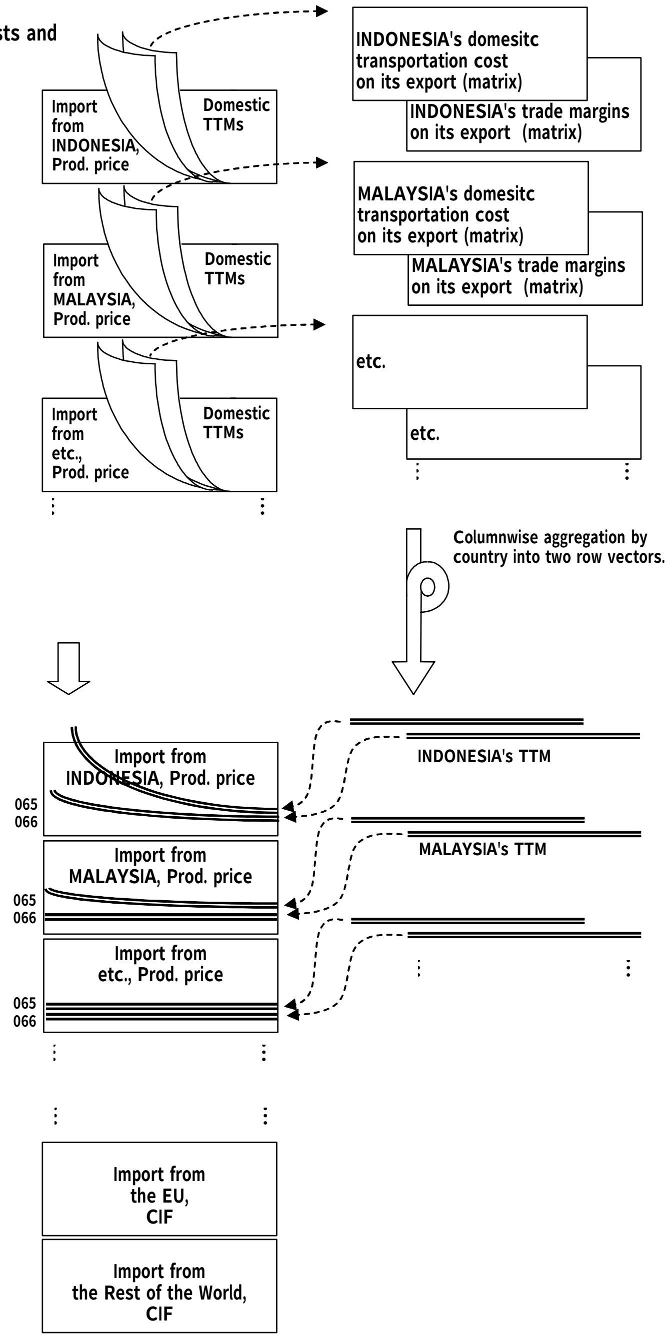
JOB 3: CONVERSION OF IMPORT MATRICIES into producer's price

<STEP 1>
The ratios of domestic transportation costs and trade margins (TTMs) on the export of the countries of origin are computed.

<STEP 2>
TTMs are removed from import matrices, country by country, using the ratios computed in the STEP 1.

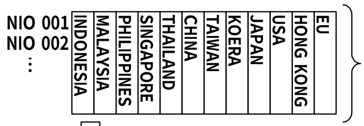
<STEP 3>
The TTM matrices thus derived are aggregated columnwise country by country, to obtain TTM vectors (rows) for the countries of origin.

<STEP 4>
The TTM vectors thus derived are added on the corresponding sectors of import matrices, being as imports of trade and transportation services.



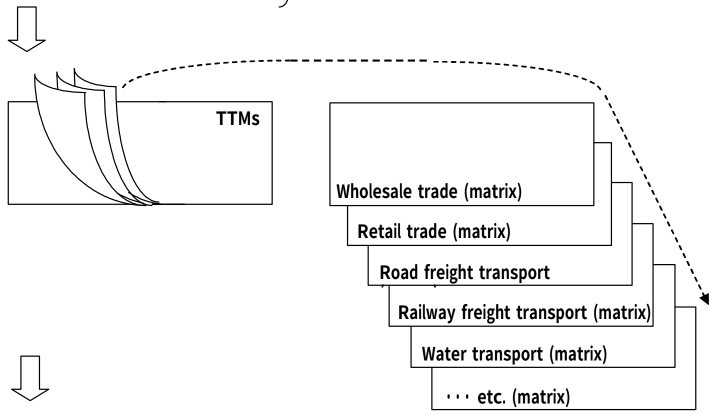
JOB 4: MAKING OF EXPORT VECTORS by countries of destination

<STEP 1>
TTM ratios for export are computed.



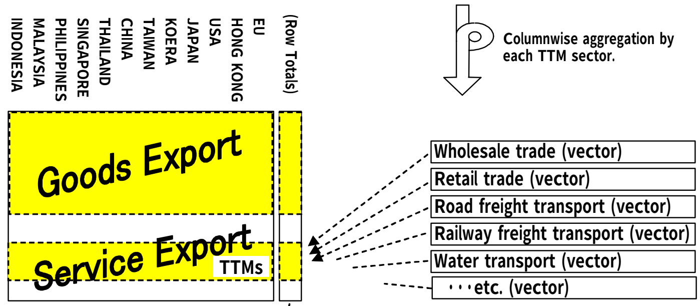
NIO export vectors to 11 countries of destination, aggregated from the Foreign Trade Statistics (FOB). (Of course, <u>there is no export vector to your own.</u>)

<STEP 2>
Remove TTMs from the export vectors to 11 countries of destination, using the ratios derived in STEP 1.
(The number of matrices to be removed is subject to the definition of TTM.)



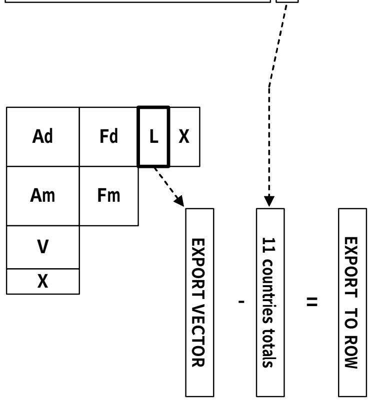
<STEP 3>
Aggregate each TTM matrix in a columnwise direction to obtain a corresponding TTM vector.

<STEP 4>
Assemble the parts thus derived to obtain export vectors at producer's price, with TTMs being export of domestic trade and transportation services.



<STEP 5>
Derive the export vector to the Rest of the World, by taking the difference between the export vector of a national I-O (producer's price) and the row-totals of the export vectors obtained in Step 4 above.

* The export vector of a national table should be valued at producer's price. Also, if direct sales to tourists and/or any other international transaction that do not pass the custom (e.g. service export) are presented in separate vectors, they should be added to the export vector to the Rest of the World.



<STEP 6>
Convert these export vectors into AIO classification using the NIO - AIO converter.

JOB 5: LINKING

	code	Intermediate Demand (A)										Final Demand (F)										Ex
		Indonesia	Malaysia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	U.S.A.	Indonesia	Malaysia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	U.S.A.	Export to Hong Kong
	code	(AI)	(AM)	(AP)	(AS)	(AT)	(AC)	(AN)	(AK)	(AJ)	(AU)	(FI)	(FM)	(FP)	(FS)	(FT)	(FC)	(FN)	(FK)	(FJ)	(FU)	(LH)
Indonesia	(AI)	A^{II}	A^{IM}	A^{IP}	A^{IS}	A^{IT}	A^{IC}	A^{IN}	A^{IK}	A^{IJ}	A^{IU}	F^{II}	F^{IM}	F^{IP}	F^{IS}	F^{IT}	F^{IC}	F^{IN}	F^{IK}	F^{IJ}	F^{IU}	LH^{I}
Malaysia	(AM)	A^{MI}	A^{MM}	A^{MP}	A^{MS}	A^{MT}	A^{MC}	A^{MN}	A^{MK}	A^{MJ}	A^{MU}	F^{MI}		F^{MP}	F^{MS}	F^{MT}	F^{MC}	F^{MN}	F^{MK}	F^{MJ}	F^{MU}	LH^{M}
Philippines	(AP)	A^{PI}	A^{PM}	A^{PP}	A^{PS}	A^{PT}	A^{PC}	A^{PN}	A^{PK}	A^{PJ}	A^{PU}	F^{PI}	F^{PM}	F^{PP}	F^{PS}	F^{PT}	F^{PC}	F^{PN}	F^{PK}	F^{PJ}	F^{PU}	LH^{P}
Singapore	(AS)	A^{SI}	A^{SM}	A^{SP}	A^{SS}	A^{ST}	A^{SC}	A^{SN}	A^{SK}	A^{SJ}	A^{SU}	F^{SI}	F^{SM}	F^{SP}	F^{SS}	F^{ST}	F^{SC}	F^{SN}	F^{SK}	F^{SJ}	F^{SU}	LH^{S}
Thailand	(AT)	A^{TI}	A^{TM}	A^{TP}	A^{TS}	A^{TT}	A^{TC}	A^{TN}	A^{TK}	A^{TJ}	A^{TU}	F^{TI}	F^{TM}	F^{TP}	F^{TS}	F^{TT}	F^{TC}	F^{TN}	F^{TK}	F^{TJ}	F^{TU}	LH^{T}
China	(AC)	A^{CI}	A^{CM}	A^{CP}	A^{CS}	A^{CT}	A^{CC}	A^{CN}	A^{CK}	A^{CJ}	A^{CU}	F^{CI}	F^{CM}	F^{CP}	F^{CS}	F^{CT}	F^{CC}	F^{CN}	F^{CK}	F^{CJ}	F^{CU}	LH^{C}
Taiwan	(AN)	A^{NI}	A^{NM}	A^{NP}	A^{NS}	A^{NT}	A^{NC}	A^{NN}	A^{NK}	A^{NJ}	A^{NU}	F^{NI}	F^{NM}	F^{NP}	F^{NS}	F^{NT}	F^{NC}	F^{NN}	F^{NK}	F^{NJ}	F^{NU}	LH^{N}
Korea	(AK)	A^{KI}	A^{KM}	A^{KP}	A^{KS}	A^{KT}	A^{KC}	A^{KN}	A^{KK}	A^{KJ}	A^{KU}	F^{KI}	F^{KM}	F^{KP}	F^{KS}	F^{KT}	F^{KC}	F^{KN}	F^{KK}	F^{KJ}	F^{KU}	LH^{K}
Japan	(AJ)	A^{JI}	A^{JM}	A^{JP}	A^{JS}	A^{JT}	A^{JC}	A^{JN}	A^{JK}	A^{JJ}	A^{JU}	F^{JI}	F^{JM}	F^{JP}	F^{JS}	F^{JT}	F^{JC}	F^{JN}	F^{JK}	F^{JJ}	F^{JU}	LH^{J}
U.S.A.	(AU)	A^{UI}	A^{UM}	A^{UP}	A^{US}	A^{UT}	A^{UC}	A^{UN}	A^{UK}	A^{UJ}	A^{UU}	F^{UI}	F^{UM}	F^{UP}	F^{US}	F^{UT}	F^{UC}	F^{UN}	F^{UK}	F^{UJ}	F^{UU}	LH^{U}
International Freight and Insurance	(BF)	BA^{I}	BA^{M}	BA^{P}	BA^{S}	BA^{T}	BA^{C}	BA^{N}	BA^{K}	BA^{J}	BA^{U}	BF^{I}	BF^{M}	BF^{P}	BF^{S}	BF^{T}	BF^{C}	BF^{N}	BF^{K}	BF^{J}	BF^{U}	
Import from Hong Kong	(CH)	HA^{I}	HA^{M}	HA^{P}	HA^{S}	HA^{T}	HA^{C}	HA^{N}	HA^{K}	HA^{J}	HA^{U}	HF^{I}	HF^{M}	HF^{P}	HF^{S}	HF^{T}	HF^{C}	HF^{N}	HF^{K}	HF^{J}	HF^{U}	
Import from EU	(CO)	OA^{I}	OA^{M}	OA^{P}	OA^{S}	OA^{T}	OA^{C}	OA^{N}	OA^{K}	OA^{J}	OA^{U}	OF^{I}	OF^{M}	OF^{P}	OF^{S}	OF^{T}	OF^{C}	OF^{N}	OF^{K}	OF^{J}	OF^{U}	
Import from the R.O.W.	(CW)	WA^{I}	WA^{M}	WA^{P}	WA^{S}	WA^{T}	WA^{C}	WA^{N}	WA^{K}	WA^{J}	WA^{U}	WF^{I}	WF^{M}	WF^{P}	WF^{S}	WF^{T}	WF^{C}	WF^{N}	WF^{K}	WF^{J}	WF^{U}	
Duties and Import commodity taxes	(DT)	DA^{I}	DA^{M}	DA^{P}	DA^{S}	DA^{T}	DA^{C}	DA^{N}	DA^{K}	DA^{J}	DA^{U}	DF^{I}	DF^{M}	DF^{P}	DF^{S}	DF^{T}	DF^{C}	DF^{N}	DF^{K}	DF^{J}	DF^{U}	
Value Added	(VV)	V^{I}	V^{M}	V^{P}	V^{S}	V^{T}	V^{C}	V^{N}	V^{K}	V^{J}	V^{U}											
Total Inputs	(XX)	X^{I}	X^{M}	X^{P}	X^{S}	X^{T}	X^{C}	X^{N}	X^{K}	X^{J}	X^{U}											

<STEP 1>

So far, all the parts except the shadowed segments have been prepared and are ready for linking.
The remaining parts are in fact directly transplanted from the corresponding parts of national tables, after due aggregation into AIO classification.
The diagram shows an example of Japan's case, with arrows indicating the parts-correspondence between the AIO table and the Japan I-O table.
The same treatment should be done for any other member countries.

<STEP 2>

After linking, all the rowwise statistical discrepancies due to the difference in data source are aggregated into a single column vector, DX.

* Note that the export vectors to the member countries are NOT used in the end, to avoid double-counting with the corresponding import matrices.