Wish List for Modifying National Statistical Infrastructures for Improved International Input-Output Databases

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Abstract

This paper briefly introduces the estimation methodologies applied at IDE-Jetro and OECD to develop international input-output databases. In particular, we review the availability of underlying source data, summarize the assumptions made, and describe the harmonization techniques used. We conclude with a wish list aimed at national statistics providers outlining possible enhancements to source data that could help in the developments of international inter-industry databases.

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Introduction

In response to the recent development of Spatial Economics (New Economic Geography), New "new" trade theory and Global Value Chains related issues, it is increasingly recognized that the concept of "space" plays an important role in the analysis of economic development and globalization. Many policy makers and researchers alike, therefore, have come to pay greater attention to the spatial aspect of the economies nowadays.

In this regard, an international input-output table as an extension of interregional or interspatial Input-Output (I-O) techniques became a significant analytical tool for the issues of current concern. The Institute of Developing Economies (IDE) for the last 30 years has been making every effort to construct international I-O tables in collaboration with statistical offices and research institutes of East and Southeast Asian countries. Now facing the rapid growth of the Chinese economy and the deepening interdependency in the Asia-Pacific region, IDE's Asian International Input-Output (AIO) Table is an indispensable apparatus for the analysis of Asian economic development from a spatial perspective. On the other hand, the OECD has also been maintaining harmonized non-competitive type I-O tables since the mid 1990s. The up-to-date OECD I-O databases now are available for 46 (33 OECD and 13 non-OECD member countries) with 37-sector classification for mid-1990s, early 2000 and mid-2000s. Based on this database, the OECD also developed a multi-national I-O model which covers 50 economies with 37 sectors for 1995, 2000 and 2005.

This report briefly introduces the estimation methodologies applied at IDE-Jetro and OECD to develop international input-output databases. In particular, we review the availability of underlying source data, summarize the assumptions made, and describe the harmonization techniques used. We conclude with a wish list aimed at national statistics providers outlining possible enhancements to source data that could help in the developments of international inter-industry databases.

Part I Compilation of Asian International Input-Output Tables (IDE-Jetro)

1. History of the Asian international Input-Output tables

1.1 Pioneering work

Interregional I-O models were pioneered by prominent economists of the time, including Leontief, Isard, Chenery, and Moses. The first international I-O model was developed in 1961 by R.J. Wonnacott for the Canadian and U.S. economies. At IDE, Watanabe proposed in 1964 the idea of using international I-O models as analytical tools for the North-South trade issues. In 1965 IDE developed an international I-O model covering six regions: North America, Europe, Oceania, Latin America, Asia, and Japan. In 1966 and 1971, IDE constructed international I-O models for ten Asian countries. Yet the I-O tables compiled in these studies were subject to a number of limitations; i.e., estimation techniques were too simple; the industrial sector classification was too crude; the tables had no import matrix, and so on. These problems notwithstanding, the models were credited with facilitating empirical analyses of structural relationships between developed countries and developing countries.

Beside such research-oriented projects, IDE's I-O tables were also utilized for evaluating the credibility and preciseness of statistical materials of developing countries. From the basic premise of data coherency between demand and supply sectors, the misspecification of estimates by local statistical agencies can be logically inferred if any deviation or inconsistency is observed in the table. The "targets" to be scrutinized ranged from production data to consumption data, or even to foreign trade statistics.

1.2 First phase (1973 to 1977)

In 1973 IDE decided to launch development of a comprehensive international I-O table to explore the situation of inter-industrial transactions among East and Southeast Asian countries. The Republic of Korea and the five ASEAN countries plus the United States were chosen to be included, as these countries have close economic relationships with Japan. Had all the countries compiled their national I-O tables at the same referential year, the project would not have been so laborious. However, Indonesia, Thailand, and Singapore had not constructed any I-O tables by that time. Also, IDE was not sufficiently experienced in compiling a comprehensive I-O table. Thus, the project

had to begin with two preliminaries: one was to construct national I-O tables for these three countries, and the other was to compile bilateral I-O tables with the countries for which the national tables were already available. Under this project, three national I-O tables (Indonesia for 1971, Singapore for 1973, and Thailand for 1975) and three bilateral I-O tables (Korea-Japan for 1970, U.S.A.-Japan for 1970, and Philippines-Japan for 1970) were constructed in collaboration with the national statistical offices and research institutes of the countries concerned.

1.3 Second phase (1978 to 1982)

In 1978, IDE started the second phase of the I-O project, with the aim of constructing the 1975 multilateral I-O table among the ASEAN countries, Japan, Korea, and the U.S.A. This project went along with the following three steps: (1) estimation of national I-O tables for the countries that did not have 1975 national tables, (2) construction of 1975 bilateral I-O tables for the countries that had already compiled national tables by the time, and (3) construction of the 1975 multilateral I-O table. First, existing tables had to be updated to the year 1975 for Malaysia, the Philippines, Singapore, and the U.S.A. Next, the 1975 bilateral I-O tables for Indonesia-Japan, for Thailand-Japan, and for Korea-Japan were constructed. Finally, these national and bilateral tables were linked together under a single multilateral I-O table for 1975, which was completed in 1983. The 1975 multilateral table has been used for various analyses of East and Southeast Asian industrial structure, and the table became the prototype for the subsequent international I-O projects.

1.4 Third phase (1988 to the present)

After completion of the 1975 international I-O tables, IDE soon relaunched for construction of the 1985 international I-O tables, to cover more Asia-Pacific countries. Since China commenced an Open-Door policy as one of its key development strategies it has rapidly increased its external trade with the United States, Japan, and others. China now plays an important role in the Asia-Pacific region, not only in providing a gigantic market but also in receiving investment from the neighboring countries. Thus, China and Taiwan were covered in the 1985 multilateral table, making it even more comprehensive than the previous 1975 version. Since then, IDE has successfully completed the multilateral tables every five years, providing powerful analytical tools for dynamic structural changes in the Asia-Pacific region.

2 Compilation procedure and methodology of the Asian international I-O table

Compilation of international I-O tables is an artistic practice. A number of statistical experts from various countries are involved, exchanging considerable amounts of valuable information and technical expertise.

Roughly speaking, the compilation process goes through three distinctive phases:

(1) Adjustment of presentation format

(2) Preparation of sector concordance and supplementary data

(3) Linking and balancing

What follows is a step-by-step illustration of how the Asian international I-O table is compiled. The first part presents a schematic description of the format adjustment for every constituent national table based on the general survey on national tables, which was conducted by IDE in 2003-4 in order to establish a common rule for the format adjustment of the tables. The second part briefly explains construction of the system of sector concordance, followed by a brief introduction of estimation methods for supplementary data. Finally, the linking procedure is illustrated, with detailed explanations of the manual balancing/reconciliation work.

2.1 Adjustment of presentation format

Despite the fact that input-output tables constitute the central apparatus of the System of National Accounts, each national table of an individual country exhibits more or less different features and characteristics, reflecting the country's economic idiosyncrasies and availability of data. Such a variety in the form, however, poses a practical difficulty when compiling international input-output tables (see Table 1). For even though the international table is composed of the segments taken from each national I-O table, the interpretation of the data should be mutually consistent and comparable for any part of the whole.

Accordingly, one of the most complicated, nerve-racking tasks of compilation is the adjustment of national tables to conform to a common format. In general, it is the detailed, information-rich table that has to concede to less-detailed ones, as the other way round would require a costly (yet often unrewarding) effort of obtaining supporting data. Therefore, there always exists a trade-off between the level of uniformity and the level of information, and hence careful and thorough consideration is called for in making adjustment rules.

This section reports on the general survey on the characteristic features of national

tables of AIO member economies. The survey was conducted in the period of 2003-04, in order to construct the basic information reserves for designing the AIO common format and adjustment rules. To our knowledge, such an extensive and detailed survey on national tables has never been carried out, and we believe that no institution but the IDE, with a history of significant cooperative relationships with I-O experts of various Asian economies, would be able to make such a substantial survey possible and successful.

Table 1. Different features and characteristics of the AIO member economies

	CHINA	INDONESIA	JAPAN	KOREA	MALAYSIA	TAIWAN	PHILIPPINES	SINGAPORE	THAILAND	U.S.A.
1. Conversion of valuation										
1.1 Basic price to producer's price								X		
1.2 Private Consumption Expenditure					X			X		X
1.3 Export vectors					X			X		
1.4 Import matrix/vector			X	X			X		X	X
2. Negative entries				X						
3. Dummy sectors	X		X	X	X			X		X
4. Machine-repair	X		X				X			X
5. Financial intermediaries			X		X			X	X	
6. Special treatment of import/export										
6.1 Water transportation										X
6.2 "Pure import" of gold										X
6.3 Re-export					X					
6.4 Telecommunication				X						
7. Computer software products						X				
8. Producers of government services									X	X

2.1.1 Questionnaire and the survey result

In the survey, a questionnaire was carefully designed so as to capture every important aspect of an I-O table. The questions are grouped under seven broad categories, namely:
(1) Benchmark-year and recording principles
(2) Availability of national tables and supporting tables
(3) Valuation
(4) Form and coverage
(5) Special treatment
(6) Public / semi-public sectors
(7) Response to the 1993 SNA.

2.1.2 Major findings

Based on the results of general survey, the major findings can be summarized as follows:
(1) Similarity to the Japanese I-O table
In Figure 1, the degree of similarity to the Japanese I-O table is illustrated. The horizontal axis is the level (number) of industrial classification, while vertical axis concerns presentation format, giving the percentage rates of the number of questions in the questionnaire to which the country gave the same answers as Japan's. (The rates are calculated against the sum of valid answers only.) The diagram shows that the most similar table of all is the Korean I-O table, as its industrial classification has just one sector difference with that of the Japanese table, and the rate of the same answer is more than 70%.

Then, we can identify the second group, including Indonesia, the Philippines, Thailand and Malaysia. Not to mention about the Korean table, there is no wonder for these tables (except Malaysia) to show high degree of similarity to the Japanese table, since their national I-O projects are known to have been initiated and conducted under the advice and support of Japanese I-O experts.

The US table is indicated as having some degree of similarity, but in the survey result it is observed that many answers remain to be “unknown”, so that no conclusive evaluation can be made against this table (although it is true that the classification difference is the second smallest after the Korean table.)

The third group, which is least similar to the Japanese table, includes Taiwan, Singapore and China. In addition to the dissimilarity of the format and of the level of

industrial classification, the benchmark years of these national tables differ from that of Japan, i.e., with “0” or “5” in the last digit of the year. So the official tables had to be updated to the year 2000 with the help of some estimation methods like RAS algorithm, and this will further disturb the accuracy of the tables. The same is true for the national table of the United States.

(2) The responsiveness to the 1993 SNA

The System of National Account is a comprehensive guideline for compiling national statistical data. If properly followed, the resulting statistics will be mutually consistent and internationally comparable. The latest version of the SNA, the 1993 SNA, underwent an extensive revision of its predecessor, the 1968 SNA, to bring the statistical notions and methods up to date. I-O tables (or more precisely supply and use tables), which constitute a core apparatus of the System, didn’t remain unaffected, and many countries including our project partners are now putting every effort to make their tables accordant to the new scheme.

The survey result (Table 4) shows that the most “responsive” countries are the Philippines and the United States, yet again one must be careful about the result on the US table as it contains a number of “unknowns”. The Thai I-O table comes next, followed by the Korean and Japanese table. Although the Korean table and Japanese table ranked the same, the former can be evaluated higher as it already succeeded in introducing one of the most challenging schemes in the 1993 SNA, i.e., the Financial Intermediary Services Indirectly Measured (FISIM). On the other hand, it is rather surprising to observe that Singapore and Malaysia came to low ranks, as these national tables are known to have followed the previous 1967 SNA schemes quite extensively.

Figure 1. Similarity to the Japenese I-O table

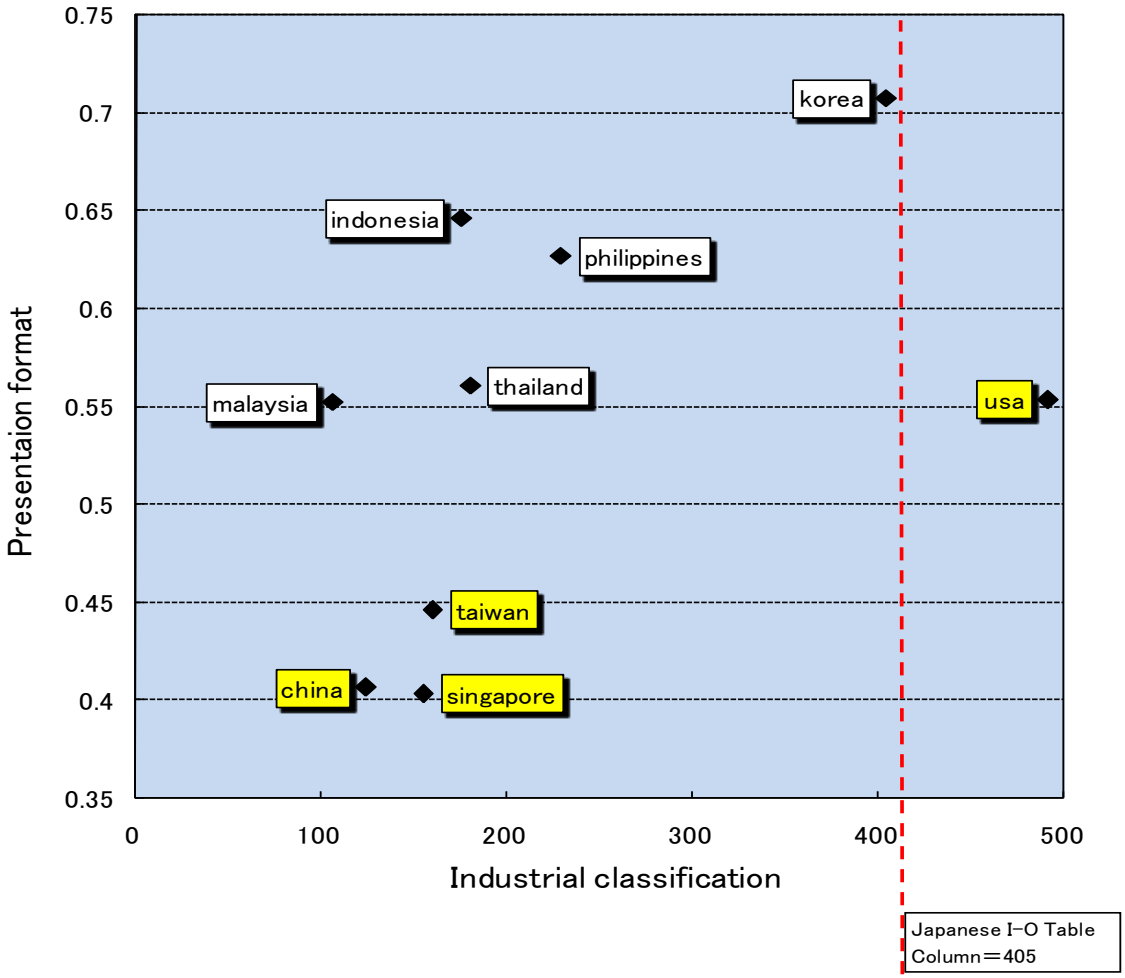

Table 2. Similarity in the presentation format

Rank	Country	Rate *	Classification
1	KOREA	0.7077	404
2	INDONESSIA	0.6462	175
3	PHILIPPINES	0.6269	229
4	THAILAND	0.5606	180
5	USA	0.5536	491
6	MALAYSIA	0.5522	106
7	TAIWAN	0.4462	160
8	CHINA	0.4063	124
9	SINGAPORE	0.4032	155

* The percentage rates of the number of questions in the questionnaire to which the country gave the same answers as Japan's.

Table 3 Similarity in the no. of industrial classification

Rank	Country	Difference in the number of industrial sectors	Classification
1	KOREA	1	404
2	USA	86	491
3	PHILIPPINES	176	229
4	THAILAND	225	180
5	INDONESIA	230	175
6	TAIWAN	245	160
7	SINGAPORE	250	155
8	CHINA	281	124
9	MALAYSIA	299	106

Table 4 Responsiveness to the 1993 SNA

Rank	Country	rate *
1	PHILIPPINES	0.5714
1	USA	0.5714
3	THAILAND	0.5385
4	KOREA	0.5000
4	JAPAN	0.5000
6	SINGAPORE	0.4545
7	INDONESIA	0.4286
7	MALAYSIA	0.4286
9	CHINA	0.3077
10	TAIWAN	0.2143

* The percentage rates of the number of questions in section 7 of the questionnaire to which the country gave the answer that follows the SNA recommendation .

(3) The areas of conflict

Finally, we shall briefly look at the areas of conflict where each country's treatment is not in line. The most prominent example is the treatment of Scraps and By-products. There are normally four adjustment methods for this problem. Each of them has both advantages and disadvantages and, the member countries employed the various schemes in quite an uncoordinated fashion. In the absence of supplementary information on the generation and use of scraps / by-products, it is not possible to convert from one scheme to another, making it difficult to reach a common agreement on the adjustment method.

The second area of conflict is about the treatment of Imputed interest. The previous 1968 SNA recommended that the output of imputed interests (= the difference between the interests receivable and the interests payable) should all go to intermediate transaction, not to final demand. The countries like Japan, Singapore and Malaysia

strictly follow this stipulation, while other countries' tables have output in final demand as well. The introduction of FISIM under the 1993 SNA may provide an integrated guideline for this issue, but so far no member country except Korea is successful in introducing this new scheme.

The last prominent area of conflict is the treatment of inventory. The related question in the questionnaire is: "Suppose that a car industry (demand-side sector) purchased a set of tyres (supply-side sector) but did not use them this time. How does this input enter in the table?" Most of the countries answered that the input should be recorded at the intersection between Tyre (supply-side) industry and Change in Stocks, but some countries like China, Taiwan and Singapore answered the opposite, i.e., at the intersection with Car (demand-side) industry. Singapore gave an explanatory comment on this. It treated this input as a stock of car since "tyres are regarded as a <work-in-progress> of a car." It is quite surprising to find out that even the very basic economic concept like an "inventory" is in fact yielding to different interpretation among countries.

2.2 Preparation of sector-concordance and supplementary data

2.2.1 The table of industrial sector concordance

Each national table has its own industrial classification. In the case of the benchmark tables for the 2000 AIO table, the number of industrial sectors ranges from 98 for the Malaysian table to 517 (row) for the Japanese table. The weight of the industrial category also differs. The countries with large agro-based economies have relatively detailed classification of agricultural sectors, while industrialised economies give more comprehensive coverage to manufacturing sectors. As such, the sector classification reflects the characteristics of the economy concerned, and a precise conversion system that bridges between national codes and AIO codes is absolutely essential for the compilation of consistent international I-O tables.

The system of sector concordance has a treelike image, where AIO classification (the broadest category) rests on the top, and each AIO code corresponds to one or several national codes. The national codes are subcategorized into the Harmonized System of Foreign Trade Statistics, which may be further converted to SITC, another classification system for the trade data.

If the concordance system has such a clear-cut tree structure, the aggregation of national tables into AIO classification poses no difficulty. The problem arises when a

national code is associated with more than two AIO codes. For example, Singapore's national code SIO092 "Land transport equipments" corresponds to both AIO055 "Motor vehicles" and AIO056 "Motorcycles." Here, the sector splitting of the national I-O table is called for before the aggregation procedure.

2.2.2 Supplementary data

For the compilation of international tables, the following supplementary data should be prepared by each country at AIO sector classification.

(1) Import data by commodity and by 11 countries of origin*
(2) Export data by commodity and by 11 countries of destination
(3) Import duties and import commodity taxes by commodity
(4) Domestic trade margins and domestic freight transport costs (TTM) on exported goods, by commodity
(5) International freight and insurance, by commodity and by 11 countries of origin
(6) Other relevant information, such as the distribution ratios of imported goods.

* 11 countries: project member countries plus Hong Kong, EU, the Rest of the World

The import and export data can be directly constructed from the Foreign Trade Statistics, with the help of the HS (or SITC) - national I-O - AIO sector concordance. The data on import duties and import commodity taxes, on the other hand, are independently presented in the original national I-O tables in most cases, but if not (as in the case of the U.S. table; see the previous section), they must be also collected from the Foreign Trade Statistics.

The data of TTM on export comes from the supporting tables of the national I-O tables. Ideally, those levied on exported goods (for the delivery from factories to ports) should be used, but if they are not available from the table the average figures of the TTM matrices can be used as proxies.

Finally, the data on international freight and insurance are collected from the Foreign Trade Statistics, where available. Yet, because not all countries have these data, it is necessary to apply some estimation methods to make up for the missing information. As illustrated below, this is done in two steps: the first step is to obtain the parameter values by creating transport-cost equations for each AIO sector, using the available data; the second step is to project the missing values based on the parameter estimates.

In most of the empirical literature on international trade that uses gravity equations, it is a common exercise to use the distance between countries as a proxy for transport

costs, owing to the limited availability of direct transport-cost data.[1] This treatment assumes that the transport cost is a function of geographic distance:

$$C_{ijk} = f\left(D_{ij}\right). \tag{1}$$

C_{ijk} represents transport costs for country i's imports from country j for sector k, and D_{ij} is the distance between them. The rationale for using distance is that, for a given mode of transport, the greater the distance, the more time and energy are consumed, and hence the transport cost rises. Based on this convention, the following simple variation of transport-cost equations is created:[2]

$$C_{ijk} = \alpha_k + \beta_k D_{ij} + \varepsilon_{ijk}\,. \tag{2}$$

The data for international freight and insurance rates (C_{ijk}) are available for nine countries (China, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Thailand, and the United States), but the quality of data varies across countries, and there exist missing data for many transactions. For Taiwan, no information on international shipping costs is available.

As the distance variable (D_{ij}), two measures of distance are calculated, i.e., the shipping-route distance and the straight-line distance. The shipping-route distance is taken from the *Distance Tables for World Shipping*, published by the Japan Shipping Exchange, Inc. in which the distances between major ports are reported. The straight-line distance, which can be regarded as an analogue of the air-flight distance, is calculated between commercial centres of the countries concerned. Of these two measures, the one that better explains variation in the international freight and insurance rates is employed for projection.

By running regressions of equation (2), the parameter estimates $\hat{\alpha}_k$ and $\hat{\beta}_k$ for each AIO sector k are obtained. In cases in which the estimates for β_k are negative, they are replaced by estimates obtained from regressions in more aggregated classifications, i.e., 24 sectors or seven sectors. If the estimates in aggregated classifications are still negative, positive estimates for related industries are used for projection (e.g., estimates for 050: "Electronic computing equipment" are used in lieu of those for 051: "Semiconductors and integrated circuits").

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[1] Refer to, for example, Anderson (1979).

[2] Several studies investigated the appropriateness of the relationship between transport costs and the distance (see Geraci and Prewo, 1977, Limao and Venables, 2001). However, in our estimation only distance was used as the explanatory variable, owing to data constraints.

Using the parameter estimates $\hat{\alpha}_k$ and $\hat{\beta}_k$, projection of the missing values for international freight and insurance rates ($\hat{C}_{ijk}$) can be done by stacking the distance measures between countries concerned (D_{ij}) into the transport-cost equation:

$$\hat{C}_{ijk} = \hat{\alpha}_k + \hat{\beta}_k D_{ij} . \qquad (3)$$

In addition, the quality of import matrices plays a critical role in determining the accuracy of the international I-O table. In order to increase the accuracy of import matrices, a special survey on imported commodities have been done in the current AIO project.

The main purposes of the survey include: (1) to identify using industries of the imported commodities by origin country; (2) to determine the value/rate of the international freight and insurance on each imported commodity; (3) to determine the value/rate of import duties and commodity taxes levied on each import commodity.

The respondent of the survey will be the establishments that import the commodities (manufacturers, trading firms, etc.) as they are considered to possess the information on amount imported by country of origin and their distribution amount to domestic industries.

The survey is basically carried out as an independent sample survey. Also it may be conducted as a rider survey attached to other official surveys, which is more efficient and comprehensive. (The sample form of the questionnaire in order to collect the information described above is presented in Figure 2).

Carrying out the special survey described above accompanies several problems.

First is the feasibility of the survey. It is difficult for some countries to conduct the survey, owing to the lack of resources (funds, personnel, connections with related authorities and firms, knowledge, etc.). For countries that the survey is infeasible, it will be required to look for some alternative solutions. One possible alternative is to modify the import matrices by referring to other countries' survey results.

Second is the sampling issue. Even if the survey can be carried out, it is not easy to collect the reliable information. For instance, the samples should be selected in order to represent the characteristics of the industry appropriately. However, identifying the typical samples that appropriately reflect the distribution structures is not easy.

Third, it may also be difficult on whether or not the distribution structure can really be determined, even if samples are chosen appropriately. This problem has two different aspects. One aspect is the difficulty to determine the final users of imported commodities by country of origin. As discussed above, the imported commodities are usually delivered to the final users through the wholesale and retail agents. The

respondent to the questionnaire, the importing firm, may not have the information on the final users if they sold their imports to the domestic wholesalers or retailers. The other aspect of the problem is that it may be difficult to determine the amount sold of each imported commodities even though the final users can be identified. This may occur if the survey year is distant from the reference year that the respondent cannot trace the transaction records as they may not keep the detailed information.

2.3 Linking and balancing

An international I-O table is not just a patchwork of the pieces taken from national tables, but it is a product of careful utilization of supplementary data and manual reconciliation/fine-tuning work. This section gives a brief introduction on the linking and balancing work of the AIO table.

2.3.1 Linking of national tables

All the pieces of each member country prepared in the previous steps are linked together to the one big table as shown in Figure 3. Figure 4 illustrates the process of linking. In this example, the linking of I-O tables for countries 1 and 2 is illustrated. As shown in this example, the basic idea of linking is to replace the export vector by the import matrix of the trading partner. At this stage, the valuation of imports in each country's national I-O table is also converted from the C.I.F. price to the producer's price by using the data of international freight and insurance, and domestic transport costs and trade margins compiled in the previous steps.

Figure 2. Sample format of questionnaire

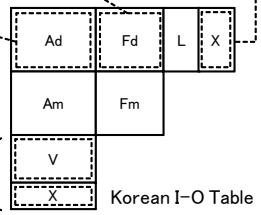
Commodity		Code of Origin Country	C.I.F. Import Value (Unit: Pesos)	Duties & Import Comm. Taxes (Unit : Pesos)	Int'l Freight & Insurance (Unit : Pesos)	Distribution of the C.I.F. Import Value (Using Sector / Destination)		
Description	SITC Code					I-O Code	Value (Unit: Pesos)	Share (%)
rice	042	1	26	5	7	022	1	3.85
						023	2	7.69
						HH	23	88.46
meat, dried, salted or smoked	012	1	203,991	1,563	5,893	019	94,737	46.44
						020	3,586	1.76
						021	5,881	2.88
						063	3,712	1.82
						HH	84,262	42.29
						OH	9,813	4.81

The total of distribution values should be the same as for the amount imported.

The total of the percentage share should be 100%.

Figure 3 Layout of the AIO table

		code	Intermediate Demand (A)										Final Demand (F)										Export (L)				
			Indonesia (AI)	Malaysia (AM)	Philippines (AP)	Singapore (AS)	Thailand (AT)	China (AC)	Taiwan (AN)	Korea (AK)	Japan (AJ)	U.S.A. (AU)	Indonesia (FI)	Malaysia (FM)	Philippines (FP)	Singapore (FS)	Thailand (FT)	China (FC)	Taiwan (FN)	Korea (FK)	Japan (FJ)	U.S.A. (FU)	Export to Hong Kong (LH)	Export to EU (LO)	Export to R.O.W. (LW)	Statistical Discrepancy (QX)	Total Outputs (XX)
	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}	L^{IH}	L^{IO}	L^{IW}	Q^{I}	X^{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}	L^{MH}	L^{MO}	L^{MW}	Q^{M}	X^{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}	L^{PH}	L^{PO}	L^{PW}	Q^{P}	X^{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}	L^{SH}	L^{SO}	L^{SW}	Q^{S}	X^{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}	L^{TH}	L^{TO}	L^{TW}	Q^{T}	X^{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}	L^{CH}	L^{CO}	L^{CW}	Q^{C}	X^{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}	L^{NH}	L^{NO}	L^{NW}	Q^{N}	X^{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}	L^{KH}	L^{KO}	L^{KW}	Q^{K}	X^{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}	L^{JH}	L^{JO}	L^{JW}	Q^{J}	X^{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}	L^{UH}	L^{UO}	L^{UW}	Q^{U}	X^{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)	A^{HI}	A^{HM}	A^{HP}	A^{HS}	A^{HT}	A^{HC}	A^{HN}	A^{HK}	A^{HJ}	A^{HU}	F^{HI}	F^{HM}	F^{HP}	F^{HS}	F^{HT}	F^{HC}	F^{HN}	F^{HK}	F^{HJ}	F^{HU}					
Import from EU		(CO)	A^{OI}	A^{OM}	A^{OP}	A^{OS}	A^{OT}	A^{OC}	A^{ON}	A^{OK}	A^{OJ}	A^{OU}	F^{OI}	F^{OM}	F^{OP}	F^{OS}	F^{OT}	F^{OC}	F^{ON}	F^{OK}	F^{OJ}	F^{OU}					
Import from the R.O.W.		(CW)	A^{WI}	A^{WM}	A^{WP}	A^{WS}	A^{WT}	A^{WC}	A^{WN}	A^{WK}	A^{WJ}	A^{WU}	F^{WI}	F^{WM}	F^{WP}	F^{WS}	F^{WT}	F^{WC}	F^{WN}	F^{WK}	F^{WJ}	F^{WU}					
Import 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>

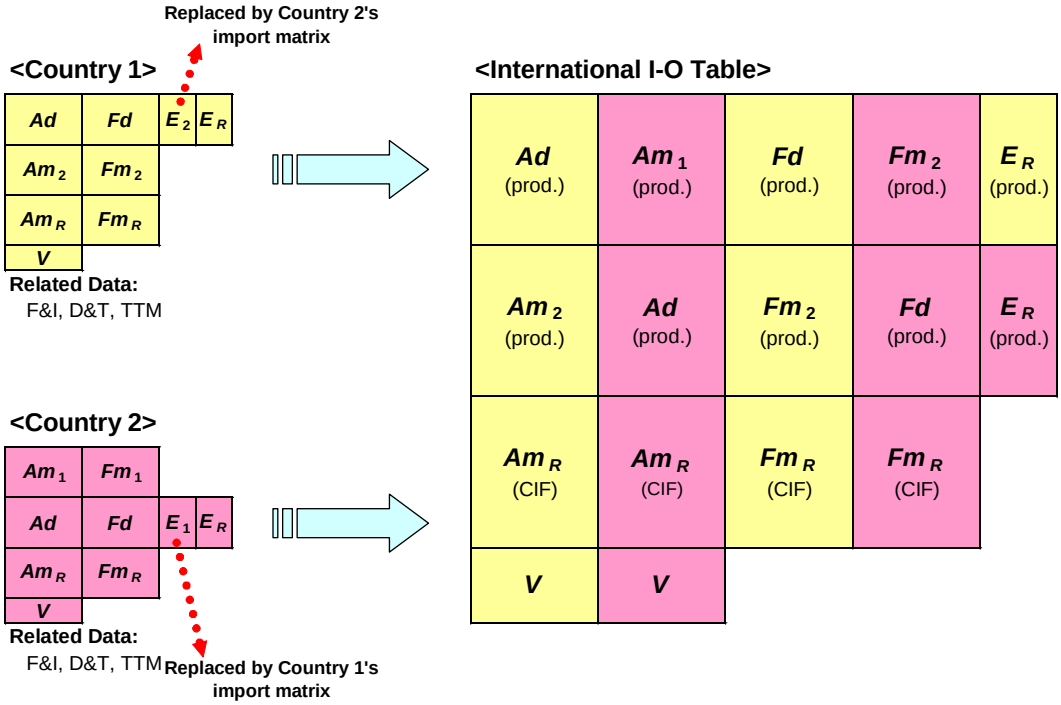
So far, all the parts except the highlighted segments have been prepared and are ready for linking. The remaining parts are in fact directly transplanted from the corresponding parts of national tables, after due aggregation into AIO classification. The diagram shows an example of Korea's case, with arrows indicating the parts-correspondance between the AIO table and the Korean I-O table.

The same treatment should be done for all the other member countries.

<STEP 2>

After linking, all the rowwise statistical discrepancies due to the difference in data source are dumped into a single column vector, QX. (Note that the export vectors to the member countries are NOT used in the end, to avoid double-counting with the corresponding import matrices.)

Figure 4. Linking of national I-O tables (two-country case)



2.3.2 Reconciliation of data

The final step of compilation is the manual balancing and reconciliation work, following the linking of all the pieces provided so far. The table is balanced with respect to the input composition, but total demand is not necessarily consistent with total supply for each country at this stage. Such an imbalance stems from the following facts.

Here, let us consider the case of Korea. As explained in the previous section, the blocks A^{KK}, F^{KK}, and L^{KZ} $(Z = H, O, W)$ in the diagram in the left page are calculated from Korea's input-output table, and they should conform to the transactions recorded in the Korean input-output table. However, the other blocks A^{KZ} and F^{KZ} $(Z \neq K)$, are estimated from the import matrices of other countries, and there is no guarantee that they will be consistent with Korea's export figures. For example, for the blocks A^{KM} and F^{KM}, at which Korea's rows and Malaysia's columns intersect, if the export and import data are to be consistent, the following equation must hold true:

$$D_i^{KM} = (\sum_j A_{ij}^{KM} + \sum_k F_{ik}^{KM}) - L_i^{KM} = 0, \qquad (4)$$

where D_i^{KM} represents the difference between Malaysia's import data and Korea's export data for ith industry, the subscripts j and k respectively denote jth industry

and kth final demand, and L_i^{KM} represents the exports of Korea's ith industry to Malaysia (expressed in producer's prices). In actuality, whether or not equation (1) holds true depends on the reliability of the international trade statistics for the two countries. As stated above, the results of our linking work show that $D_i^{KM} \neq 0$, of course, the same imbalance occurs with all the other countries of the project. Therefore, we consider that D_i^{KM} denotes the discrepancies in international trade statistics of the two countries, as well as to include the margins of error in estimating blocks A^{KM} and F^{KM}.

To rationally and efficiently decrease the discrepancies generated through the linking process, the procedure shown in Figure 5 below is employed in final reconciliation of the AIO table.

(a) Initially, we use the linking results to summarize the transactions among the industries of all countries and compile an AIO table that there is only one sector per country. Then it becomes easy to check whether or not the present data in the AIO table at the national level are consistent with the published data sources, such as the GDP statistics for the country or the IMF statistics. Through the above checking, we gain knowledge of the preliminary linking results.

(b) For determining the size of the final adjustment in detail, we calculate the error rates of CT rowwise by sector for each country. Figure 6 shows the distribution of the summarized absolute CT's error rates for different levels. The vertical axis represents the number of sectors in which CT's errors are larger than the specified levels. Obviously, China, Japan, and the U.S.A. have relatively smaller numbers that are counted in each level. On the other hand, Indonesia, Malaysia, the Philippines, Singapore, and Thailand have relatively larger numbers. Korea and Taiwan exhibit a similar pattern. The distribution shown in Figure 6 not only depends on the economic scale but also relates to the statistic system of each country. Considering the large scale of the AIO table and the distribution pattern of error rates, any sector that has a CT' error rate over 5% is determined as a target for preliminary adjustment.

(c) Though 5% is determined as the criterion for the preliminary adjustment, considering that positive errors may offset some negative errors in the row sector, we have to investigate the structure of the error rowwise. As stated in the previous section, the AIO table is based on the import matrices for each country, and the matrices conform to import statistics, but the export statistics are not necessary consistent. In order to discuss the structure of the error in detail, for example, in the case of Korea, we calculate matrix $D_i^{KZ} = (\sum_j A_{ij}^{KZ} + \sum_k F_{ik}^{KZ}) - L_i^{KZ}$, which represents the difference between country Z's imports from Korea and Korea's exports to country Z for ith

industry. If one refers to this matrix, the structure of Korea's CT's error rowwise becomes easy to understand, and it offers us information about which sectors and which countries should be the main targets for adjustment.

(d) The discrepancy is mainly caused by the following three factors: (1) The inconsistency between each country's sector classifications. Though each country is required to make its own code concordance from HS code to AIO sector classification, the possibilities of differences in statistical concept still exists. (2) Entrepot trade is counted in different ways by the trade partners. For example, in the case of China, export via Hong Kong to the U.S.A. may be counted by the U.S.A as import from China. In the case of Singapore, where international trade is extremely large compared to the scale of its economy, and there is a large volume of entrepot trade, there are especially large statistical discrepancies in its international trade matrices. (3) Other statistical reasons.

Figure 5　Adjustment procedure

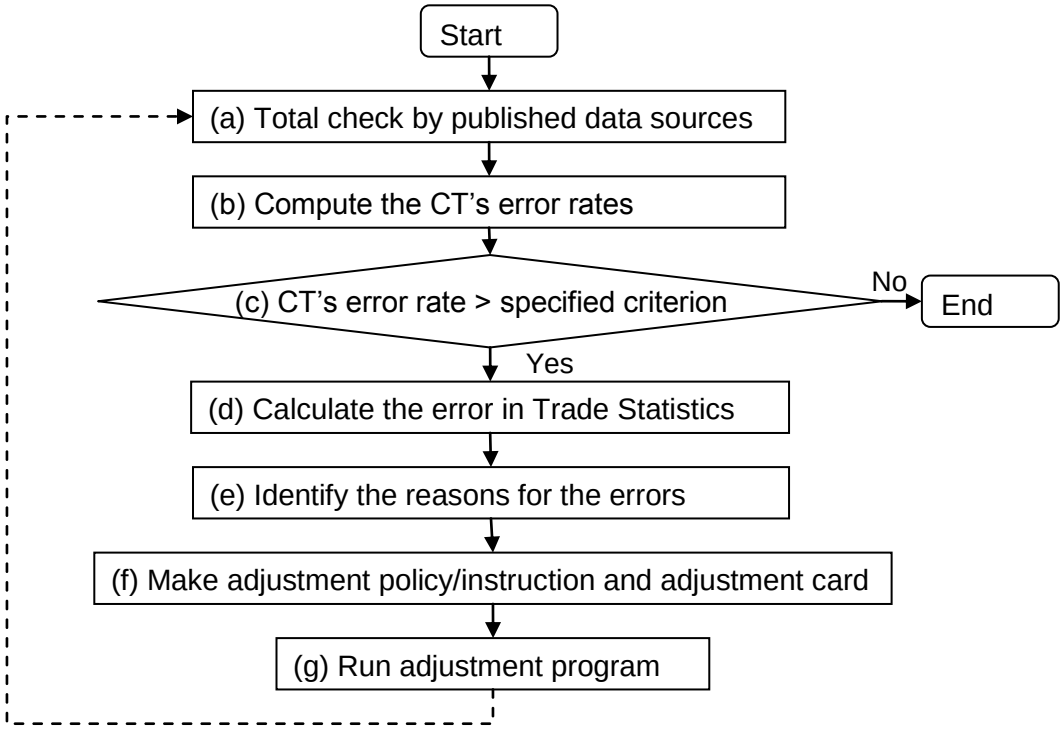
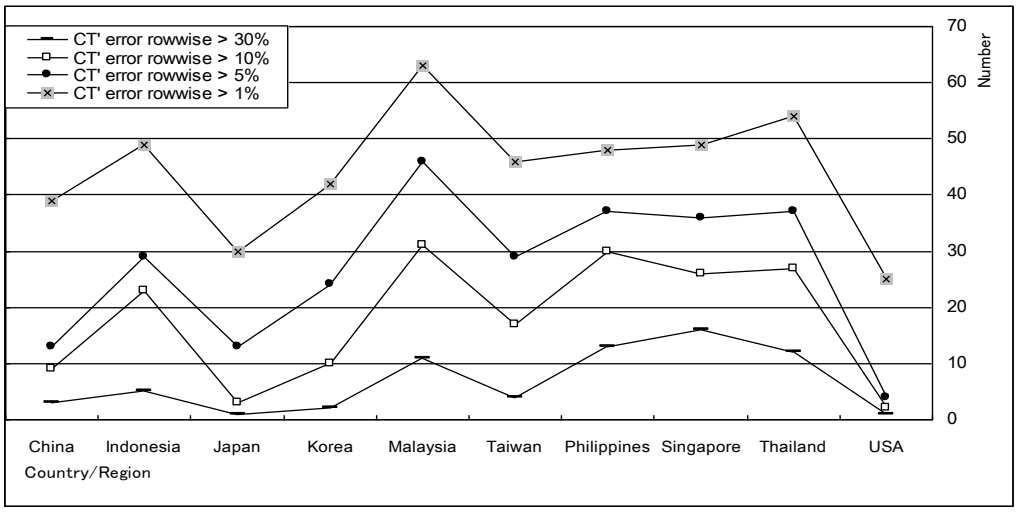


Figure 6 Distribution of CT's error



(e)　According to the analysis of "matrix D" introduced above and careful investigation of the HS-AIO code concordance, the majority of errors can be specified. Then the adjustment policy will be determined. In our project, since the portion for each country has a professional in charge, that person will give instructions to other staff based on the adjustment policy. Then the staff member in charge of a country will aggregate all

the instructions coming from those in charge of other countries into the adjustment card for his/her country.

(f) The adjustment cards are used as input files in the adjustment program. Basically, the adjustment is merely executed on the import matrices, and it vertically moves the same amount from one sector to other sectors. This means that CT balance will be maintained columnwise.[3]

The above procedure (a) – (f) will be repeated until the results satisfy the specified criteria. Additionally, spot-check is conducted at the end of the adjustment. This is to "spot out" any unnatural entries in the table that might have been brought in during the course of the adjustment. For example, the output of electricity, gas & water supply or some other service sectors is not supposed to enter any cells along Fixed Capital Formation or Change in Stocks. Any of such mis-tabulation should be cleared and dealt with properly.

It is extremely rare for the international trade statistics of different countries to be consistent with one another. There are usually rather large gaps and errors. While a number of existing studies have analyzed the extent and nature of this problem, a standardized methodology for reconciling the international trade statistics of various countries has not yet been established. Even though in our project we require each country to make a code concordance between the AIO's sector classification and HS code, it is extremely difficult to eliminate the discrepancies completely, because of the large number of codes involved and differences among statistical systems from one country to another.

[3] Basically, The remaining CT' error rowwise will be moved to the vector QX (Statistical Discrepancy).

Part II The OECD Intercountry I-O model

1 Introduction

The OECD has been updating and maintaining harmonized I-O tables, splitting intermediate flows into tables of domestic origin and imports, since the mid-1990s - usually following the rhythm of national releases of benchmark I-O tables. It is basically based on *pure* official statistics and used for various country comparative analyses.[4]

As countries have increased dependencies on external markets both for inputs (intermediate and final goods imports) and outputs (exports), the limitation of single-country-based analytical framework become apparent, because the feedback and spillover effects have been become negligibly small anymore. The inter-country I-O framework is thus useful tool to understand the inter-country spillover effects.

In fact, the development of inter-country I-O model is very data-intensive approach. It requires highly harmonised data from neighbour countries to measure the inter-country economic spillover. We should therefore suggest that the statistical cooperation across national statistic institutes become much more important to pursue this research avenue.

At OECD, using the harmonised input-output tables and bilateral trade coefficients in goods and services, the inter-country input-output tables for the reference years of 1995, 2000 and 2005 are estimated applying the multi-regional input-output model techniques previously established for regional analyses (Chenery-Moses; Isard).

2. Data sources

OECD Input-Output updates

Ideally, national authorities would provide the latest Supply-Use tables and benchmark symmetric input-output tables (SIOTs) at the most detailed level of economic activity possible; with a basic price valuation; and, preferably, separating domestically produced and imported intermediate goods and services,. However, few countries can meet such requirements. Therefore, in order to maximize country coverage, all relevant *partial* data is used. It should be noted that one of the main reasons that I-O analysis has benefited from renewed attention in recent years is the improved availability and quality of I-O tables and related statistics from national sources.

Coverage – countries and years

[4] Such as measurement of global value chains, vertical specialization and carbon emissions embodied in international trade

The first edition of the OECD I-O Database dates back to 1995 and covered 10 OECD countries with I-O tables spanning the period from early 1970 to early 1990. The first updated edition of this database, released in 2002, increased the country coverage to 18 OECD countries, China and Brazil, and introduced harmonized tables for the mid-1990s. Since 2006 this tradition of growth has continued so that there are now tables available for 44 countries. (33 OECD and 11 non-OECD countries) with tables for the mid-2000s (mainly 2005) now available for most of them (Table 1). For more details, and information on how to access OECD I-O tables, go to www.oecd.org/sti/inputoutput.

Table 1. Country coverage of OECD Input-Output 2009ed (As of May 2011)

OECD	mid-90s	early-00s	mid-00s	OECD	mid-90s	early-00s	mid-00s	Non-OECD	mid-90s	early-00s
Australia	1994/95	1998/99	2004/05	Japan	1995	2000	2005	Argentina	1997	-
Austria	1995	2000	2005	Korea	1995	2000	2005	Brazil	1995	2000
Belgium	1995	2000	2005	Luxembourg	1995	2000	2005	China	1995	2000
Canada	1995	2000	2005	Mexico	-	-	2003	Chinese Taipei	1996	2001
Chile	1996	-	2003	Netherlands	1995	2000	2005	India	1993/94	1998/99
Czech Republic	1995	2000	2005	New Zealand	1995/96	2002/03	-	Indonesia	1995	2000
Denmark	1995	2000	2005	Norway	1995	2000	2005	Romania	-	2000
Estonia	1997	2000	2005	Poland	1995	2000	2005	Russia	1995	2000
Finland	1995	2000	2005	Portugal	1995	2000	2005	South Africa	1993	2000
France	1995	2000	2005	Slovak Republic	1995	2000	2005	Thailand	-	-
Germany	1995	2000	2005	Slovenia	-	2000	2005	Viet Nam	-	2000
Greece	1995	2000	2005	Spain	1995	2000	2005			
Hungary	1998	2000	2005	Sweden	1995	2000	2005			
Iceland	-	-	-	Switzerland	-	2001	-			
Ireland	1998	2000	2005	Turkey	1996	1998	2002	*not published - internal use only*		
Israel	1995	-	2004	United Kingdom	1995	2000	2005	*Malaysia*		*2000*
Italy	1995	2000	2005	United States	1995	2000	2005	*Singapore*	*1995*	*2000*

Available year, -: not available

Industry classification

The industry classification used in the current version of the I-O database is based on ISIC Rev.3 (Table 2), meaning that it is compatible with the other OECD industry-based analytical data sets such as the Structural Analysis database (STAN), based on SNA by activity, and bilateral trade in goods by industry (derived from merchandise trade statistics via standard Harmonized System to ISIC conversion keys).

Table 2. OECD Input-Output Industry classification

ISIC Rev.3 code		Description
1+2+5	1	Agriculture, hunting, forestry and fishing
10+11+12	2	Mining and quarrying (energy)
13+14	3	Mining and quarrying (non-energy)
15+16	4	Food products, beverages and tobacco
17+18+19	5	Textiles, textile products, leather and footwear
20	6	Wood and products of wood and cork
21+22	7	Pulp, paper, paper products, printing and publishing
23	8	Coke, refined petroleum products and nuclear fuel
24ex2423	9	Chemicals exluding pharmaceuticals
2423	10	Pharmaceuticals
25	11	Rubber and plastics products
26	12	Other non-metallic mineral products
271+2731	13	Iron & steel
272+2732	14	Non-ferrous metals
28	15	Fabricated metal products, except machinery and equipment
29	16	Machinery and equipment, nec
30	17	Office, accounting and computing machinery
31	18	Electrical machinery and apparatus, nec
32	19	Radio, television and communication equipment
33	20	Medical, precision and optical instruments
34	21	Motor vehicles, trailers and semi-trailers
351	22	Building & repairing of ships and boats
353	23	Aircraft and spacecraft
352+359	24	Railroad equipment and transport equipment n.e.c.
36+37	25	Manufacturing nec; recycling (include Furniture)
401	26	Production, collection and distribution of electricity
402	27	Manufacture of gas; distribution of gaseous fuels through mains
403	28	Steam and hot water supply
41	29	Collection, purification and distribution of water
45	30	Construction
50+51+52	31	Wholesale and retail trade; repairs
55	32	Hotels and restaurants
60	33	Land transport; transport via pipelines
61	34	Water transport
62	35	Air transport
63	36	Supporting & auxiliary transport activities; activities of travel agencies
64	37	Post and telecommunications
65+66+67	38	Finance and insurance
70	39	Real estate activities
71	40	Renting of machinery and equipment
72	41	Computer and related activities
73	42	Research and development
74	43	Other Business Activities
75	44	Public administration and defence; compulsory social security
80	45	Education
85	46	Health and social work
90-93	47	Other community, social and personal services
95+99	48	Private households and extra-territorial organisations

OECD Bilateral Trade Database by Industry and End-Use Category

The OECD is currently developing estimates of *Bilateral Trade Database by Industry and End-Use Category* (BTDIxE), 1988-2009, derived from OECD's International Trade by Commodities Statistics (ITCS) database and UN Comtrade database, where values and quantities of imports and exports are compiled according to product classifications and by partner country (Figure 1 for world export structure of 2009 and for evolution of export structures for selected countries).

Figure 1. Export share by industry and category (World, 2009)

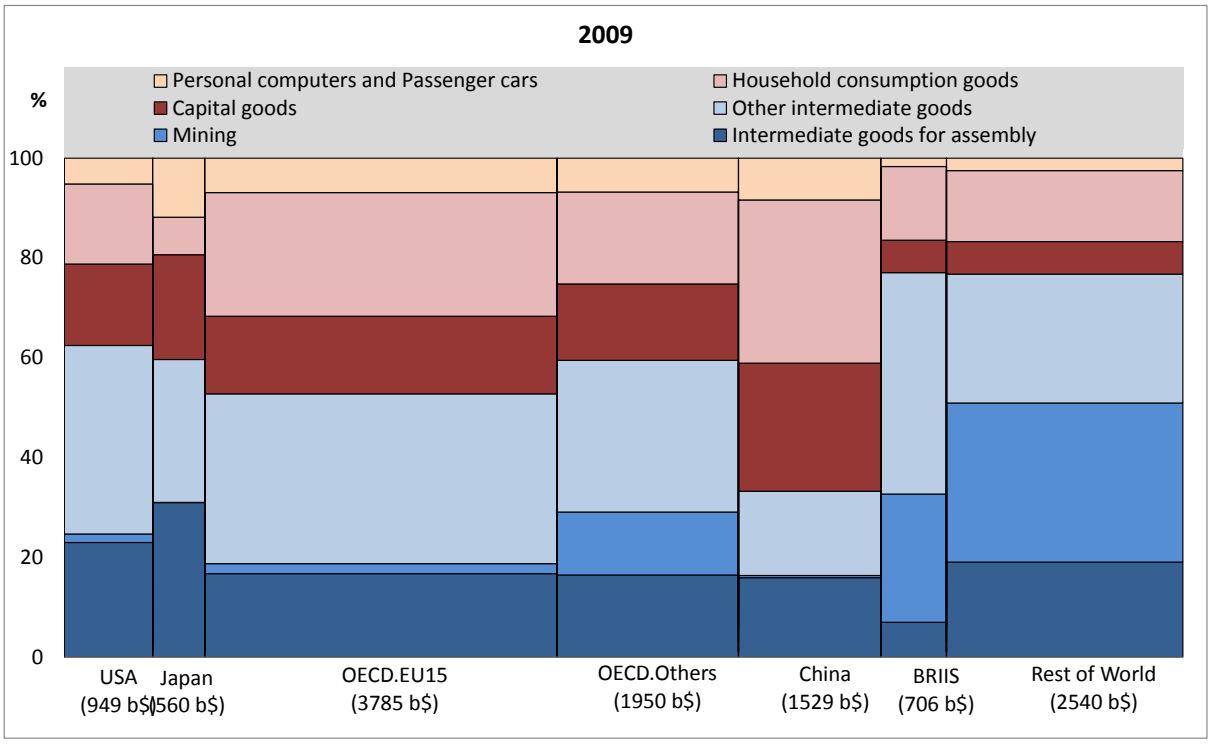
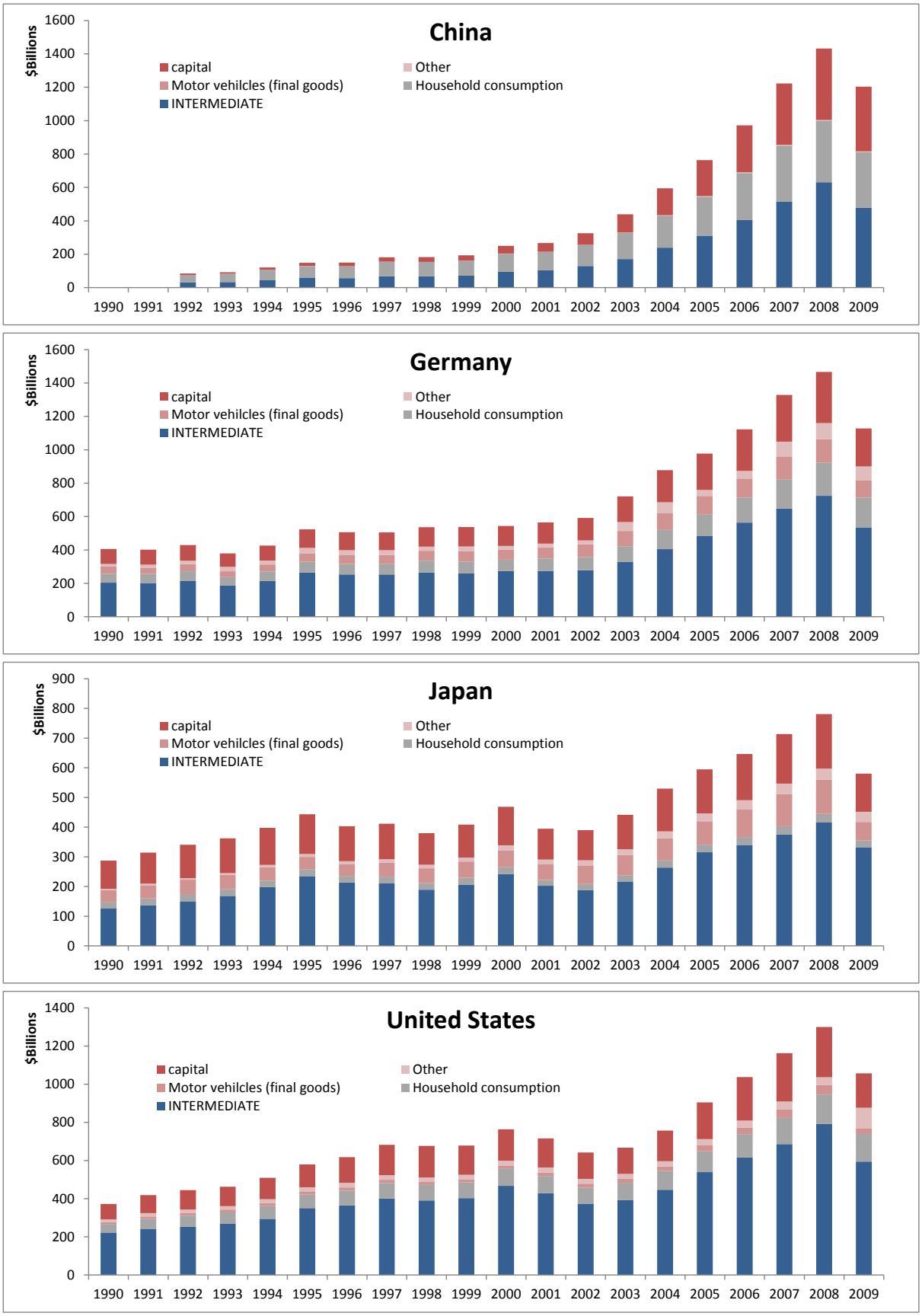


Figure 2. Export share by industry and category (China, Germany, Japan and United States)



The OECD International Trade by Commodities Statistics (ITCS) database is updated on the basis of annual data submissions received from OECD Member Countries as well as from Chinese Taipei and, in some cases, from EUROSTAT. Due to the convergence of OECD ITCS and UN Comtrade[5] updating processes, data sharing and other related co-operation between the two organizations, tables can also be computed for non-OECD members as declaring countries, notably the countries which belong to the OECD Enhanced Engagement Program, namely Brazil, China, India, Indonesia and South Africa.

In ITCS and UN Comtrade, data are classified by declaring country (i.e. the country supplying the information), by partner country (i.e. origin of imports and destination of exports), and by product (i.e. according to Harmonized System (HS)). In both data sources, trade flows are stored according to the product classification used by the declaring country at the time of data collection. In general, source data are held according to Standard International Trade Classification (SITC) Rev. 2 for the time period 1978-1987, the Harmonized System (1988) for 1988-1995, HS Rev. 1 (1996) for 1996-2001, HS Rev. 2 (2002) for 2002-2006 and HS Rev.3 (2007) from 2007 onwards.
To generate estimates of trade in goods by industry and by end-use category, 6-digit product codes from each version of HS from ITCS and COMTRADE were assigned to a unique ISIC Rev.3 industry and a unique end-use category according to the Broad Economic Categories (BEC) classification - and hence SNA basic classes of goods. Thus, 8 sets of conversion keys were estimated by using classification correspondence tables, developed internally by the OECD Science Technology and Industry Directorate, and available classification correspondence tables published by UNSD.

2.3 Benchmark year tables

The process of compiling OECD's I-O database greatly depends on cooperation with national statistical institutes. Methodology for transformation to the harmonized industry-by-industry tables depends on the availability of data sources. Some countries have been able to provide symmetric industry-by-industry I-O tables at basic prices in ISIC Rev.3 based classification, whereas others have only been able to provide supply and use tables and symmetric product-by-product I-O tables.
Industry-by-industry format is chosen because of these reasons (Yamano and Ahmad, 2006)

[5] http://unstats.un.org/unsd/comtrade/.

Harmonized industry analysis using other industry-based database e.g. OECD STAN, labor statistics, and R-D expenditures.
Policy focus. Many OECD database are fundamentally concerned with industrial structures
Simplicity of the conversion techniques. No negative number in estimated symmetric industry-by-industry table is produced by the converting methodology using fixed product sales structure assumption.

The process of transformation is described as follows.

Available data sources	Symmetric I-O (i x i) e.g. NLD, DNK, CAN	Supply (or make) and Use (or input)tables e.g. USA (interpolate)	Symmetric I-O (pxp) and Supply (make) table e.g. JPN, DEU, FRA
Confidential values	If necessary (fill the missing cells by biproportional method)		
Convert to basic prices	If necessary (estimating tax and transport margins information)		
Separate domestic and import matrices	If necessary (straight forward proportional, BEC based intermediate, household consumption and capital		
Convert SUT to Symmetric		Using fixed product sales structures	
Sector concordance	Preparation of sector concordance table between ISIC Rev.3 and national system		
Sector aggregate	Sector aggregate to OECD harmonized sector level		

i x i: industry-by-industry, p x p : product-by-product
References: Eurostat (2008) and United Nations (1999)

2.4 Development of inter-country I-O model.

The similar methodology of Asian Input-Output database at IDE-Jetro is applied to evelop the inter-country input-output model by linking the national input-output tables and bilateral trade data. The rest of estimation procedures are summarized as follows.

a) Preparation of Input-Output tables for reference years using the latest published data sources e.g. supply and use tables, national account and trade statistics.
b) Preparation of bilateral merchandize data by end-use categories for reference years.

The published trade statistics are adjusted for *analytical* purposes (namely, confidential flows, re-exports, exclusion of waste and scrap products and manual adjustment of high-value valuables). Trade coefficients of utility services are estimated based on cross border energy transfer. Other trade coefficients of service sectors are based on OECD Trade in Services and UN Service Trade statistics. However, many missing flows are filled by econometric model estimates.

c) Conversion of c.i.f. price based import figures to fob price-based imports to minimize the inconsistency issues of mirror trade (import=export) in international I-O system.

d) Separation of import matrix of each country by *cleaned* trade coefficients

e) Total adjustment (missing sectors, trade with rest of the world, etc) Minimization of discrepancy columns by biproportional method.

f) Merged inter-country database to regional blocs

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