

The Methodology of Compiling APECSUTs with Discrepancy

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Abstracts: With the leadership of China and U.S and the collective effort of the 21 APEC economies, the official APEC TiVA database will be completed in the early 2019. It is the first official APEC database constructed in the framework of SUT and based on bottom-up approach with the participation of 21 APEC economies. This article describes the methodology and procedures on how to build APECSUTs with discrepancies based on official supply and use tables of 21 APEC economies. APECSUTs with discrepancies means the draft version of APECSUTs linked based on the international SUTs of each economy, and the trade flow in the APECSUTs SUT doesn't consistent with the trade data. Firstly, official supply and use tables submitted by 21 APEC economies are adopted, however, at present, supply and use tables are not available for most APEC economies, so, the SUT furthers of APEC economies are discussed and the methodologies of estimating and updating, price adjustment and import use matrix compiling by different categories of basic data also be introduced. Then, the linking process of the APECSUTs are discussed. The APECSUTs are available for the 2005 and 2012 with 51 products and give the values of transactions among 34 industries in 20 economies plus the rest of the world and from these industries to households, governments and users of capital goods in the same set of economies. The article describes how information from the National Accounts, Supply and Use Tables and International Trade Statistics have been harmonized, reconciled and used for estimation procedures to arrive at APECSUTs.

Keywords: APEC TiVA, SUT, inter-regional input-output model

This paper provides the available SUTs/IOTs of APEC economies and technical details on estimating the SUTs/IOTs of each economy and APECSUTs with discrepancy in benchmark years of 2005 and 2012 for the APEC TiVA database initiative. It consists four sections: section one summarizes the available SUTs or IOTs for each APEC economy; section two presents the general methodologies of estimating SUTs of each economy; section three presents the linking process of APECSUTs with discrepancy and section four summaries the data characteristics and estimation methods.

1. The Data Situation of APEC Economy

After two rounds of data submission, 19 APEC economies submit the needed SUTs or IOTs

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(except the Philippines and Papua New Guinea). Ten economies submitted the supply table at basic price, use table at both basic and purchaser's price and import use matrix at CIF in both two benchmark years, and other economies either submitted at least one benchmark year's SUTs or co-estimated with the CTTF. For Singapore, Department of Statistics does not compile use tables at purchasers' prices. They directly compile use tables at basic prices, the use tables at purchasers' prices are unavailable. PNG didn't submit any data, so CTTF estimated the IO tables at basic and purchaser's price in two benchmark years. The detailed available data situation can be seen in the table one.

2. Methodologies of Main Processes of Estimating SUTs of Each Economy

To get the harmonized national SUTs is the first step of compiling APECSUTs, the process of estimating SUTs at basic price of each economy including following main steps:

(1) Updating/estimating SUTs at purchaser's price

For most economies, the supply table records outputs at basic prices but has also the valuation adjustment matrix that translates outputs at basic prices to those at purchasers' prices, the use table is at purchasers' prices. The supply table and use table can be updated separately by using the popular RAS method. However, the traditional RAS method requires the data of supply totals by products which are not available for most APEC countries. Therefore, we suggest using the so-called SUT-RAS method which can jointly updates the SUTs and does not require the data of supply totals by products (Temurshoev and Timmer, 2011). This method is also used in the construction of WIOD database.

Besides the supply table (at basic prices and includes the transformation into purchasers' prices) and the use table (at purchasers' prices) in the benchmark year, the information required for updating SUTs are summarized in Table 1. Figures in the grey area are to be estimated and figures in the remaining area are required information in the projection year (except the gross output by product \mathbf{q} , which is determined endogenously).

Table 2 Required information for updating SUTs

	Product	Industry	Final demand	Total
Product		U (Intermediate use matrix)	Y (Final demand matrix)	q
Industry	V (make matrix)			x
Import	m' (Import vector)			M
	T (Valuation adjustment matrix)			t
Total	q'+c'	u' = x' - v' (Intermediate use totals)	y' (Final demand totals)	

Define

$$\bar{\mathbf{x}} = \begin{bmatrix} \mathbf{x} \\ M \\ \mathbf{t} \end{bmatrix} \text{ and } \bar{\mathbf{u}} = \begin{bmatrix} \mathbf{u} \\ \mathbf{y} \end{bmatrix}$$

and further define $z_{ij} \equiv x_{ij} / a_{ij}$, where x_{ij} is the element to be estimated and a_{ij} is its corresponding element in the benchmark year (known). For $a_{ij} = 0$, set $z_{ij} = 1$.

Define sets $s_1 = \{\text{products}\}$, $s_2 = \{\text{industries, final demand categories}\}$, $s_3 = \{\text{industries, total import, margins and next taxes on products}\}$. Then, the SUT updating task can be modeled by solving constrained optimization problem.

(2) Estimating Supply-Use Tables Valued at Basic Prices

Estimating supply-use tables valued at basic prices bases on harmonized and benchmarked national use tables valued at purchasers' prices, this process aims to transform use tables valued at purchasers' prices into basic prices.

The difference between purchasers' prices and basic prices is described as follows:

$$\begin{aligned} \text{basic prices} &= \text{purchasers' prices} - \text{Trade margins} - \text{Transport margins} \\ &\quad - \text{Taxes and duties on imports} - \text{Tax on products} \\ &\quad + \text{Subsidies on products} \end{aligned}$$

In short, the equation is:

$$\text{basic prices} = \text{purchasers' prices} - \text{margin} - \text{net taxes}$$

Margins and taxes mentioned above are usually called the valuation matrices in the supply and use framework. More concretely, valuation matrices comprise information on trade margins, transport margins, taxes on products and subsidies on products.

Some APEC economies have uploaded margin matrices and net matrices in detail but some not, which makes the estimating process a little different (Figure 1). If the economy has uploaded the detailed data, which is called the ideal scenario, we will obtain use tables valued at basic prices by deducting margin matrices and taxes matrices directly. On the contrary, if the economy only uploaded the total amount of each item in supply tables, which we call it the general scenario, the valuation matrices need to be estimated first.

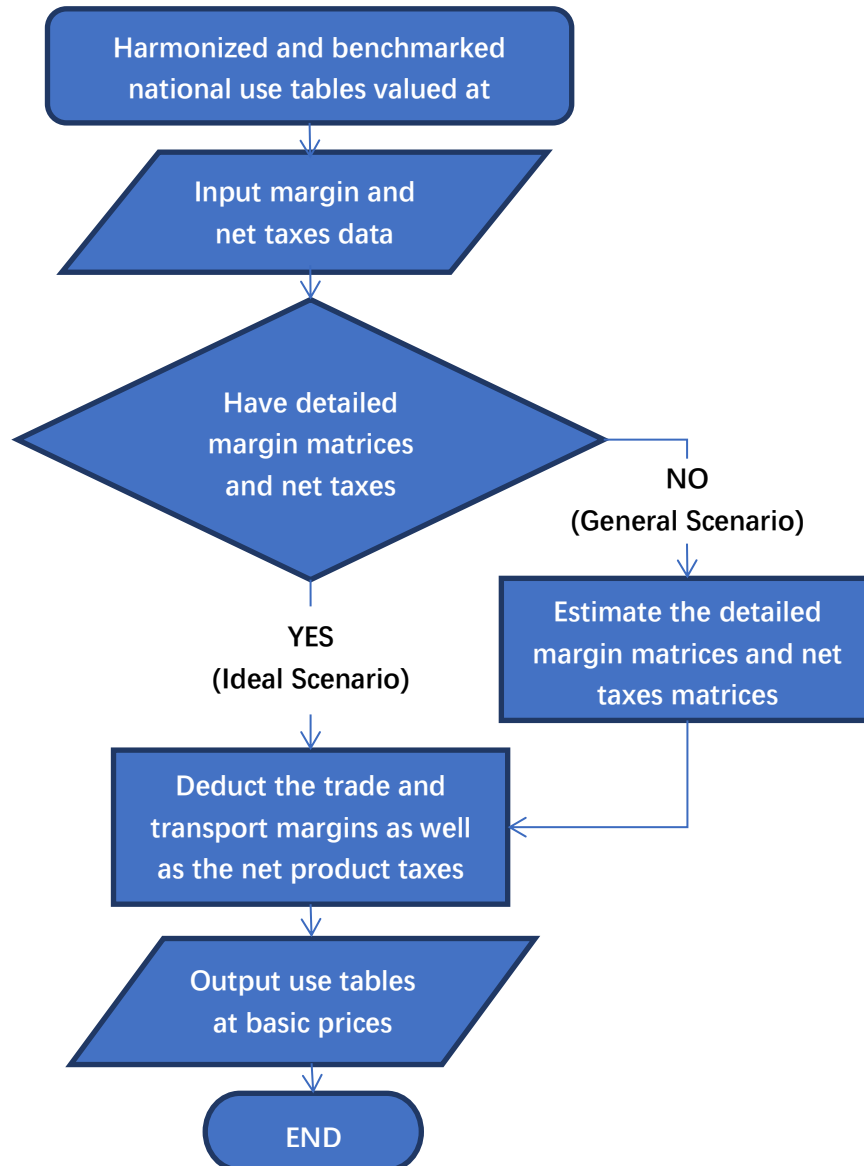


Figure 1: Flow chart of estimating use tables valued at basic prices

A. The ideal scenario

Ideal scenario means all matrices we need to estimate use tables valued at basic prices are known, including trade margin matrices, transport margin matrices and taxes less subsidies on products matrices. What we need to do in the ideal scenario is deducting the related matrices from use tables valued at purchasers' prices.

B. The general scenario

General scenario means the detailed matrices we need to estimate use tables at basic prices are not available. According to the 2nd round data submission, most economies did not upload detailed data, and what we can obtain is a vector of the total amount. So, we need to estimate these matrices before deducting. In the general scenario, we will use RAS method to get the margin matrix and tax matrix.

When we estimate these related matrices, we assume that each kind of product shares the same margin rate and tax rate whatever the industry (or final use) it was used, for we don't have more information about the distribution of margins and taxes. The matrices estimation processes are as follows:

Tax matrix

Tax here means taxes less subsidies on products. Because we don't have additional information about the distribution, taxes are shared in proportion of usage. The sum of each column is a new added row called taxes less subsidies on product. We don't need to use RAS method to balance the matrix, for there is no restriction on columns. According to the assumption above, we can get the taxes rate for each product:

$$taxr_i = \frac{Tax_i}{Xtb_i}$$

Then the initial values of taxes matrix are calculated:

$$Tax_{ij}^0 = taxr_i \times U_{ij}, Tax_{ik}^0 = taxr_i \times F_{ik}$$

Table 3: Construction of tax matrix

	Industries	Final uses	Total
Products	Tax_{ij}^0	Tax_{ik}^0	Tax_i
Total: taxes less subsidies	$\sum_i Tax_{ij}^0$	$\sum_i Tax_{ik}^0$	

Margin matrix

Margin here contains trade margin and transport margin. Margins also are shared in proportion of usage. The sum of the margin matrix rows is the total margin for each product, and the sum of the margin matrix columns is total margin for each industry (which is known as zero).

At first, the margin rate can be calculated:

Trade margin rate computed from supply table: $trmr_i = \frac{Tr_i}{Xtp_i}$

Transport margin rate computed from supply table: $tpmr_i = \frac{Tp_i}{Xtp_i}$

Then the initial values of the margin matrix are calculated as:

$$Trm_{ij}^0 = trmr_i \times U_{ij}, Trm_{ik}^0 = trmr_i \times F_{ik}$$

$$Tpm_{ij}^0 = tpmr_i \times U_{ij}, Tpm_{ik}^0 = tpmr_i \times F_{ik}$$

Table 4: Construction of trade margin matrix

	Industries	Final uses	Total
Products	Trm_{ij}^0	Trm_{ik}^0	Tr_i
Total	0	0	0

Table 4: Construction of transport margin matrix

	Industries	Final uses	Total
Products	Tpm_{ij}^0	Tpm_{ik}^0	Tp_i
Total	0	0	0

But the sum of the columns (initial value) may not satisfy the column restrictions:

$$\sum_i Trm_{ij}^0 = 0, \sum_i Trm_{ik}^0 = 0, \sum_i Tpm_{ij}^0 = 0, \sum_i Tpm_{ik}^0 = 0$$

So, in the construction of margin matrix, RAS method would be used to make the matrix satisfied both the row restrictions and the column restrictions. Then we obtain the balanced margin matrix.

(3) *Compiling and adjusting import use table at basic price*

Import use table is the basic information of compiling APEC-SUTs, most APEC economies didn't provide the import use table along with the SUTs, so after harmonizing and updating the SUTs with national account and adjusting the SUTs prices from purchasers' price to basic price, the import use table should be prepared.

Compiling and adjusting import use table at basic price includes following processes: compiling import use table at CIF prices plus import duties; estimating import use table at FOB_{pp}; and constructing the international import use table with trade partners and estimating international import use table at FOB_{bp}.

A. Some concepts of import price

In general national accounting, the price of export goods is FOB, and the price of import goods is CIF. For the exporter, FOB is the consumer price, and for the importer, CIF is the basic price, plus import duties and product taxes, minus subsidies to obtain the producer price of the importer, and further plus the transportation and trade margin to obtain the consumer price of importer. However, in the perspective of international trade, CIF is not the real "basic" price of import as it contains the international transport and insurance, and certain domestic transport margin and taxes of exporter, as a result, the basic price of import should be traced back to the ex-factory price of exporter, the price change of imports can be shown in the figure below:

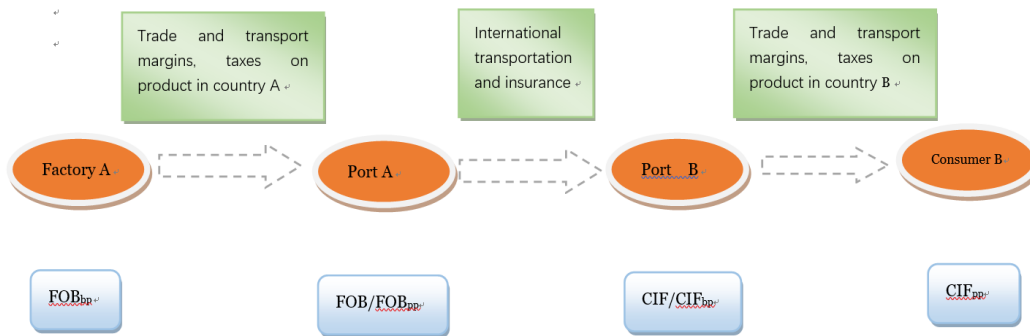


Figure 2: The price change of import in the international trade

B. The process of Compiling and adjusting import use matrix at basic price

Step one: Compiling import use tables at CIF prices plus import duties

In this process, import use structure is the key information to estimate the import use matrix, and what we should do is maximum utilization of information from the economy, NA account, SUTs, IOTs and any other information sources to get the structure. In ideal situation, economy has import use structure by product from survey, and we apply the structure to distribute the import column into import matrix. However, most of APEC economies don't have the structure directly, and the following two scenarios are the most common situation for APEC economies:

- ① Having import use matrix in non-benchmark years, adopting the import use structure from the most recent benchmark year to estimate the import use matrix of benchmark year.
- ② No more available data outside of supply-use framework, adopting import proportionality approach combined with BEC end use categories. Using imports and import duty columns from supply tables as total control, combined with BEC end use categories to disaggregate import into intermediate, final and capital goods (each economy can adjust the categories by its' situation) and calculate the import tax rate; then, based on the national account data (such as survey on use of import goods), estimate the import use structure and derive the import use tables on CIF prices that include import duties. Thirdly, deduce the above import use tables from use tables and derive the final domestic use tables.
- ③ Regarding re-exports, if by product, the sum of intermediate and final use of one economy is larger than imports, we assumed there were no re-exports. If not, we assumed re-exports incurred, and that by product, the import rate of exports equals to the import rate of total supply at basic price. We also sought the comments from each economy so that we could adjust re-exports by product to be more consistent with NA data and trade statistic.

Step two: Estimating import use table at CIF prices

Based on the import use tables derived by the step one, combined with the import tax rate which is calculated by the use imports and import duty columns from supply tables to take import duties out and convert the import use table to CIF price basis.

Step three: Estimating import use table at FOB_{PP}

The difference between CIF and FOB_{PP} is the international transports and insurance, so we adopted CIF-FOB margin rate by economies and products estimated by OECD to estimate the goods international transports and insurance, and then obtain the import at FOB_{PP}.

More generally, most APEC economies are lack of import duty and specific taxes on imports, and import use structure on intermediate use and final consumption based on business survey. So, the import duty rate on products from the similar economies can be an alternative solution on the condition of absencing import duty, and domestic use structure or import use structure by product of similar economies should be considered as a substitute.

3. Compiling international SUTs and constructing APECSUTs with discrepancy

This section describes how the international of each economy and APECSUTs with discrepancy are compiled. Firstly, using the import share of goods and service by product and economy from the adjusted, benchmarked, harmonized, balanced trade statistics (balanced and calculated by trade work stream), we got the international SUTs of each economy and; then the international SUTs have been merged into APEC SUT. In this part, the APECSUTs contains 20 APEC economies (except PNG, as there is no available data to compile the SUTs), other economies are defined as rest of the world (RoW), which is exogenous in APECSUTs. In the processing of merging the international SUTs to APECSUTs, the column export to RoW was derived as a residual, it equals to total use minus domestic use and export to APEC economy by product. All measurement errors, aggregation biases, inconsistencies between National Accounts and ITS, and other problems that pertain to the trade flows among the APEC economies tend to accumulate in the residual, in particular, it is possible that exports to ROW when measured residually become negative, so this kind of use table we called is APECSUTs with discrepancy. Absolutely, this is undesirable in a normal regional use table, and in the following chapter will introduce the balance process of how to get the final APECSUTs and APECIOTs.

4. The Summaries of the Data Characteristics and Estimation Methods

This section described the characters and issues of submitted SUTs/IOTs, and introduce the special treatment of estimating SUTs/IOTs for each economy. The national SUTs harmonized with national account is the basic data for compiling APECSUTs, unlike the developed economies having the better system of compiling SUTs, the situation in most APEC economies is much more complicated, four main issues existed in the submitted underlying data:

(1) lacking of the initial building blocks for some economies, it means there is no national SUTs at basic or purchaser's price or import use matrices in both benchmark and non-benchmark years;

(2) the inconsistency between total control in SUTs and national account, such as output, value added, exports, imports, final demand categories, margins and taxes;

(3) non-benchmark year SUTs, it means some economies only submit the SUTs or IOTs in non-benchmark year;

(4) the inconsistency of classification and currency between each economy and APEC TiVA.

The SUT work stream of APEC TiVA Core Technical Task Force (CTTF), consists of four teams of SUT professionals from China and the United States, worked in collaboration on processing available data in estimating all APEC member economies' SUT/IOTs. Besides the above standard methods, various other estimation techniques and processes are adopted depending on the availability of SUT data submissions by member economies, and efforts were made in seeking data from other sources when limited or no data were submitted. The SUT estimation methodologies and techniques can be summarized in the following:

- (1) Eleven APEC economies (Australia, Canada, China, Hong Kong, China, Indonesia, Malaysia, Russia, Singapore, Chinese Taipei, Thailand, and the United States) submitted all or most of SUT data for two benchmark years 2005 and 2012. Most of these data are consistent to APEC industry and product classifications and valuation requirements, the submitted SUT data are validated and processed with or without minor adjustments. The values of original data are converted from local currency to millions of US dollars, using IMF published exchange rates or the advised exchange rates by economy of reference benchmark years.
- (2) Five APEC economies, South Korea, Japan, Mexico, New Zealand, and Vietnam, submitted partial benchmark year SUT data, the estimation methods utilized the submitted data in projecting the missing benchmark SUTs, linking other source data of the estimated benchmark year. The processes included adjusting submitted data to APEC required format, such as transforming industry/product classifications to APEC classifications, estimating other SUT components, and techniques in balancing SUTs.
 - Whatever the partial benchmark year SUT data has been submitted, the first step is to make the concordance table between APEC and economy in missing benchmark year. This is one of the biggest challenges for CTTF, as there is no enough information for disaggregating the sectors, so we aggregated the mixed sectors in one sector and set the other relative sectors to zero so as to keep the total controls in SUTs consist with NA.
 - Japan and South Korea are the most representative economies in the Asia-pacific region that have good system of compiling IOTs and lacking the experience of compiling SUTs. So maximizing the use of IOTs information is the key process of SUTs' estimation. For South Korea and Japan, except the SUTs of partial benchmark year, information of SUTs in non-benchmark year and IOTs can also be adopted in the process of estimation. SUTs of South Korea in 2005 has been estimated based on IOTs of 2005 at basic and purchaser's price, and the import use table was estimated also based on the import structure of import use IOT in 2005. For Japan, the situation is much

more complicated, the producer's value supply table and "purchaser's " use table were estimated mainly by using U and V matrices and related information released by Cabinet Office, then, estimated supply table at basic price and use table at purchaser's price.

- Except the normal necessary data, data from North American Trade in Value Added (NA-TiVA), ADB for Mexico and Vietnam are also adopted in the process of updating, and the SUT-RAS, G-RAS and other integrated RAS balancing approaches are used in the updating process for these five economies.
- (3) Three APEC economies, Brunei, Chile, and Peru, submitted no benchmark year data but other year. The SUTs in benchmark year were estimated by using SUT-RAS approach or integrated RAS balancing approach, together with integrating national accounts data of both benchmark and non-benchmark years and the structure information from data of submitted non-benchmark year.
- (4) Two APEC economies, Philippines and Papua New Guinea did not submit data to APEC. Estimating their SUT/IOT using unofficial data that are available from research institutes that provide SUT/IOT for economies through economic modelling.
- For Philippines, most of the required data for SUTs' construction were not submitted. Therefore, the CTF used the IOTs in 2005 and 2012 from PSA and OECD, SUTs in 1994 from PSA and national account data from PSA, UN and WB as the alternative data foundation. Based on the assumption, using make table to estimate supply table, then using the IOT and estimated supply table to estimate use tables. In this process, the margin rates of Vietnam, Thailand and Indonesia were also referenced when estimated the margin as there was on further information of Philippines. Integrated RAS balancing approach was adopted in the process of balancing all the matrixes.
 - PNG did not submit data to APEC. Therefore, the APEC technical team looked for alternative source data for estimating the PNG input-output tables, instead of estimating the SUTs. So in the APECSUTs with discrepancies, PNG was exogenous, and in the balanced APECIOTs it was endogenous. APEC technical team searched and found the 1999 to 2012 PNG input-output (I-O) tables that were estimated in the EORA database. The EORA multi-region input-output table (MRIO) database provides a time series of high resolution I-O tables with matching environmental and social satellite accounts for 187 countries. The PNG IOTs are in basic and purchasers' prices, with 26 sector classifications, FIJI industry output structure of ADB SUTs database are also adopted. Integrated RAS balancing approach was adopted in the process of estimating all the matrixes.

Table 1. The available SUT/IOTs of APEC economy

APEC economy	2005				2012			
	Supply	Use (pp)	Use (bp)	Import use (CIF)	Supply	Use (pp)	Use (bp)	Import use (CIF)
Australia	*	*	*	*	*	*	*	*
Brunei	√	√	√	√	√	√	√	√
Canada	*	*	*	*	*	*	*	*
Chile	√	√	√	√	√	√	√	√
China	*	*	*	*	*	*	*	*
Chinese Taipei	*	*	*	*	*	*	*	*
Indonesia ⁽¹⁾	*	*	*	*	*	*	*	*
Hong Kong, China	*	*	*	*	*	*	*	*
Japan ⁽²⁾	√	√	√	√	*	*	√	√
S. Korea	√	√	√	√	*	*	*	*
Malaysia	*	*	*	*	*	*	*	*
Mexico	√	√	√	√	*	*	*	*
New Zealand ⁽³⁾	√	√	√	√	*	√	*	√
PNG (IOT)	√				√			
Peru	√	√	√	√	√	√	√	√
Philippines ⁽⁴⁾	√	√	√	√	√	√	√	√
Russia	*	*	*	*	*	*	*	*
Singapore	*		*	*	*		*	*
Thailand	√	√	√	√	*	*	√	√
USA	*	*	*	*	*	*	*	*
Vietnam	√	√	√	√	*	*	*	*

Note:

√: Data or documentation was estimated or prepared by CTTF

*: Data was submitted by economy

(1) The SUTs of Indonesia are compiled by of BPS of Indonesia together with CTTF

(2) Japan only submitted the supply table at producer's price and use table at "purchaser's" price in 2012, which the output and value added by industries are at producer's price.

(3) New Zealand has submitted 2013 SUTs at basic prices in NA06CC. CTTF transformed these tables into APEC classification and estimated the use tables at purchasers' prices.

(4) Philippines' SUTs for 2012 are at producers' prices for the lack of essential information data.