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Handbook of National Accounting

Handbook of Input-Output Table Compilation and Analysis

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NOTE

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Preface

The Statistical Commission of the United Nations has been concerned with conceptual or practical difficulties in the implementation of the System of National Accounts (SNA) since it was introduced in 1968. At its 1983 session, the Commission agreed that the SNA should be revised with the specific objectives of clarifying it and harmonizing it with related statistical systems rather than modifying it. Since 1986, many expert group meetings have been convened by the United Nations jointly with other international organizations including the International Monetary Fund (IMF), the Organisation for Economic Cooperation and Development (OECD), the World Bank and the Statistical Office of the European Communities (EUROSTAT), to make specific recommendations to revise the 1968 version of the *System of National Accounts, Studies in Methods* (ST/STAT/SER.F/2/Rev.3, Sales No. E.69.XVII.3). Their recommendations, a major advance in national accounting, have been incorporated into the *System of National Accounts 1993* (ST/ESA/STAT/SER.F/2/Rev.4, Sales No. E.94.XVII.4). Adoption of the 1993 SNA was unanimously recommended to the United Nations Economic and Social Council by its Statistical Commission at its twenty-seventh session, held in New York from 22 February to 3 March 1993. The Council recommends that Member States consider using the 1993 SNA as the international standard for the compilation of national accounts statistics to promote the integration of economic and related statistics, as an analytical tool, and in the international reporting of comparable national accounting data.

This Handbook is issued as part of a series being developed by the member organizations of the Inter-Secretariat Working Group on National Accounts (ISWGNA).[1] Their general objective is to support the implementation of the 1993 SNA through further elaboration of concepts with regard to specialized areas of national accounting, discuss existing and new compilation methodologies to measure the concepts of the specific field dealt with in each Handbook, and finally present illustrative examples of analytical and policy uses of the concepts. The relative extent to which each of the three elements is dealt with differs between the Handbooks: Some focus more on conceptual issues, others detail compilation methodologies, while a third group may focus on particular analytical and policy uses.

This Handbook is more than a revision of the United Nations publication entitled *Input-Output Tables and Analysis* (ST/STAT/SER.F/14/Rev.1, Sales No. E.73.XVII.11), which was published by the United Nations in 1973. It was almost entirely rewritten by Vu Quang Viet, a staff member of the United Nations Statistics Division (UNSD), in the Department of Economic and Social Affairs (DESA), under the general guidance of Jan W. van Tongeren, taking into account more recent developments. A draft of this Handbook had been sent to international organizations and many I/O experts for comments. The draft was then revised taking into account these comments as far as possible. Valuable comments were received from Erling Flottum of Statistics Norway; Jean-Etienne Chapron of Institut national de la statistique et des études economiques (INSEE), France; S.J. Keuning of Statistics Netherlands; Norbert Rainer, Austrian Central Statistical Office; Thijs ten Raa of Tilburg University, the Netherlands; Felizardo Suzara of UNSD; and Willem van den Andel. The Handbook deals with an area of concepts, compilation and analysis which has

[1] To date the following have been published: *Balance of Payments Manual* (IMF, 1993); *Balance of Payments Compilation Guide* (IMF, 1994); *Handbook on Integrated Environmental and Economic Accounting* (ST/STAT/SER.F/6, Sales No. E.93.XVII.12); *Handbook on Inflation Accounting* (OECD, 1996); *Handbook on System Accounting: Use of the System of National Accounts in Economies in Transition* (ST/ESA/STAT/SER.F/66, Sales No. E.96.XVII.11); and *A System of Economic Accounts for Food and Agriculture* (FAO, 1996).

been developed in great detail by many economists, who generally were not national accountants. However, it is not the objective of the Handbook to give an overview of all these developments. Instead, its focus is on the much more recent conceptual and analytical integration of input-output tables within the national accounting system, which was largely accomplished in the 1968 SNA, but was further developed and refined in the 1993 SNA.

By integrating input-output tables and analysis with national accounting, an additional use of input-output in national accounts compilation is added to the many analytical uses that have been developed since Leontief created the analytical I/O model. This is the statistical use of so-called supply and use tables, a special non-symmetric format of I/O tables first developed in the 1968 SNA, which is used to check the internal consistency of data on production and products.

Part One of the Handbook is devoted to the analytical foundation of I/O analysis, the SNA accounting and statistical foundation of I/O tables, and the methods of converting the supply and use tables into a single symmetric I/O table. In this context, a bridge is made between the terminology used by input-output specialists and the terminology developed in the 1993 SNA.

Part Two focuses on the compilation aspects of the supply and use tables with further elaborations on the SNA concepts. Included here are compilation of production accounts (output, intermediate consumption, value added), of final demand and imports, table balancing and updating. This part tries to be as comprehensive as possible in presenting SNA concepts within the context of compiling the supply and use tables so as to lessen the need by compilers to go back and forth checking with the 1993 SNA. However, this part does not enter into the data resources in much detail; for that aspect the reader is referred to a handbook of national accounting issued by the United Nations in 1986.[2]

Part Three presents a few applications of input-output tables and models dealing with price deflation and annual national accounts estimates, impact analysis and pollution study. The scope of this part of the Handbook is obviously not complete in respect of the extensive literature in this field. It is generally restricted to the use of input-output in dealing with basic economic issues and does not enter into much detail on I/O topics such as productivity and price analysis, analysis of energy consumption, use of I/O in economic projections and forecasting, regional, interregional and international I/O tables or their use in production and trade modelling, dynamic input-output analysis, etc. These types of studies normally require highly advanced mathematical techniques that cannot easily be covered in depth in this Handbook. For information on these advanced uses of I/O techniques the reader is referred to the numerous textbooks, books of readings on input-output economics and numerous articles published in economic journals.[3]

The Handbook includes numerous examples which clarify many difficult concepts and methods of economic compilation. Readers are advised to go through the examples in order to obtain a better

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[2]*Handbook of National Accounting, Accounting for Production: Sources and Methods* (ST/STAT/SER.F/39, Sales No. E.86.XVII.11) is outdated in concepts but it contains valuable discussions on data sources and estimation techniques.

[3]To look for references of articles published in economic journals and books, readers should consult the *Journal of Economic Literature*, classification 222, published by the American Economic Association. Current economic research using I/O, besides other economic journals, may be found in *Economic Systems Research*, published by the International Input-Output Association.

understanding of these concepts and methods. Furthermore, since economic analysis using input-output tables involves the manipulation of large matrices, readers are encouraged to work through these examples using a computer with the help of APL, LOTUS and EXCEL. The two latter softwares can easily manipulate matrices with up to 60 sectors.

Main Abbreviations

C.i.f./f.o.b.	Cost, insurance and freight / free on board
CCIS	Cross-classification between Industries and Sectors
COFOG	Classification of the Function of Government
COICOP	Classification of Individual Consumption by Purpose
COPNI	Classification of the Purposes of Non-profit Institutions serving Households
COPP	Classification of Outlays of Producers According to Purpose (COPP)
CPC	Central Product Classification
FISIM	Financial Intermediation Services Indirectly Measured
GDP	Gross Domestic Product
I/O	Input-Output
ISIC	International Standard Classification of All Economic Activities
NPISHs	Non-profit Institutions serving Households
PIM	Perpetual Inventory Method
R&D	Research and Development
SAM	Social Accounting Matrix
SIOT	Symmetric Input-Output Table
SNA	System of National Accounts
SUT	Supply and Use Tables
VAT	Value Added Taxes

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PART ONE

ANALYTICAL AND STATISTICAL FOUNDATION OF INPUT-OUTPUT MODEL

I. BASIC INPUT-OUTPUT SYMMETRIC MODEL (SIOT)

A. Historical background

1.1. Input-output (I/O) analysis as a theoretical framework and an applied economic tool in a market economy was developed by Wassily Leontief with the construction of the first input-output tables for the United States for the years 1919 and 1929 which were published in 1936. Since then, tables describing the interrelationships among various producers of an economy have been constructed for over 90 countries. For the development of input-output methodology and its application to important economic issues, Leontief was honored with a Nobel prize in Economic Science in 1973. The integration of an input-output framework into the system of national accounts was developed and published in 1968 by the United Nations as a *System of National Accounts, Studies in Methods*. The integrated work earned Professor Richard Stone, a Nobel prize winner in Economic Science in 1984 "for having made fundamental contributions to the development of the systems of national accounts and hence greatly improved the basis for empirical economic analysis".

B. A simple input-output framework

1.2. The fundamental contribution of input-output in economics is the transformation of Francois Quesnay's *Tableau Economique* - a descriptive device showing sales and purchases relationships between different producers and consumers in an economy - into an analytical framework which facilitates economic projections and analyses. It assumes that the inputs used in producing a product are related to the industry output by a linear and fixed coefficient production function (at least in the short run). Under this assumption, input and output relationships are transformed into technical relationships, with each column in an input-output coefficient table representing a technique of production.

1.3. In a simple, refined form based on the open system[1] originally designed by Professor Leontief, an input-output coefficient table represents, in each of its columns, a technique of production by which only one product is produced.[2] One may understandably argue against the application of so simple an assumption as the assumption of linear and fixed coefficients. However, the use of input-output economics can be justified on the notion that a technique of production will not change much over a short period and, even if it does change, the engineering data or statistical data collected by censuses on inputs utilized by an industry, which represent a new technology in an input-output column, can be obtained to replace the old column. Because input-output tables in theory can be in monetary units or in both physical and monetary units, the construction of such tables may be implemented independently of national accounts. In fact many economists have attempted to combine both physical and monetary units in an input-output table, especially with respect

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[1]An open system does not internalize every transaction in the economy. It treats part of the economic transactions in the economy, specifically final demand as exogenous.

[2]Because of the assumption that one industry produces only one product, the inter-industry transaction table, which is also called the table of intermediate consumption, must necessarily be not only square but also symmetric. The I/O model based on this table will be called symmetric I/O model or SIOT.

to energy and mineral products and therefore engineering data are quite useful to them. However, because input-output tables elaborated as supply-and-use tables in monetary terms have been found to be powerful tools for compiling production accounts in national accounts, they have been integrated into the United Nations System of National Accounts since 1968. This enhances the accuracy of input-output tables through the process of balancing supply and use of every commodity in a given economy as it is transacted in the market at different prices to different users. Because of the latter reason, the Handbook will focus mainly on the construction of an input-output table as part of a national accounting system, but the final product should satisfy the basic requirements of an input-output model.

1.4. The following parts of this chapter will explain the basic input-output economic model and some of its basic economic implications. For simplicity in presentation, the various elements of net final demand, which include final consumption expenditures and gross capital formation of the household sector, the government sector and the sector of non-profit institutions serving households and exports minus imports[3] will be considered as a single column vector and elements of value added, which are also referred to in economic literature as primary inputs, will be considered as a single row vector. It is also assumed that producers do not engage in any secondary production, i.e., they produce only their characteristic products or, in other words, one type of producers produces only one type of products. Thus, henceforth, no distinction will be made between industries and products.

1.5. An input-output table focuses on the interrelationships between industries in an economy with respect to the production and uses[4] of their products and the products imported from abroad. In a table form (see table 1.1) the economy is viewed with each industry listed across the top as a consuming sector and down the side as a supplying sector.

Table 1.1. A highly simplified input-output accounting framework

	Industries	Net final demand	Total output
Industries	F	Y	X
Value added (Primary inputs)	V		
Total input	X		

1.6. Table 1.2 below shows a simplified set of accounts distinguishing three producers and showing the

[3]Because imports are netted out, hence the term "net final demand" is used.

[4]It is important to note that purchases of goods and services by a producer should not be equated to usages or consumption since on the one hand part of current purchases may be held as stocks for future uses, and on the other hand, current consumption may exceed current purchases of input by the quantity or value of stocks which were bought in previous periods and are brought out for use in the current production period. This distinction between purchases and consumption is important for the balancing of input-output tables.

input-output flow matrix describing their transactions. The values in the square box represent intermediate consumption, i.e. uses of products as inputs in the production process.

Table 1.2. Input-output flow table and accounts

	Industry A	Industry B	Industry C	Final demand	Total output
Industry A	0	20	45	35	100
Industry B	30	0	30	140	200
Industry C	0	80	0	70	150
Value added	70	100	75		
Total input	100	200	150		

1.7. Input-output analysis became an economic tool when Leontief introduced an assumption of fixed-coefficient linear production functions relating inputs used by an industry along each column to its output flow, i.e., for one unit of every industry's output, a fixed amount of input of each kind is required. This fixed relationship is introduced in table 1.3. The entries in each column of table 1.3 are obtained by dividing the entries in the column by the total input of the consuming industry.

Table 1.3. Input-output coefficient table
Inputs per unit of output

	Industry A	Industry B	Industry C
Industry A	0.00	0.10	0.30
Industry B	0.30	0.00	0.20
Industry C	0.00	0.40	0.00
Value added	0.70	0.50	0.50

1.8. In the above table, for example, one unit of output of industry B requires 0.10 unit of output of industry A, 0.40 unit of output of industry C, and generates 0.50 unit of value added. Similarly, one unit of output of industry C requires 0.30 unit of output of industry A, 0.20 unit of output of industry B and generates 0.50 unit of value added. Thus, in order to produce output X_A, X_B and X_C, the amount of product A (output of industry A) required as intermediate input is equal to

(1.1) $0.00\, X_A + 0.10\, X_B + 0.30\, X_C$

1.9. Equation 1.1 calculates the total amount of product A used as intermediate input in the production process of an economy. If the remaining value of the same product left for net final demand, i.e. 35 in table 1.2 is further added to intermediate consumption, the total output of industry A is obtained in equation 1.2.

(1.2) $0.00\, X_A + 0.10\, X_B + 0.30\, X_C + 35 = 100$

It is possible to check the equality property of equation 1.2 by replacing the values of X_A, X_B and X_C in table 1.2 by their actual values. The results are shown in equation 1.3.

$$(1.3) \quad 0.00 \times (100) + 0.10 \times (200) + 0.30 \times (150) + 35 = 100$$

The utilization of products B and C as intermediate inputs of production may be similarly calculated. In general, the ratios shown in the box in table 1.2 could be written in more abstract terms, such as those in table 1.4, so that an input-output model may be formulated.

Table 1.4. Input-output coefficient table in more general terms

	Industry 1	Industry 2	Industry 3	Net final demand
Industry 1	a_{11}	a_{12}	a_{13}	Y_1
Industry 2	a_{21}	a_{22}	a_{23}	Y_2
Industry 3	a_{31}	a_{32}	a_{33}	Y_3
Value added	V_1	V_2	V_3	

The relationships in equations 1.1, 1.2, 1.3 using general terms of table 1.4 can be written as follows:

$$(1.4) \quad \begin{aligned} a_{11} X_1 + a_{12} X_2 + a_{13} X_3 + Y_1 &= X_1 \\ a_{21} X_1 + a_{22} X_2 + a_{23} X_3 + Y_2 &= X_2 \\ a_{31} X_1 + a_{32} X_2 + a_{33} X_3 + Y_3 &= X_3 \end{aligned}$$

In matrix form, equation 1.4 can be written as follows:

$$(1.5) \quad \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \times \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \end{bmatrix} = \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix}$$

1.10. In a more general form with n industry and n products, where a_{ij} stands for input i (product of industry i) used in the production of one unit of output of industry j, systems of equations 1.4 and 1.5 can be written as follows:

$$(1.6) \quad \begin{array}{lllllll} a_{11} X_1 & + a_{12} X_2 + & \ldots + & a_{1n} X_n & + & Y_1 & = X_1 \\ a_{21} X_1 & + a_{22} X_2 + & \ldots + & a_{2n} X_n & + & Y_2 & = X_2 \\ . & + \ . \ + & \ldots + & . + & & . & = . \\ a_{n1} X_1 & + a_{n2} X_2 + & \ldots & + \ a_{nn} X_n & + & Y_n & = X_n \end{array}$$

and in matrix form,

$$(1.7)\qquad \begin{bmatrix} a_{11} & a_{12} & \cdot & a_1n \\ a_{21} & a_{22} & \cdot & a_2n \\ \cdot & \cdot & \cdot & \cdot \\ a_{n1} & a_{n2} & \cdot & a_{nn} \end{bmatrix} x \begin{bmatrix} X_1 \\ X_2 \\ \cdot \\ X_n \end{bmatrix} + \begin{bmatrix} Y_1 \\ Y_2 \\ \cdot \\ Y_n \end{bmatrix} = \begin{bmatrix} X_1 \\ X_2 \\ \cdot \\ X_n \end{bmatrix}$$

The computation of the coefficient matrix can be described in the following mathematical form:

$$a_{ij} = \frac{F_{ij}}{X_j}$$

where F_{ij} stands for an element of the flow table as described in a square box of table 1.1. Equation 1.7 is usually written in matrix form, as

$$(1.8)\qquad AX + Y = X$$

1.11. Relationship 1.8 is the basic input-output system of equations. Matrix A is called the input-output coefficient matrix, vector X is the vector of output and vector Y is the vector of net final demand. The dimension (size) of matrix A is constrained only by the statistical information on inputs and outputs available to statisticians since some countries have constructed input-output tables of up to almost 500 industries.

C. The inverse matrix

1. Solution of an input-output model

1.12. Equations in the form of equation 1.8 are much more suitable to model-building or analysis. If the values of the coefficients and of net final demand are known, then it is possible to solve this set of simultaneous equations in order to find the level of output of various industries necessary to satisfy the specified level of net final demand.

1.13. Mathematically, the vector of output X in the system of equation 1.8 can be solved as follows:

$$(1.9)\qquad \begin{aligned} X - AX &= Y \\ (I - A)X &= Y \\ X &= (I - A)^{-1}Y \end{aligned}$$

where I stands for the identity matrix which is a square matrix where all the diagonal elements are equal to 1 and all other elements are equal to zero. $(I - A)^{-1}$ is the Leontief inverse which can be calculated with difficulty. At present, microcomputers can easily invert a matrix of a size greater than 200. The availability of microcomputers has facilitated the application of input-output analysis in developing countries.

1.14. However, as shown in equation 1.9, $(I - A)^{-1}$ is just a big black box without much economic meaning, and it is therefore important to explain the economic meaning of this inverse.

2. Economic interpretation of the inverse

1.15. The input structures represented by the A-matrix and discussed in previous sections of this chapter show the type and amount of various inputs each industry requires in order to produce one unit of its output but tell nothing about indirect effects. For example, the effect of the production of a motor vehicle does not end with the steel, tyres and other components required. It generates a long chain of interaction in the production processes since each of the products used as inputs needs to be produced and will, in turn, require various inputs. The production of tyres, for instance, requires rubber, steel and cloths, etc. which, in turn, require various products as inputs including the transport service provided by motor vehicles that necessitates the production of motor vehicles in the first place. One cycle of input requirement requires another cycle of inputs which in turn requires again another cycle. This chain of interactions goes into infinity. However, the sum of all these chained reactions is determined from the value of the Leontief inverse.

1.16. The chain of actions in a simplified form is illustrated in the following chart.

Direct effects ⇒ Direct inputs ⇒ Indirect inputs

Indirect effects

Direct effects initially results in the requirement for direct inputs which then require a chain of indirect inputs. The sum of direct inputs and indirect inputs is normally called indirect effects.

1.17. In chain reactions in input-output analysis, the first exogenous shock is assumed to be initiated by an exogenous increase in net final demand, like an increase in export demand, or an increase in fixed capital formation. This assumption is made mainly for the sake of simplicity of exposition. Actually, the first shock can happen anywhere. It can be an increase in domestic production of intermediate consumption to replace imports, an increase in indirect taxes, a change in technology represented by changes in input structures, etc.

1.18. In table 1.5, an initial increase in the net final demand of 1,000 units of product B is assumed.

Table 1.5. Direct and indirect inputs

	Initial increase in net final demand	Direct input	Indirect inputs					Total output
		Round 1	Round 2	Round 3	Round 4	...	Round n	
Formula	F	AF	$A^2 F$	$A^3 F$	$A^4 F$	...	$A^n F$	
A	0	100	120	11	16.8	...	...	257
B	1,000	0	110	36	12.1	...	...	1,171
C	0	400	0	44	14.4	...	...	468

1.19. The chain reactions generated by an increase in net final demand include a string of outputs. In the first round, it is the incremental output to meet the increase in net final demand. In the second round, it is the incremental output to meet the input requirement of production to meet the increase in net final demand. In the third round, it is the incremental output to meet the input requirement of the incremental output of the second round. The number of rounds goes on to infinity. Since the coefficient matrix A describes the input requirement of any increase in output, the chain reactions can be written as follows:

Exogenous shock		$\Rightarrow$	F	=	F
First round	F	$\Rightarrow$	A x F	=	AF
Second round	AF	$\Rightarrow$	A x AF	=	$A^2 F$
Third round	$A^2 F$	$\Rightarrow$	A x $A^2 F$	=	$A^3 F$
...	...	...	...		...
n^{th} round	$A^{n-1} F$	$\Rightarrow$	A x $A^{n-1} F$	=	$A^n F$
TOTAL IMPACT		$\Rightarrow$			$(I+A+..+A^n)F$

Total impact = gross outputs generated

$$= F + AF + A^2F + A^3F + \dots + A^nF$$

$$= (I + A + A^2 + A^3 + \dots + A^n)\, F$$

1.20. Table 1.5 includes the values of each round in the chain reactions to an exogenous shock on net final demand. The values of these rounds can be calculated as follows:

$$F = \begin{bmatrix} 0 \\ 1000 \\ 0 \end{bmatrix}$$

$$AF = \begin{bmatrix} 0 & .10 & .30 \\ .30 & 0 & .20 \\ 0 & .40 & 0 \end{bmatrix} x \begin{bmatrix} 0 \\ 1000 \\ 0 \end{bmatrix} = \begin{bmatrix} 100 \\ 0 \\ 400 \end{bmatrix}$$

$$A^2F = \begin{bmatrix} 0 & .10 & .30 \\ .30 & 0 & .20 \\ 0 & .40 & 0 \end{bmatrix} x \begin{bmatrix} 100 \\ 0 \\ 400 \end{bmatrix} = \begin{bmatrix} 120 \\ 110 \\ 0 \end{bmatrix}$$

Mathematically,

(1.10)[5] $$I + A + A^2 + A^3 + ... + A^n = (I - A)^{-1}$$

as n approaches infinity (or, more formally, as $n \rightarrow \infty$). However, it is not necessary to use the iterative approach used in equation 1.10 to calculate the Leontief inverse as there are other approaches that can calculate it directly. The Leontief inverse of the I/O coefficients in the example of table 1.3 is shown in table 1.6 below.

Table 1.6. The inverse matrix $(I\text{-}A)^{-1}$

	Industry A	Industry B	Industry C
Industry A	1.077	0.257	0.375
Industry B	0.351	1.171	0.340
Industry C	0.141	0.468	1.136

1.21. The inverse matrix $(I\text{-}A)^{-1}$ is fundamental to input-output analysis as it shows the full impact of an exogenous increase in net final demand on all industries. With such a matrix it is possible to unravel the technological interdependence of the productive system and to trace the generation of output demand from final consumption which is part of net final demand throughout the system. It is then possible to calculate what output levels would be required to meet various postulated levels of net final demand and consequently how output levels would be required to change to meet postulated changes in net final demand.

[5]This relation holds under certain conditions on the structure of matrix A as discussed in the appendix to this chapter, para. 1.60.

D. Measurement unit

1.22. In previous sections, the units used to measure inputs and outputs have not been discussed. Nevertheless, it is easy to detect that the flow matrix of table 1.2 and the I/O coefficients derived from it in table 1.3 are all based on monetary values. Henceforth, in an input-output table, the following postulates are maintained:

(a) Total input is equal to total output in each producing unit;

(b) Each I/O coefficient is smaller than 1.0; and

(c) As a result of (a) the sum of I/O coefficients plus value added coefficients in each column of the I/O coefficient table is equal to 1.0.

1.23. In the inverse matrix describing total direct and indirect input requirements, the diagonal elements in the Leontief inverse shown in table 1.6 are at least equal to 1.0. This means that to produce one additional unit for delivery to net final demand, it is necessary to increase output by at least one unit.

1.24. An input-output model, however, does not have to be measured in monetary values. In fact, each input and output can be measured in different physical units - steel in tons, petroleum in liters or gallons, services in money, etc. If so, each I/O coefficient would no longer be smaller than 1.0 and the sum of the coefficients along each column cannot be meaningfully calculated, since it is not possible to add apples to oranges.

1.25. As commonly done in most countries, an input-output system is compiled in monetary values, sometimes but rarely supplemented with additional tables of physical units. The main advantage of a monetary value table is that errors can be detected by the requirement that the column sum and the row sum of each producer in the flow table must be equal (of course only if each producer is producing only one product).

E. Prices and costs

1. Prices as costs of production

1.26. It was noted earlier that a column of an input-output matrix together with value added accounted for all the expenditures of a producer. It follows that the price of each product can be built up from the prices of inputs that are used to produce that product.

1.27. As can be seen from matrix A in equation 1.7, in order to produce one unit of product 1, one needs the set of input (a_{11} a_{21} ... a_{i1} ... a_{n1})[6]. Then, if p_i is the price per unit of product i, the cost of intermediate inputs to produce a unit of product 1 can be written as follows:

(1.11) $$p_1 a_{11} + p_2 a_{21} + \ldots + p_i a_{i1} + \ldots + p_n a_{n1}$$

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[6]a_{ij} is now a "real" technical coefficient.

1.28. The difference between the unit price of product 1 and the cost of intermediate inputs for the production of a unit of product 1 is equal to the value added per unit of product 1.

$$p_1 - (p_1 a_{11} + p_2 a_{21} + \ldots + p_1 a_{i1} + \ldots + p_n a_{n1}) = v_1 \qquad (1.12)$$

By switching elements of 1.12 around, a simplified system of price equations follows:

$$\begin{aligned} p_1 &= p_1 a_{11} + p_2 a_{21} + \ldots + p_i a_{i1} + \ldots + p_n a_{n1} + v_1 \\ p_2 &= p_1 a_{12} + p_2 a_{22} + \ldots + p_i a_{i2} + \ldots + p_n a_{n2} + v_2 \\ &\vdots \\ p_n &= p_1 a_{1n} + p_2 a_{2n} + \ldots + p_i a_{in} + \ldots + p_n a_{nn} + v_n \end{aligned} \qquad (1.13)$$

1.29. Solving for price is easier using matrix methods. The price equations are transformed into:

$$\begin{bmatrix} p_1 \\ p_2 \\ \cdot \\ p_n \end{bmatrix} = \begin{bmatrix} a_{11} & a_{21} & \cdot & a_{n1} \\ a_{12} & a_{22} & \cdot & a_{n2} \\ \cdot & \cdot & \cdot & \cdot \\ a_{1n} & a_{2n} & \cdot & a_{nn} \end{bmatrix} x \begin{bmatrix} p_1 \\ p_2 \\ \cdot \\ p_n \end{bmatrix} + \begin{bmatrix} v_1 \\ v_2 \\ \cdot \\ v_n \end{bmatrix} \qquad (1.14)$$

1.30. The block of "a" coefficients in the above equation 1.14 is the coefficient matrix "A" with its rows and columns interchanged, i.e., it is matrix A that is transposed and can be written as A'. As p is defined as the price vector and v as the value added vector, the above set of equations can then be simply written as:

$$p = A'p + v \qquad (1.15)$$

which, when solved for p gives

$$p = (I - A')^{-1} v \qquad (1.16)$$

1.31. It should be noted that the inverse matrix in equation 1.16 is similar to the Leontief inverse described in the previous section. In fact, it can be proven that the inverse in 1.16 is the transpose of the Leontief inverse. (Proof can be found in most textbooks on linear algebra).

$$(I-A')^{-1} = ([I-A]^{-1})'$$

1.32. As one can see below:

$$(I\text{-}A)^{-1} = \begin{bmatrix} 1.077 & 0.257 & 0.375 \\ 0.351 & 1.171 & 0.340 \\ 0.141 & 0.468 & 1.136 \end{bmatrix}$$

then

$$((I\text{-}A)^{-1})' = \begin{bmatrix} 1.077 & 0.351 & 0.141 \\ 0.257 & 1.171 & 0.468 \\ 0.375 & 0.340 & 1.136 \end{bmatrix}$$

each column of the matrix on the left hand becomes a row of the matrix on the right hand, with the column indexing becoming row indexing.

2. Price analysis in input-output

1.33. In a simplified input-output model with constant coefficients, price analysis is shown in equation 1.16 which allows the calculation of the effects on price levels induced by changes in value added, i.e., given that v is known, p can be calculated.

1.34. However, in order to clearly understand price analysis in input-output methodology, particularly when most input-output tables are in monetary values, it is useful to show price analysis when input-output analyses are constructed in physical units.

1.35. Equation 1.16 shows that v is the vector of value added in monetary terms per unit of physical output if A is the input-output coefficient matrix constructed in physical output. However, if A is measured in monetary terms, v is the vector of value added per monetary unit of output (for example per one dollar of output). Then every element of the price vector p is equal to 1.0 (see table 1.7). This simply means that the selling price of 1 dollar worth of output is 1 dollar. For the value of v, see table 1.3.

Table 1.7. Effects of value added on prices using I/O table in value terms

$$p = (I\text{-}A')^{-1}v$$

$$\begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 1.077 & 0.351 & 0.141 \\ 0.257 & 1.171 & 0.468 \\ 0.375 & 0.340 & 1.136 \end{bmatrix} x \begin{bmatrix} .70 \\ .50 \\ .50 \end{bmatrix}$$

1.36. The price of every product in vector p in table 1.7 is equal to 1 when no change is made in coefficient A or in the vector of value added v. This does not mean that such a calculation is of no useful application. In fact, it is quite useful to calculate changes in prices as a result of changes in value added.

1.37. Table 1.8 shows a useful application of price analysis. It attempts to answer a question of the type "what will be the effect on the product prices if value added per unit of product B increases by 10 per cent."

Table 1.8. Effects of value added on prices using I/O table in monetary terms

$$p^n = (I-A')^{-1} v^n$$

$$\begin{bmatrix}1.017\\1.058\\1.018\end{bmatrix} = \begin{bmatrix}1.077 & 0.351 & 0.141\\0.257 & 1.171 & 0.468\\0.375 & 0.340 & 1.136\end{bmatrix} x \begin{bmatrix}.70\\.55\\.50\end{bmatrix}$$

Changes in relative prices are equal to:

$$\frac{p_i^n}{p_i} = p_i^n \ since \ p_i = 1$$

1.38. With the new value of v (denoted by v^n) for product B at .55 in table 1.8 (that is 10 per cent higher than the old v value in table 1.7), the price of product B increases by almost 6 per cent while prices of other products increase by almost 2 per cent.

3. Some rules in price analyses

1.39. The following rules can be derived in analyses of changes in relative prices due to technical changes as reflected by changes in the I/O coefficients or value added:

(a) Changes in relative prices, given changes in value added or technical coefficients, will be the same whether the I/O table is constructed in physical units or monetary units;

(b) Changes in value added or coefficients can be directly introduced into the I/O table in monetary units without any further adjustment as long as the prices of the base period where each price is equal to 1 is used for comparison; thus, the sum of the coefficients in each column, including the coefficients with new values need not be equal to 1.

1.40. The example in table 1.9 (see below) will demonstrate that the relative price changes, as shown by p^n in table 1.8, will be the same whether the I/O coefficients table is in monetary terms or in physical units. From the same example, if the new price vector is used to update the I/O coefficient matrix, by the relationship:

$$(1.17) \quad \hat{p} \, A^n \, \hat{p}^{-1}$$

then the sum of each column of the new updated I/O coefficient will be equal to 1. The following paragraphs will explain the rules mentioned above through an example in table 1.9. The I/O table in constant prices discussed in chapter XI is the table obtained by applying the relationship in 1.17

1.41. The physical tables shown on the left-hand side of table 1.9 present flow and coefficient tables expressed in physical units; the value tables on the right-hand side are flow and coefficient tables in monetary terms, similar to what has been shown in tables 1.2 and 1.3.

1.42. In the flow table of physical units, value added and price per unit of physical output can be used to derive the flow table and other information in monetary terms on the opposite side. These are shown in lines 1-6. For example, the first row of the flow table in monetary terms on the right-hand side is calculated by multiplying the first row of the flow table in physical units on the left-hand side, which refers to the intermediate consumption of the first product, by the unit price of the first product 0.20 shown as the first element in line 6. Coefficient tables and value added coefficients are calculated on the basis of information provided in lines 1-6 and are shown in lines 7-10. Unit prices for the table in monetary terms on the right-hand side of line 6 are all equal to 1.0, as explained in para. 1.35.

1.43. The second set of information relating to changes in value added is shown in lines 11-12. New values of value added per unit of physical output are shown on the left-hand side of line 11. Here, only value added per physical unit of the second producer is assumed to change, increasing it 10 times, from 5.0 (line 10) to 50. This increase may result from a substantial one in taxes on products due to, for instance, a desire by the Government to drastically reduce the production and consumption of that product. New value added per unit value of output of the second producer on the right-hand side of line 11 can be calculated by dividing value added per unit of physical output on the left-hand side of line 11 by the price per unit of physical output on the left-hand side of line 6. It should be recognized here that this calculation is based on the old price system. In the table in monetary terms, the new value added coefficients on the basis of the old price system can be calculated directly. In our example, if the new value added coefficient of producer 2 is increased 10 times, it should be equal to 0.50 x 10 = 5.0.

1.44. Using the formula and procedure in table 1.8 above, the new price per unit of physical output based on new value added coefficients is shown in line 12 while changes in relative prices, which are calculated by dividing values in line 12 by corresponding values in line 6, are shown in line 13. One could conclude from this exercise that changes in prices, given changes in value added coefficients, are the same whether one uses physical or value I/O tables for analysis.

1.45. It is interesting to note, however, that when changes are introduced in the coefficient tables compiled in monetary terms, the sum of the new coefficients in each column does not have to be equal to 1.0. For example, as can be seen from column 2 of the coefficient table on the right-hand side, the sum of intermediate consumption in line 7 to 9 and the new value added coefficient in line 11 is not equal to 1.0. In fact, the value added coefficient in value terms alone is equal to 5. One may introduce changes in technical coefficients and consequently in input-output coefficients in monetary terms and one would also obtain the same results without having to reduce the column sum of the new matrix terms to 1.0. In this case, the new I/O coefficient table is still measured in the old price system. The conversion of the new I/O coefficient table to the new price system will bring back the standard rule that the sum of each column I/O coefficient table must be equal to 1.0. The new I/O coefficient matrix in the new price system is obtained by using the following formula:

$$\hat{p}^n A^n (\hat{p}^n)^{-1}$$

where $\hat{p}^n$ is the diagonal matrix with values of vector p in the diagonal. The new value added coefficient in the new price system is obtained by dividing each element of v^n with the corresponding value in p^n. A^n

and pn are shown in the lower part of table 1.9 from line 14 to line 17 To summarize then: When changes in technology are introduced into coefficients of an input-output table in monetary terms in the same price system, the sum of each column of the new table does not need to add up to 1.0. However, given these changes, a new price system is established and if the input-output coefficients are recalculated on the basis of this new price system, the sum of each column of the new table should add up to 1.0.

1.46. Furthermore, the introduction of an arbitrarily large change in value added per unit of physical output and the reflection of that change on product prices on the basis of adding up costs were purely for illustrative purposes. The basis for such an example may be considered economically unsound because the reaction to an increase in taxes may result in production cut-backs or in changes in demand which cannot be easily be formulated in a simple input-output model.

Table 1.9. Analysis of price changes using physical and value I/O tables

	Physical tables			*Lines*	Value tables			
	Flow table				Flow table			
	0	100	225	*(1)*	0	20	45	
	3	0	3	*(2)*	30	0	30	
	0	80	0	*(3)*	0	80	0	
Value added in monetary terms	70	100	75	*(4)*	70	100	75	Value added in monetary terms
Output in physical units	500	20	150	*(5)*	100	200	150	Output in monetary units
Price per unit of output	0.20	10	1.0	*(6)*	1	1	1	Unit price index
	Coefficient table				Coefficient table			
	0	5	1.50	*(7)*	0.00	0.10	0.30	
	0.006	0	0.02	*(8)*	0.30	0.00	0.20	
	0	4	0	*(9)*	0.00	0.40	0.00	
Old value added per unit of physical output	0.14	5.0	0.5	*(10)*	0.70	0.50	0.50	Old value added per unit value of output
New value added per unit of physical output	0.14	50	0.5	*(11)*	0.70	5.0	0.50	New value added per unit value of output
New unit price of output	0.516	62.69	2.528	*(12)*	2.580	6.269	2.528	New unit price index
Changes in relative prices	2.580	6.269	2.528	*(13)*	2.580	6.269	2.528	Changes in relative prices

New coefficient table in new price system

(14)	0.000	0.041	0.306	Inter-
(15)	0.729	0.000	0.496	mediate
(16)	0.000	0.161	0.000	consumption
(17)	0.271	0.798	0.198	Value added

Appendix

MATHEMATICAL BACKGROUND

1.47. Following are some of the fundamental definitions and operations in matrix algebra. Readers are advised to consult textbooks on advanced econometrics if they wish to learn more about matrix algebra.

A. Fundamental matrix definitions

1.48. **Matrix**: In a general form, a matrix is a rectangular grid containing elements in m rows and n columns. It is said to have an (m x n) dimension. Below is an example of a matrix with m=3 and n=2:

$$A = \begin{bmatrix} 4 & 5 \\ 2 & 1 \\ 6 & 3 \end{bmatrix}$$

1.49. **Column vector**: A column vector is a matrix with only one column and more than one row. Below is an example of a column vector:

$$B = \begin{bmatrix} 4 \\ 2 \end{bmatrix}$$

1.50. **Row vector**: A row vector is a matrix with only one row and more than one colum. Below is an example of a row vector:

$$C = \begin{bmatrix} 4 & 5 & 6 \end{bmatrix}$$

1.51. **Scalar**: A scalar is a real number, i.e. a matrix with one row and one column: 4 for instance is a scalar.

1.52. **Square matrix**: In a square matrix, the number of rows is equal to the number of columns, i.e. m=n. Below is an example of a square matrix:

$$D = \begin{bmatrix} 4 & 5 & 6 \\ 2 & 1 & 3 \\ 6 & 3 & 8 \end{bmatrix}$$

1.53. **Diagonal matrix**: A diagonal matrix is a square matrix with all off-diagonal elements equal to zero. A diagonal matrix is normally denoted with a hat. Below is an example of a diagonal matrix:

$$\hat{E} = \begin{bmatrix} 4 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 8 \end{bmatrix}$$

1.54. **Identity matrix**: An identity matrix is a diagonal matrix with all diagonal elements equal to 1. Below is an example of an identity matrix:

$$I = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

1.55. **Transpose**: A transpose of a matrix is formed by transforming each of the columns of the original matrix into a row or vice versa. A transpose of A is normally written as A'. Below is the transpose of matrix A:

$$A' = \begin{bmatrix} 4 & 2 & 6 \\ 5 & 1 & 3 \end{bmatrix}$$

B. Fundamental matrix operations

1.56. **Addition**: Matrices may be added together if they have the same dimension. For example, if A1 is added to B1, then each element of the new matrix C1 identified by a row number and a column number (the row number is always identified first followed by the column number) is the sum of the element of matrix A1 and the element of matrix B1 identified in the same position as the element in the resulting matrix. For example element $C_{12} = A1_{12} + B1_{12}$. Below is an example for adding the two matrices:

$$\begin{bmatrix} 4 & 3 & 2 \\ 2 & 2 & 1 \end{bmatrix} + \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 2 \end{bmatrix} = \begin{bmatrix} 4+1 & 3+2 & 2+1 \\ 2+0 & 2+0 & 1+2 \end{bmatrix}$$

$$= \begin{bmatrix} 5 & 5 & 3 \\ 2 & 2 & 3 \end{bmatrix}$$

1.57. **Subtraction**: Similarly to addition, one matrix can be subtracted from the other if they have the same dimension. The process of subtraction is similar to the process of addition. Below is an example of subtraction:

$$\begin{bmatrix} 4 & 3 & 2 \\ 2 & 2 & 1 \end{bmatrix} - \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 2 \end{bmatrix} = \begin{bmatrix} 4-1 & 3-2 & 2-1 \\ 2-0 & 2-0 & 1-2 \end{bmatrix}$$

$$= \begin{bmatrix} 3 & 1 & 1 \\ 2 & 2 & -1 \end{bmatrix}$$

1.58. **Multiplication of a row vector and a column vector**: In order for a row vector to be multiplied with a column vector or vice versa, the number of elements in the two vectors must be equal. The result will be a scalar which is the sum of the products of corresponding elements. Below is an example of a multiplication:

$$\begin{bmatrix} 4 & 3 & 2 \end{bmatrix} x \begin{bmatrix} 1 \\ 2 \\ 0 \end{bmatrix} = (4x1)+(3x2)+(2x0) = 10$$

1.59. **Multiplication**: Two matrices may be multiplied to one another only if the second dimension of the matrix on the left-hand side is equal to the first dimension of the matrix on the right-hand side. Thus:

$$\underset{(m \times n)}{K} \quad x \quad \underset{(n \times k)}{M} \quad = \quad \underset{(m \times k)}{N}$$

The second dimension of K, i.e n is equal to the first dimension of M, i.e n. In multiplication, to obtain the elements of the first row of N, the first row of K is multiplied respectively by the columns of matrix M following the procedure in para. 1.58. The elements of other rows of N are also obtained similarly. Below is an example of the product of two matrices:

$$\begin{bmatrix} 4 & 3 & 2 \\ 2 & 2 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 \\ 2 & 3 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 10 & 11 \\ 6 & 7 \end{bmatrix}$$

In the example above, K has a 2x3 dimension, M has a 3x2 dimension, N must have a 2x2 dimension.

C. Solution of a linear equation system

1.60. Consider the following relationships:

$$X_1 + 3X_2 = 8$$

$$2X_1 - X_2 = 10$$

then

$$B = \begin{bmatrix} 1 & 3 \\ 2 & -1 \end{bmatrix}, \quad X = \begin{bmatrix} X_1 \\ X_2 \end{bmatrix}, \quad Y = \begin{bmatrix} 8 \\ 10 \end{bmatrix}$$

The system can now be written as $BX = Y$ and the solution of X is $X = B^{-1}Y$. B^{-1} is called the inverse. The necessary and sufficient conditions for B to be invertible is that B is a square matrix and that no row or column in B is proportional respectively to other rows and columns, or a linear combination of other rows and columns, i.e. all rows and columns are linearly independent. The system of equations may have a solution only if B is invertible. In a simple system where B is a scalar, X and Y are one-element variables. The solution is quite simple. Let $bx = y$, then $x = (1/b)y$. If $b = 2$, $y = 10$ then $x = 5$. $1/a$ is similar in nature to the inverse of matrix B. If $a = 0$ then x is indeterminate, i.e. it has no solution. No mathematical technique for matrix inversion is presented because it is tedious and not economically revealing. Readers can find it in advanced econometric textbooks.

1.61. The simple input-output economic model in which one industry produces only one commodity is a linear equation system. Then $B = (I-A)^{-1}$ which is called the Leontief inverse. This Leontief inverse is always non-negative when:

-A is measured in value terms;
-a_{ij}, any element of A is non-negative and smaller than 1, which under normal economic conditions, is always satisfied since the value of any input used is smaller than the value of output.

II. THE SYSTEM OF NATIONAL ACCOUNTS (SNA) FRAMEWORK OF SUPPLY AND USE TABLES (SUT): OVERVIEW

2.1. The input-output (I/O) model built around a symmetric I/O coefficient matrix and described in chapter I can be derived from the SNA framework of supply and use tables (SUT) which is an essential part of the SNA integrated national accounting structure. In this chapter, the SNA SUT, and the links between SUT and institutional accounts of the SNA will be discussed. The appendixes will discuss the statistical units and classification schemes based on which data for SUT are collected. Methods used in deriving the symmetric I/O coefficient table (SIOT) from the SUT are discussed in chapter IV.

2.2. The SNA provides a comprehensive framework in which basic statistical data on transactions among micro-producing units, i.e., the establishments, may be presented with minimum manipulation of statistical data. Establishments as statistical units will be discussed in paragraph 2.54 below. Statistical data are realistically presented in the basic supply and use framework of the SNA in the following senses:

-Any producing unit may engage in more than one activity producing more than one type of product;

-Goods and services as outputs are as far as possible valued at the prices at which they first entered the market, i.e. basic prices or at equivalent market prices; they are only valued at costs when no equivalent market prices are available;

-Goods and services as intermediate or final products are valued at the prices which users have to pay for them.

2.3. Tables 2.1, 2.2 (see paragraph 2.24 below) describe fully the SNA SUT. They are the supply-and-use tables that are closely linked. The supply table which is referred to in the SNA of 1968 as the commodity table describes the sources of supply of products to the economy. The use table which was called the industry table in the 1968 SNA describes where the products and other primary factors are used, as well as the derivation of value added as the difference between output and intermediate consumption of goods and services in production. The basic principle in deriving these two tables is that the total supply of a product must equal the total use of the product.

A. Basic concepts used in SUT

2.4. Before the supply and use tables are described, many concepts used in the SNA SUT are reviewed below.

2.5. **Industry**: "An industry consists of a group of establishments engaged in the same, or similar, kinds of activity. At the most detailed level of classification, an industry consists of all the establishments falling within a single Class of ISIC and which are therefore all engaged on the same activity as defined in the ISIC. At higher levels of aggregation corresponding to the groups, divisions and, ultimately, sections of the ISIC, industries consist of groups of establishments engaged in similar types of activities[1]. An establishment "combines both the kind-of-activity dimension and the locality dimension". An establishment is defined as an enterprise, or part of an enterprise, that is situated in a single location and in which only a single (non-ancillary) productive activity is carried out or in which the principal productive activity accounts for most of the value added[2]. The ISIC is the United Nations *International Standard Industrial Classification of All Economic Activities*[3]. The basis of these classifications is the establishment, i.e. the statistical unit which will be elaborated on in part D of this chapter and in chapter V. The term "producer" is used interchangeably with the term "industry". Thus a "producer" does not refer to the owner of an enterprise or to the enterprise itself but to a group of similar economic activities classified under the same classification unit. Countries and groups of countries may develop their own industrial classification to meet their specific requirements, but they should be able to link with ISIC. European Union countries uses the general Industrial Classification of Economic Activities within the European Communities (NACE, Rev.1) for their European System of National Accounts (ESA 95), which is broadly consistent with the System of National Accounts of the United Nations (1993 SNA) as regards the definitions, accounting rules and classifications but incorporates certain differences, particularly in its presentation, which is more in line with its use within the European Union. NACE is harmonized with ISIC.

2.6. **Product**: "Products" are used interchangeably with "goods and services" and are classified according to the United Nations *Central Product Classification (*CPC*)* (ST/ESA/STAT/SER.M/77 Version 1.0) (see appendix B). Similar to industries, countries and groups of countries may develop their own product classification to meet their specific requirements, but they should be able to link with ISIC. European Union countries use the Classification of Product by Activity (CPA) as the standard for their European System of National Accounts, which is harmonized with the United Nations Central Product Classification.

2.7. **Industry output**: Industry output is the total value of all products produced by an industry including both primary and secondary products.

2.8. **Product output**: Product output is the total value of a product produced by all industries, i.e. all resident producers in the economy.

2.9. **Market, own final use and other non-market producers**: Industries in the SNA are grouped into three broad categories: market, own final use and other non-market producers. "A market producer is an establishment or enterprise all or most of whose output is marketed. It is perfectly possible for market producers, both small unincorporated enterprises and large corporations, to have some non-market output in the form of production for own final consumption or gross fixed capital formation. Own-account producers consist of establishments engaged in gross fixed capital formation for the enterprises of which they form part or unincorporated enterprises owned by households all or most of whose output is intended for final consumption or gross fixed capital formation by those households: for example, owner-occupiers or subsistence farmers who sell none, or only a small fraction, of their output. Other non-market producers consist of establishments owned by government units or NPISHs [non-profit institutions serving households] that supply goods or services free, or at prices that are not economically significant, to households or the

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[1]*System of National Accounts 1993* (United Nations publication, Sales No. E.94.XVII.4), para. 5.40.

[2]*Ibid.*, paragraph 5.21.

[3]United Nations Publications, Sales No. E.90.XVII.11.

community as a whole. These producers may also have some sales of secondary market output whose prices are intended to cover their costs or earn a surplus: for example, sales of reproductions by non-market museums."[4] Products are also similarly grouped into three broad categories: market, for own final use and other non-market. The classification of activities and products into the three categories is not required to obtain an I/O table SIOT as described in chapter I but it will provide useful information in estimating new I/O coefficients if there are changes in the shares of the categories. This is because in an I/O model based on an SIOT table, a column representing a production technology used in producing a product is normally a weighted average of different technologies used in producing that product. To be more useful to I/O analysis, market producers should be classified into two groups: unincorporated and own-use producers of household activities which may use more primitive technology; and corporate enterprises which are large and may use more advanced technology. This latter distinction is also useful for the purpose of identifying value added generated by the household sector.

2.10. **Valuation of outputs**: "Goods and services produced for sale on the market at economically significant prices may be valued either at basic prices or at producer's prices. The preferred method of valuation is at basic prices, especially when a system of VAT, or similar deductible tax, is in operation, although producer's prices may be used when valuation at basic prices is not feasible."[5] "The *basic price* is the amount receivable by the producer from the purchaser for a unit of a good or service produced as output minus any tax payable, and plus any subsidy receivable, on that unit as a consequence of its production or sale. It excludes any transport charges invoiced separately by the producer; the producer's price is the amount receivable by the producer from the purchaser for a unit of a good or service produced as output minus any VAT, or similar deductible tax, invoiced to the purchaser. It excludes any transport charges invoiced separately by the producer."[6]

2.11. **Value added**: "Value added is the balancing item in the production account for an institutional unit or sector, or establishment or industry. It measures the value created by production and may be calculated either before or after deducting the consumption of fixed capital on the fixed assets used....*Gross value added* is defined as the value of output less the value of intermediate consumption; *net value added* is defined as the value of output less the values of both intermediate consumption and consumption of fixed capital."[7] Value added at basic prices of an industry is the difference between the industry output at basic prices and the intermediate consumption of the industry at purchasers' prices.

2.12. **Operating surplus** is a balancing item, which is equal to value added minus compensation of employees, minus taxes less subsidies on production and imports. Operating surplus that includes consumption of fixed capital is called *gross operating surplus*; without consumption of capital, it is called *net operating surplus*. Operating surplus is calculated residually given value added and compensation of employees, other taxes less subsidies on production and consumption of fixed capital. Value added at market prices (either at producers' prices or purchasers' prices) for the total economy is the sum of value added at basic prices plus taxes less subsidies on products.

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[4]*System of National Accounts 1993,* para. 6.52.

[5]*Ibid.*, para. 6.218.

[6]*Ibid.*, para. 6.222.

[7]*Ibid.*, para. 6.222.

2.13. **Compensation of employees**: "Compensation of employees is defined as the total remuneration, in cash or in kind, payable by an enterprise to an employee in return for work done by the latter during the accounting period.... No compensation of employees is payable in respect of unpaid work undertaken voluntarily, including the work done by members of a household within an unincorporated enterprise owned by the same household. Compensation of employees does not include any taxes payable by the employer on the wage and salary bill - for example, a payroll tax. Such taxes are treated as taxes on production in the same way as taxes on buildings, land or other assets used in production."[8]

2.14. **Taxes on production and imports**: Taxes on production and imports include taxes on products and other taxes on production.

- **Taxes on products**: Taxes on products are "payable on goods and services when they are produced, delivered, sold, transferred or otherwise disposed of by their producers; they include taxes and duties on imports that become payable when goods enter the economic territory by crossing the frontier or when services are delivered to resident units by non-resident units; when outputs are valued at basic prices, taxes on domestically produced products are not recorded in the accounts of the System as being payable by their producers."[9] Taxes on products can consist of: value added type taxes (VAT), taxes and duties on imports excluding VAT, export taxes, taxes on products except taxes listed above. These taxes are called *commodity taxes* in the 1968 SNA. Subsidies on products are defined in a similar way.

- **Other taxes on production**: Other taxes on production consist "mainly of taxes on the ownership or use of land, buildings or other assets used in production or on the labour employed, or compensation of employees paid. Taxes on the personal use of vehicles, etc. by households are recorded under current taxes on income, wealth, etc."[10]. Examples of other taxes on production are taxes payable by producers for business licenses, payroll taxes, stamp duties, etc. These taxes are not proportional to the value of goods and services produced. In the 1968 SNA, these taxes are called *other indirect taxes*.

2.15. **Subsidies on production and imports**: "Subsidies are current unrequited payments that government units, including non-resident government units, make to enterprises on the basis of the levels of their production activities or the quantities or values of the goods or services which they produce, sell or imports."[11]. "Subsidies are not payable to final consumers, and current transfers that governments make directly to households as consumers are treated as social benefits. Subsidies also do not include grants that governments may make to enterprises in order to finance their capital formation, or compensate them for

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[8]*Ibid.*, para. 7.21.

[9]*Ibid.*, para. 7.49.

[10]*Ibid.*, para. 7.49.

[11]*Ibid.*, para. 7.71.

damage to their capital assets, such grants being treated as capital transfers."[12]. Subsidies on production and imports are divided into two distinct items:

- **Subsidies on products**: "A subsidy on a product is a subsidy payable per unit of a good or service."[13]

- **Other subsidies on production**: These "consist of subsidies except subsidies on products which resident enterprises may receive as a consequence of engaging in production."[14] Examples are subsidies on payroll or workforce, subsidies to reduce pollution.

2.16. **Gross mixed income**: "Mixed income contains an unknown element of remuneration for work done by the owner of the enterprise, or other members of the same household, as well as the [operating] surplus accruing from production."[15] Mixed income is the term reserved for the balancing item in the generation of income account for "unincorporated enterprises owned by members of households either individually or in partnership with others in which the owners, or other members of their households, may work without receiving a wage or salary. Owners of such enterprises must be self-employed: those with paid employees are employers, while those without paid employees are own-account workers. In a few cases it may be possible to estimate the wage or salary element implicitly included within mixed income, but there is usually not enough information about the number of hours worked or appropriate rates of remuneration for values to be imputed systematically."[16] The concept of mixed income is necessary because, practically, satisfactory estimates of compensation of employees for owners are not possible. Dwelling services for own consumption produced by owner-occupiers do no generate mixed incomes since "there is no labour input into the production of the services of owner-occupied dwellings so that any surplus arising is operating surplus."[17]

2.17. **Consumption of fixed capital**: "Consumption of fixed capital is a cost of production. It may be defined in general terms as the decline, during the course of the accounting period, in the current value of the stock of fixed assets owned and used by a producer as a result of physical deterioration, normal obsolescence or normal accidental damage. It excludes the value of fixed assets destroyed by acts of war or exceptional events such as major natural disasters which occur very infrequently."[18] Consumption of fixed capital is therefore not the same as depreciation allowed for tax purposes. Consumption of fixed capital is commonly calculated by the perpetual inventory method (PIM).

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[12]*Ibid.*, para. 7.72.

[13]*Ibid.*, para. 7.73.

[14]*Ibid.*, para. 7.79.

[15]*Ibid.*, para. 7.85.

[16]*Ibid.*, para. 7.85.

[17]*Ibid.*, para. 4.150.

[18]*Ibid.*, para. 6.179.

B. Structure of SUT

2.18. The SUT in the revised SNA are presented as tables 2.1 and 2.2. A more elaborate framework with numerical examples can be found in the *System of National Accounts 1993* (see footnote 1). These tables are shown in general form so that they can be used later in the discussion of SUT and production accounts in constant prices; this is the main reason for showing a column of price indexes in table 2.1(column 10) which normally should not be there. The same tables but with numerical examples can be found in tables 3.1 and 3.2 in chapter III on valuation. Readers are advised to read tables 2.1 and 2.2 together with tables 3.1 and 3.2 in chapter III. The structure of tables 2.1 and 2.2 also differs slightly from table 15.1 on page 350 of the *System of National Accounts* where taxes minus subsidies on products, trade and transport margins and total product supply at purchasers' prices are shown on the left hand side of the supply and use tables.

2.19. In the SUT, every activity or industry is classified by the way its outputs are used (market, for own final use or other non-market) and its aggregate industry outputs are similarly classified. The design of tables 2.1 and 2.2 is a simplified version of the SUT in SNA 1993, which does not take into account the identification of industries by types of uses of the outputs they produce so as to assist the explanation of the double deflation method in chapter XI . Activities may be classified into three groupings. In tables 2.1 and 2.2, goods, market services and other non-market services. The first two groups produce products for sale so they have market prices or equivalent . These two groups also include producers for own final uses. The last group representing government services and services provided by non-profit institutions serving households has neither market prices nor equivalent. Products are similarly classified.

2.20. The SUT framework has two tables: the supply table and the use table that are closely linked together. The supply table shows both the value of different products at basic prices produced in every industry and the total supply of every product in both basic prices and purchasers' prices. The use table shows both the cost of production in every industry, and the use of every product at purchasers' prices in the economy. In both tables, products are presented as rows better to illustrate the balancing of their supply and use in the SUT of the SNA. The supply of every product must be equal to the use of that product when measured in the same price, and the output of an industry must be equal to its cost of production: these two principles are used in balancing the supply and use tables.

1. The supply table

2.21. In the supply table 2.1 (see also table 3.1), goods and services produced in the economy are measured at basic prices. Basic prices do not include trade and transport margins and taxes on products. Values in basic prices of products produced are shown in columns 1-3 and rows 1-3. The first row shows the supply of goods by different industries from column 1-3. The total supply of goods at basic prices is obtained in column 6 after imports c.i.f. are added to the supply domestically produced at basic prices. So:

$$SB1 = X11 + X12 + X13 + M1$$

2.22. Imports c.i.f. which exclude import duties are treated as equivalent to basic prices. The total supply of goods at purchasers' prices is obtained by adding to the total supply of goods at basic prices their trade and transport margins, and taxes minus subsidies on products including imports.

Thus: $SP1 = SB1 + TM + TX1$

Table 2.1. The supply table

	Industries with output at basic prices			Imports c.i.f. (Total f.o.b)	C.i.f./f.o.b. adjust-ment	Total product supply at basic prices	Trade and transport margins	Taxes minus subsides on products	Total product supply at purchasers' prices	Price indexes*
	Goods	Market services	Other non-market services							
Products:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Goods	X11	X12	X13	M1		SB1=(1+.+5)	TM	TX1	SP1=(6+.+8)	P1
Market services	X21	X22	X23	M2	-ADJ	SB2=(1+.+5)	-TM	TX2	SP2=(6+.+8)	P2
Other non-market services	X31	X32	X33			SB3=(1+.+5)		TX3	SP3=(6+.+8)	
C.i.f./f.o.b. adjustment				-ADJ	+ADJ				0	
Purchases of residents abroad				R					R	
Total industry output at basic prices	I1=X11+ X21+X31	I2=X12+ X22+X32	I3=X13+ X23+X33							
Other column total				M	0	SB	0	TX	SP	

* Price indexes are irrelevant for this chapter but will be used to describe the double deflation method in chapter XI.

Table 2.2 The use table at purchasers' prices

		Industries Intermediate consumption			Exports. f.o.b.	Household final expenditure*	Government final expenditure	Gross capital formation**	Total product uses
		Goods	Market services	Other non-market services					
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Products	Goods	U11	U12	U13	E1	HC1		K1	U1=(1+.+7)
	Market services	U21	U22	U23	E2	HC2		K2	U2=(1+.+7)
	Other non-market services					HC3	GC		U3=(1+.+7)
Purchases of residents abroad						R			R
Purchases of non-residents at home					NR	-NR			0
Gross value added at basic prices		V1	V2	V3					
Compensation of employees		W1	W2	W3					
Other taxes on production		OT1	OT2	OT3					
Consumption of fixed capital		CC1	CC2	CC3					
Operating surplus/gross mixed income		OS1	OS2						
Total industry output at basic prices		I1	I2	I3					
Other column total					E	HC	GC	K	U
Price indexes				P3					

* In order to reduce the size of the table, household consumption also includes final consumption of non-profit institutions serving households (NPISHs).
** Gross capital formation includes gross fixed capital formation, change in inventories and acquisition less disposal of valuables,

2.23. The supply of market services and non-market services is similarly treated. To obtain the value of output produced by each industry, we only need to sum the values of different products produced by the industry as shown in the corresponding column. The value of the industry producing goods at basic prices is equal to:

$$I1 = X11 + X21 + X31$$

2.24. The supply table needs one adjustment that can be explained immediately: the c.i.f./f.o.b. adjustment. Other adjustments are taken in both the supply and the use tables or can only be understood in the context of both tables and will be explained later.

The c.i.f./f.o.b. adjustment

2.25. As we know M1, the value of imported goods c.i.f. includes the value of:

- Imported goods f.o.b;
- Transport services rendered by both resident and non-resident transporters;
- Insurance services rendered by both resident and non-resident insurers.

2.26. The two latter services when rendered by non-residents are however already included in M2 which shows the total value of imports of market services. In addition, the value of transport and insurance services rendered by residents is domestic output and thus should not be treated as imports. If no adjustment is introduced, imports are obviously higher than they should be by the total value of transport and insurance services rendered by both residents and non-residents. One must be careful in the treatment of the value of transport and insurance services on imports rendered by residents. If these services are bought and paid for by non-resident exporters to resident carriers and insurers, their value will be recorded as export of services in the balance of payments, and therefore must be excluded from export of services. To sum up, SUT has to satisfy two conditions:

- Each imported product must be valued c.i.f. in the supply table since it is equivalent to the basic value of the same domestic goods;
- The total value of imports must be valued f.o.b. since this is the true value of imports as explained above.

2.27. To adjust for the above problem, a column of adjustment is introduced and an adjustment value (ADJ) is introduced separately for transport services and insurance services though in table 2.1 the two commodities are aggregated together in the group of market services. This adjustment value should be as follows:

ADJ = Value of transport services or insurance services (or both) rendered by both resident and non-resident producers

By doing this the total value of imports is measured f.o.b., i.e.:

Imports f.o.b. = M1 c.i.f. + M2 - ADJ

The row of c.i.f./f.o.b. adjustment is introduced so that its total row value is equal to 0, like the total value of the corresponding column.

2.28. In the 1968 SNA, the total value of imports is valued c.i.f. so ADJ has to be included in exports to keep the balance of trade accurate. However, that treatment obviously distorts the value of both imports and exports.

2. The use table

2.29. The use table shows in a column the cost of production in the corresponding industry. All intermediate costs are measured in purchasers' prices. Thus U11 to U23 are in purchaser's prices. The purchaser's price is the price that the purchaser has to actually pay for the product unit. If the taxes paid on the purchased products can be deducted by the purchaser when used as inputs in production, the deductible value added tax (VAT) has to be excluded from the purchasers' price. This applies only to VAT countries. For every industry, the total industry output at basic prices, i.e from I1 to I3 has to be calculated from the supply table. Given this industry output and intermediate consumption obtained in the use table, it is possible to measure value added as a residual. Thus for the goods industry,

$$V1 = I1 - (U11 + U21)$$

and then given other components of value added, operating surplus is measured residually.

2.30. Every product is shown as consumed in production, exports, household final expenditure, government final expenditure and gross capital formation. The sum along every row is equal to the total use of the product at purchasers' prices. So:

$$U1 = U11 + U12 + U13 + E1 + HC1 + K1$$

and then U1 in the use table must equal SP1 in the supply table. This is true for every U and SP.

2.31. The use of the product *other non-market services* as intermediate consumption by business is also possible (for example, payment for some government services) but it is very small and assumed to be zero here just for the sake of highlighting the presentation.

2.32. GC in column 6 of table 2.2 stands for government final consumption expenditure. For the purpose of deriving detailed inflation indexes, government final expenditure GC should be split into two categories:

- The collective expenditure that benefits society at large; and
- The individual expenditure that benefits directly the individuals in the society Households may pay part of it. This part which is normally called user charges has to be included in HC3 of column 5 and not included in GC in column 6.

HC3 in column 5 stands for final consumption of non-market services of non-profit institutions serving households (which is also equal to its output). Thus HC3 includes both the part that is paid by households and the part that is provided free by the Government or the non-profit institutions.

2.33. Gross capital formation (column 7) may be broken down by industries and/or institutional sectors: by industries to calculate gross fixed assets by industry; by institutional sector for the purpose of integrated institutional accounts. In the SNA, gross fixed capital formation is recommended to be classified by industry only. Changes in inventories are normally prepared for the economy as a whole since data for changes in inventories by industry are more difficult to collect. Acquisition less disposal of valuables cannot be classified by industry since they are owned by enterprises and do not relate to production.

2.34. In the supply and use tables there are three more adjustments to be explained:

(a) The adjustment for trade and transport margins

2.35. As seen in the use table, trade services included in the market services grouping in row 2 show only those that are consumed directly by producers and final users. They do not include trade and transport margins which are instead included in the value of the goods at purchasers' prices shown in the first row. Therefore, trade and transport margins are not included in U2, the total use of market services in the use table (column 8). Consequently, in the supply table, trade and transport margins should be deducted from the total supply of market services in row 2. This is done by entering trade and transport margins (TM) as a negative number in column 7, row 2 in order to balance the supply and use of trade and transport services at purchasers' prices.

(b) The adjustment for purchases of residents abroad

2.36. Purchases of residents abroad are treated as both imports and household final expenditure by the SNA, assuming that these purchases are mostly by household residents. Thus a value of R has to be entered in the import column of the supply table and also entered in the column of household final expenditure in the use table. The *European System of National Accounts* (ESA) refines the SNA treatment further and recommends that these purchases be classified by product and two categories must be distinguished: R1, expenditure by business travellers which are treated as intermediate consumption and R2, expenditure by households which are treated as household final consumption. In the ESA, adjustments, if necessary, are introduced directly into the import column 4 of the supply table and the household final expenditure (column 5) of the use table. The ESA treatment will require expensive surveys to obtain detailed information on purchases by households and business.

(c) The adjustment for purchases of non-residents at home

2.37. Purchases of non-residents at home should be treated as exports and if they are included in the column of household final expenditure through the process of balancing for which this column is normally treated as a residual, these purchases have to be deducted from household final expenditure. Thus a value of NR is entered in the export column (column 4) and -NR is entered in the column of household final expenditure (column 5). Similarly to the treatment of purchases abroad by residents, the *European System of National Accounts* (ESA) recommends the classification of purchases by non-residents by products with adjustments made directly on the column of household final expenditure.

3. The advantage of using basic prices in SUT

2.38. In SUT, one may use either basic prices or producer prices to measure industry outputs. However, as will be shown below, it is much better to use basic prices. In the SNA supply table 2.1 taxes and subsidies on products including import duties and trade margins are shown for every commodity. The link between taxes paid and subsidies received and the values of products used in the economy can clearly be seen. In the tables that have industry outputs measured at producer prices, as is currently done by many countries, there are two alternative treatments. The first one is to include in producer prices taxes less subsidies on products only that are collected directly by the producers for the Government. But in so doing, most of the taxes on products collected through wholesaling and retailing would appear in the wholesale and retail trade industries. This method shows the link between the output of each industry (which is the sum of possibly many products produced by the industry) and product taxes paid, but the direct link between an individual product and the taxes paid on it is not shown. The other alternative is to itemize taxes and subsidies paid by each industry by product, i.e. to obtain a matrix of taxes on industry output classified by product and by industry. This method which shows the direct link between taxes and products produced by each industry requires much more information than does the SUT.

4. Balances between value added and final demand in the use table

2.39. Undoubtedly, SUT is an extremely useful device to arrange basic statistics not only for the derivation of the symmetric I/O table (SIOT) that will be used for economic analysis as presented in chapter I, but also for the compilation of value added by industry, final demand by product and by institutional sector in both current and constant prices in a systematic way. In the following paragraphs the basic link between value added and final demand will be further explored.

2.40. The gross domestic product (GDP) is the net contribution of economic activities to incomes (i.e. value added) which are then used for final demand, therefore total incomes must equal total net final demand. The relationship of value added and final demand is shown in table 2.3 below.

2.41. In the I/O framework, the GDP can be measured as sum of value added or of primary incomes or as net final demand.

(a) GDP as sum of value added (the production approach)

2.42. GDP = Total industry output at basic prices

GDP = Total industry output at basic prices - Total industry intermediate consumption in purchasers' prices + Taxes less subsidies on products.

In table 2.1. and table 2.2,

$$GDP = (I1 - U11 - U21) + (I2 - U12 - U22) + (I3 - U13 - U13) + TX = V1 + V2 + V3 + TX$$

In the supply and use tables 3.1 and 3.2 of chapter III, value added at basic prices can be found in row 9 of the use table 3.2 and taxes less subsidies on products can be obtained in row 7, columns 9 and 10 of the supply table 3.1.

Value added at basic prices = 108 + 49 + 39 = 196

Taxes less subsidies on products = 3 + 17 = 20

GDP = 196 + 20 = 216

2.43. This approach allows the calculation of value added at basic prices originating from each industry by subtracting the intermediate consumption of each industry at purchasers' prices from its output at basic prices. Information on industry output and intermediate consumption is available in the use table. Information on taxes less subsidies on products is available in the supply table when deriving total supply at purchasers' prices.

(b) GDP as sum of primary incomes (the income approach)

2.44. "GDP is also equal to the sum of primary incomes distributed by resident producer units."[19] Values added at basic prices are calculated as the sum of compensation of employees, other taxes less subsidies on production, gross mixed incomes, and gross operating surplus. The gross operating surplus of each establishment or industry cannot be directly estimated because the operating surplus of each industry is, by definition, calculated as a residual. However, the gross operating surplus of incorporated enterprises may be estimated directly. It is equal to:

(1)		Additions to retained earnings
(2)	Plus	Depreciation and depletion
(3)	Plus	Bad debts (not yet written off)
(4)	Plus	Net property incomes payable including: Net rents on non-produced assets Net interest payable Dividends
(5)	Plus	Net current transfers payable
(6)	Plus	Net capital transfers payable
(7)	Minus	Gains (net of loss) on sales on fixed assets and securities

The net concepts in items 2-6 refer to receivables less payables. They are considered costs in business accounting but part of gross operating surplus in national accounts. Therefore, they need to be added to additions to retained earnings (item 1) in order to obtain gross operating surplus. Item 7 is part of incomes in business accounting, but it is only capital gains due to changes in prices in national accounts and therefore must be subtracted.

[19] *Ibid.*, para. 2.176.

Table 2.3 Relationships in national accounts aggregates

Gross Domestic Product as net contribution to incomes	Gross Domestic Product as net final demand
Gross value added at basic prices	Household final consumption expenditure
Compensation of employees	Final consumption expenditure of non-profit institutions serving households (individual)
Other taxes less subsidies on production	Government final consumption expenditure
Consumption of fixed capital	Collective
Operating surplus/Mixed incomes	Individual
Taxes less subsidies on products	Gross capital formation
	Gross fixed capital formation
	Changes in inventories
	Acquisitions less disposal of valuables
	Exports f.o.b.
	Minus imports f.o.b.

2.45. Many countries have adopted this approach to measure GDP without using the full information in SUT. This means that supplies of goods and services, product by product, need not be balanced with uses. Only a balance of overall production incomes and final demand is obtained as can be seen in table 2.3. The approach can provide value added for aggregated industries in a summarized way. However, many income items listed from (1) to (7) such as additions to retained earnings, interest, etc., cannot be split into different industries. Because of that, the approach does not provide value added by detailed industries and full information on production accounts. In addition, the income approach does not work for small household activities whose owners either do not keep full business accounts or are not able to separate income from production from property income or current transfers. In this case, the production approach is more appropriate. In conclusion, the income approach is not a pure approach and it is restricted to the measurement of value added by institutional sectors and total GDP only. Without the supply and use tables, if discrepancies arise, it will be very difficult to detect their origin and to reduce them. In contrast, using the income approach jointly with a supply-and-use table would allow the compilation of components of incomes (compensation of employees, other taxes less subsidies, operating surplus) by industry and the link between value added by industry with value added by institutional sector discussed in section C.

(c) GDP as net final demand (the expenditure approach)

2.46. "GDP is also equal to the sum of the final uses of goods and services (all uses except intermediate consumption) measured in purchasers' prices, less the value of imports of goods and services."[20] Final uses or final demand are equal to: household final expenditure + final expenditure of non-profit institutions

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[20] *Ibid.*, para. 2.173.

serving households, the general government sector + gross capital formation + exports f.o.b. When final demand is net of imports, it is called net final demand. *Final demand* is not the terminology used in the SNA but it is convenient to refer to an analysis of future demand. For accounting purposes, demand and uses are used interchangeably. Net final demand is a concept necessary for input-output analysis using the Leontief inverse. It was introduced in chapter I and will be used frequently later in the Handbook.

In tables 2.1 and 2.2,

$$GDP = HC + GC + K + E - M$$

In the supply and use tables 3.1 and 3.2 of chapter III, total imports are obtained from row 7 and column 5 of the supply table and other components of final demand are obtained from row 7, columns 5-8 of the use table.

$$GDP = 153 + 10 + 40 + 38 - 25 \quad = 216$$

(d) The commodity flow approach

2.47. The SNA SUT framework combines all three approaches in estimating national accounts statistics by balancing the supply and use of every product using the use and supply tables and in this way it has a consistent way to cross-check information at a very detailed level. This SUT approach is more popularly called the commodity flow approach.

5. Final consumption expenditure versus actual final consumption

2.48. A new concept of actual final consumption has been introduced in the revised SNA that is very useful in studying the behaviour of households and in comparing their actual consumption among nations. The relationship between the concept of final consumption expenditure and actual final consumption is presented in table 2.4. In table 2.3, final expenditure was broken down by institutional sectors that actually spent for different purposes. The Government spends for collective purposes such as public administration, defense, security, general health improvement, etc. that benefit the society as a whole but not specific individuals. Besides expenditure for collective benefit, the government also spends to benefit specific individuals for instance health care, education, food aid, etc. The non-profit institutions serving households are defined by the SNA to spend for the benefit of individuals only. Final consumption expenditure to benefit individuals of the general government sector and non-profit institutions serving households can be added to household final consumption expenditure to derive actual individual final consumption. The latter concept measures the actual final consumption of households whether paid by themselves or by other institutions. Full elaboration of the concept and compilation of final consumption expenditure and actual final consumption can be found in chapter VII.

2.4 Relationship between two concepts of final consumption

Final consumption expenditure	Actual final consumption
Households final consumtion expenditure	Actual final consumption of households (or actual individual consumption)
Government final consumption expenditure	Households final consumption expenditure
Collective	Individual government final consumption expenditure
Individual	Final consumption expenditure of NPISHs
Non-profit institutions serving households' final consumption expenditure	Actual final consumption of general government (or actual collective consumption)
	Collective government final consumption expenditure

C. Link between SUT and production accounts of institutional sectors in the SNA

2.49. National accounting studies not only value added generated by industries but also value added and incomes generated and distributed among institutional sectors (see section D of this chapter for definition). For example, a non-financial enterprise that manages or "owns" an activity classified as an industry in SUT would have to pay compensation to its workers and taxes to the Government. Even the operating surplus generated by the industry in question and by other industries that the enterprise manages must also be distributed to other institutional sectors: interests on its loans to enterprises in the financial sector, dividends to other enterprises or to households that own shares of the enterprise, etc. In addition, the same enterprise may also receive income from its ownership of shares in other enterprises or of deposits at financial institutions. It is thus not possible to trace the redistribution process on the basis of the industries but only of the enterprises that manage or "own" them. Distribution and redistribution of incomes belong to another part of the structure of national accounts, namely the distribution and use of income accounts. To facilitate the integration of production accounts classified by industry to the distribution and use-of-income accounts and other sequence of accounts in the SNA, production accounts by industry must be cross-classified by institutional sectors. The cross-classification scheme is presented in table 2.5. Only aggregate values of outputs and intermediate consumption of industries or establishments are needed. Information on establishments is first to be classified acording their institutional sectors. To obtain industry outputs, intermediate consumption and value added by institutional sectors, one simply adds up the corresponding information on specific institutional sectors. For example, in table 2.5, the value added by the non-financial sector is the sum of value added shown in columns 1-3. This scheme is implementable only if every establishment covered in production censuses is identified by the type of institutional sector to which the enterprise that owns the establishment belongs. Practically, production censuses should be designed to let enterprises fill in requested information for all the establishments they own or to let the establishments fill in information under the supervision of the enterprises.

2.50. In the above scheme, industries must be classified into one of five institutional sectors, or sub-sectors if each institutional sector is divided further. In the scheme in table 2.5

- The non-financial and financial corporations sectors include (i) all government and privately-owned corporations and quasi-corporations that produce goods and services principally for sale on the market but may have activities that produce goods and services for their own final uses and other non-market uses and (ii) all private non-profit institutions serving corporations and quasi-corporations;

- The household sector includes all unincorporated enterprises that produce for both the market and their own final uses and household activities that perform mainly for their own final uses;

- The general government sector includes all central, state or local government units performing other non-market activities, all social security funds, all non-profit institutions controlled and financed by government units and all unincorporated government enterprises producing mainly other non-market goods and services;

- The non-profit institutions' sector serving households includes only private non-profit institutions that produce mainly non-market goods and services to households.

2.51. In the table 2.5 scheme, gross fixed capital formation, opening stocks of produced fixed assets, and closing produced fixed assets by industry may also be cross-classified by institutional sector to be used in other SNA accounts and in the dynamic analysis of the economy. Closing produced fixed assets are equal to opening produced fixed assets plus changes in assets. Changes in assets include:

- Changes in volume of produced fixed assets due to transactions which are actually gross fixed capital formation;

- Changes in volume of produced fixed assets not due to transactions (such as unanticipated destruction or disappearances); and

- Changes in produced fixed assets due to changes in prices.

The cross-classification scheme may also be applied to non-produced assets that are used in production.

2.52. The cross-classification matrix, if relationships are assumed not to change in the short run, can be used to link the effects of production on industries to those on institutional sectors.

2.53. It should be pointed out that gross capital formation and fixed produced assets are classified by ownership; so if owned by government agents and classified as producers of government services but benefiting mainly other producers, they may need to be reclassified wherever appropriate for production analysis. For example, roads are classified as the assets of producers of government services but in fact they benefit directly producers of transport services.

Table 2.5

Cross-classification of value added by industry and institutional sectors

	Non-financial corporations sector (classified by ISIC)				Financial corporations sector (classified by ISIC)				General government sector (classified by ISIC)				Household sector (classified by ISIC)				Non-profit institutions serving households (classified by ISIC)			
	Total	Ind. 1	...	Ind. n	Total	.	.	.	Total	.	.	.	Total	.	.	.	Total	Ind. 1	...	Ind.n
		(1)	(2)	(3)																
Industry output at basic prices																				
Intermediate consumption at purchasers' prices																				
Value added at basic prices																				
Compensation of employees																				
Other taxes less subsidies on production																				
Consumption of fixed capital																				
Operating surplus/Mixed incomes																				
Opening stocks of produced fixed assets																				
Gross fixed capital formation																				
Other changes in volume																				
Revaluation																				
Closing stocks of produced fixed assets																				

D. The statistical units and classification schemes for data collection

2.54. For the purpose of compiling the SNA SUT as shown in tables 2.1 and 2.2, it is important to decide on the statistical units and on the schemes to classify them. Table 2.6 shows the elements of SNA and the classification schemes they need for classification. In addition, items in the first two columns may also be cross-classified with the classifications of the last column as discussed previously.

Table 2.6. Uses of classification schemes

Industrial classification (ISIC)	Central product classification (CPC)	Institutional classification
Economic activities	Intermediate consumption	Enterprises (smallest legal unit)
Industries	Final demand	Government units
Industry output	Final consumption expenditure	Non-profit institutions serving households
Value added	Gross capital formation	Households
	Exports	
	Imports	
	Product output	

1. Statistical units and classification scheme for an activity or industry

2.55. The statistical unit for activities or industries recommended by the SNA is the establishment. An operational definition of the establishment unit is a production unit consisting of either "an enterprise, or a part of an enterprise, that is situated in a single location and in which only a single (non-ancillary) productive activity ... accounts for most of the value added."[21] (SNA, para. 5.21). Under this operational definition, an establishment may engage "in one or more secondary activities, [which] should be on a small scale compared with the principal activity. If a secondary activity within an enterprise is as important, or nearly as important, as the principal activity, then that activity should be treated as taking place within a separate establishment from that in which the principal activity takes places. The definition of an establishment does not permit an ancillary activity to constitute an establishment on its own." (SNA, para. 5.22). If an enterprise has more than one establishment, normally identified with a separate location or book of manufacturing business accounts, data manipulation is needed to allocate the managing and other costs shared by all establishments in the enterprise. In many cases, the headquarters and warehouses may be in separate location, but not classified separately as establishments by the SNA; they are treated only as ancillary activities.

[21]*Ibid.*, para. 5.21.

2.56. The categories into which data on activities or industries may be classified are in the United Nations publication entitled *International Standard Industrial Classification.* (ST/ESA/STAT/SER.M/41/Rev.3) These categories are used to classify establishments into various kinds of economic activities. At present, the ISIC contains 17 major sections (with alphabet coding), 60 divisions (with two-digit coding), 169 groups (with three-digit coding) and 291 classes (with four-digit coding). Thus with ISIC it is possible to classify activities into 291 industries. National classification standards may be elaborated from the standards recommended by the United Nations. If a country prefers to have more details, it may further break down a certain class of activities into various sub-classes, and on the other hand, if it requires less information it may aggregate many classes into one.

2.57. The main purpose of the ISIC is to provide a hierarchical set of categories of economic activities which can be utilized when dissecting production statistics according to kinds of activities. The definition of ISIC categories is strongly linked with the way the economic process is organized, with each unit as homogeneous as possible. For this reason, the groups and classes of the ISIC are in some cases too detailed to be used in classifying enterprises or similar institutional units by kind of economic activity since a significant number of enterprises will own establishments which engage in a range of activities spanning more than one ISIC class. Thus, establishments are recommended as the statistical units used in identifying economic activities.

2.58. In SUT, "industry" refers to the kind of activity into which all units which engage primarily in that kind of activity are aggregated.

2.59. Appendix A to this chapter gives the full list of divisions (two-digit level) of the ISIC classification of activities. The detailed definition of each activity at four-digit level can be found in the United Nations publication referred to in paragraph 2.56 above.

2.60. Appendix B which gives the classification of products is discussed below in paragraphs 2.61-2.62. Appendix C gives the *Classification of the Functions of Government* (COFOG) which is important to split expenditures by producers of government services into various kinds of activities and to identify the items that can be classified as part of individual final consumption.

2. Statistical units and classification scheme for products

2.61. The statistical unit for products is a unit of homogeneous goods and services and the *Central Product Classification version 1.0*[22] is recommended for the classification of products which are either outputs of domestic production activities or imports from non-resident sources.

2.62. The product dimension of the SNA input-output framework may be based on *Central Product Classification* (CPC) covering both goods and services. It is exhaustive and all products are mutually exclusive. In principle, CPC is meant to be used for all kinds of statistics which need product detail. It was developed primarily to include categories for everything that can be the object of a domestic and international transaction. This means that in CPC, not only are all products which are an output of an economic activity represented but also the purchase or sale of land are covered or similar transactions as well

[22]*Central Product Classification, version 1.0*, Series M, No. 77, United Nations, 1997.

as those that arise from legal contracts (such as patents, licences and copyrights), though some of these assets are not regarded as goods and services in the SNA.

2.63. Appendix B includes only the aggregated list of CPC by major division (with two-digit coding) with correspondence with ISIC, Rev. 3. The detailed classification, however, consists of 10 sections (one-digit coding), 69 divisions (two-digit coding), 291 groups (three-digit coding), 1,036 classes (four-digit coding) and 1,787 sub-classes (five-digit coding). The full classification can be found in the United Nations publication referred to above. In theory, the classification coding can accommodate 65,610 categories. Thus, the CPC allows for expanding classification into a more detailed one.

3. Correspondences between ISIC and CPC

2.64. In obtaining the symmetrical input-output table (SIOT) of either product-by-product or industry-by-industry tables from the supply-and-use tables of SUT, the classification of economic activities must be the same as the classification of products. Thus a correspondence between ISIC and CPC is needed. Theoretically, these two classifications need not match. The CPC is a system of categories covering both goods and services in which homogeneity within categories is maximized whereas the ISIC covers industrial activities of similar types. The principles of classification used by the CPC are as follows:

(a) For transportable goods, categories of products should be based on the physical properties and the intrinsic nature of the products, i.e. the raw materials of which they are made, their stage of production, the use they are intended for, the prices at which they are sold, whether or not they can be stored, etc.;

(b) Individual goods and services as far as possible should contain only goods and services which are produced by a single industry.

2.65. With the first principle as the main criterion, different products may come out of the same industry. For example, meat and hides are both produced by a slaughterhouse but they are put into entirely separate CPC categories: unprocessed hides are considered animal materials and are classified in section 0 "Agriculture, forestry and fishery products", whereas meat is classified in section 2 among food products. Similar problems also arise in agriculture, mining, manufacturing, etc. A farm may produce farm products and also provide farming services. A particular industry may produce a specific product and provide repair, maintenance services or manufacturing services on a fee or contract basis. These goods and services are classified under different parts of the CPC. These services are given a separate division (86). The CPC provides a correspondence between itself and ISIC at the four-digit level but the correspondence is only a general guideline because there can be no fixed correspondence at an aggregate level. For example, common salt (Na Cl) can be produced in mining - a mining product, and also in food production (sea salt) - a food product. At the most detailed level, an approximate correspondence is possible given that the most common production processes used in a particular country are taken into account. For the member countries of the European Union, *Classification of Products according to Activities* (CPA) and the detailed *Classification of Products for Community Surveys on Manufacturing Industries* (PRODCOM) have been used as national classifications since 1993 in order to build a better correspondence between product and activity classifications.

4. Statistical units for institutional sectors

2.66. An institutional unit that is used frequently in this chapter can be a household, or a legal, social entity. It is defined as "an economic entity that is capable, in its own right, of owning assets, incurring liabilities and engaging in economic activities and in transactions with other entities."[23] The SNA provides five broad categories of institutional sectors to classify institutional units: the non-financial corporations sector, the financial corporations sector, the household sector, the non-profit-institutions-serving- households sector and the general government sector.

2.67. In the area of business, an institutional unit is normally a legal entity that is collectively owned by shareholders with the authority to appoint directors who are responsible for its general management, can enter into contracts; receive and dispose of its income, maintain an independent, complete set of accounting records, including profit and loss accounts and balance sheets; at the same time, the unit has its own rights, privileges and liabilities as distinct from its owners. All corporate enterprises or corporations are classified into either the non-financial sector or the financial sector. Quasi-corporate enterprises are unincorporated but operate as if they are de facto corporations to their owners and therefore keep complete sets of accounts. They are treated as corporate enterprises in the SNA. Cooperatives and limited liability partnerships are also treated by the SNA as corporations. Non-profit institutions serving business interests are classified in the institutional sector they serve.

2.68. Private non-profit institutional units serving households are also legal entities which are organized like profit-oriented corporations. Their aims are however to produce mainly non-market goods and services to serve households. The non-profit institutional sector serving households excludes the private non-profit institutional units serving businesses and the units controlled and financed by the Government.

2.69. In the government sphere, a government institutional unit is a unique kind of legal entity established by political processes with legislative, judicial or executive authority over other institutional units within a given region. Its principal function is to assume responsibility for the provision of other non-market goods and services to the community or to individual households. It has the authority to raise funds by collecting taxes or compulsory transfers from other institutional units. By this definition, all corporations which produce mainly market goods and services are classified into either the non-financial or the financial corporations sectors. The general government sector includes only government units providing other non-market services and government unincorporated enterprises (i.e. without full sets of accounts) owned by government units that may produce both market and non-market goods and services. An example of a government unincorporated enterprise is a unit within a governmental branch producing government documents. The classification of the functions of government (COFOG) and the relationship between ISIC and COFOG are helpful in classifying government activities both in terms of establishment-type units and institutional units and in the preparation of two types of government final consumption: individual and collective final consumption. It should be noted that COFOG is being revised to take into account changes in the SNA 1993.

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[23]*System of National Accounts 1993*, para. 4.2.

Appendix A

INDUSTRY CLASSIFICATION

INTERNATIONAL STANDARD OF INDUSTRIAL CLASSIFICATION
OF ALL ECONOMIC ACTIVITIES

LIST OF TABULATION CATEGORIES AND DIVISIONS
(BROAD STRUCTURE)

Tabulation categories	Division	Description
A		**AGRICULTURE, HUNTING AND FORESTRY**
	01	Agriculture, hunting and related service activities
	02	Forestry, logging and related service activities
B		**FISHING**
	05	Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing
C		**MINING AND QUARRYING**
	10	Mining of coal and lignite; extraction of peat
	11	Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction excluding surveying
	12	Mining of uranium and thorium ores
	13	Mining of metal ores
	14	Other mining and quarrying
D		**MANUFACTURING**
	15	Manufacture of food products and beverages
	16	Manufacture of tobacco products
	17	Manufacture of textiles
	18	Manufacture of wearing apparel; dressing and dyeing of fur
	19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
	20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
	21	Manufacture of paper and paper products
	22	Publishing, printing and reproduction of recorded media
	23	Manufacture of coke, refined petroleum products and nuclear fuel
	24	Manufacture of chemicals and chemical products
	25	Manufacture of rubber and plastics products
	26	Manufacture of other non-metallic mineral products
	27	Manufacture of basic metals
	28	Manufacture of fabricated metal products, except machinery and equipment
	29	Manufacture of machinery and equipment n.e.c.

30 Manufacture of office, accounting and computing machinery
31 Manufacture of electrical machinery and apparatus n.e.c.
32 Manufacture of radio, television and communication equipment and apparatus
33 Manufacture of medical, precision and optical instruments, watches and clocks
34 Manufacture of motor vehicles, trailers and semi-trailers
35 Manufacture of other transport equipment
36 Manufacture of furniture; manufacturing n.e.c.
37 Recycling

E ELECTRICITY, GAS AND WATER SUPPLY

40 Electricity, gas, steam and hot water supply
41 Collection, purification and distribution of water

F CONSTRUCTION

45 Construction

G WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES, MOTORCYCLES AND PERSONAL AND HOUSEHOLD GOODS

50 Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel
51 Wholesale trade and commission trade, except of motor vehicles and motorcycles
52 Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods

H HOTELS AND RESTAURANTS

55 Hotels and restaurants

I TRANSPORT, STORAGE AND COMMUNICATIONS

60 Land transport; transport via pipelines
61 Water transport
62 Air transport
63 Supporting and auxiliary transport activities; activities of travel agencies
64 Post and telecommunications

J FINANCIAL INTERMEDIATION

65 Financial intermediation, except insurance and pension funding
66 Insurance and pension funding, except compulsory social security
67 Activities auxiliary to financial intermediation

K REAL ESTATE, RENTING AND BUSINESS ACTIVITIES

70 Real estate activities
71 Renting of machinery and equipment without operator and of personal and household goods
72 Computer and related activities
73 Research and development

74 Other business activities

L PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY

75 Public administration and defence; compulsory social security

M EDUCATION

80 Education

N HEALTH AND SOCIAL WORK

85 Health and social work

O OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICE ACTIVITIES

90 Sewage and refuse disposal, sanitation and similar activities
91 Activities of membership organizations n.e.c.
92 Recreational, cultural and sporting activities
93 Other service activities

P PRIVATE HOUSEHOLDS WITH EMPLOYED PERSONS

95 Private households with employed persons

Q EXTRA-TERRITORIAL ORGANIZATIONS AND BODIES

99 Extra-territorial organizations and bodies

Appendix B

CENTRAL PRODUCT CLASSIFICATION, VERSION 1.0

THE LIST OF SECTIONS AND DIVISIONS
OF CENTRAL PRODUCT CLASSIFICATION (CPC)

Tabulation categories	Division	Description
0		**AGRICULTURE, FORESTRY AND FISHERY PRODUCTS**
	01	Products of agriculture, horticulture and market gardening
	02	Live animals and animal products
	03	Forestry and logging products
	04	Fish and other fishing products
1		**ORES AND MINERALS; ELECTRICITY, GAS AND WATER**
	11	Coal and lignite; peat
	12	Crude petroleum and natural gas
	13	Uranium and thorium ores
	14	Metal ores
	15	Stone, sand and clay
	16	Other minerals
	17	Electricity, town gas, steam and hot water
	18	Water
2		**FOOD PRODUCTS, BEVERAGES AND TOBACCO; TEXTILES, APPAREL AND LEATHER PRODUCTS**
	21	Meat, fish, fruit, vegetables, oils and fats
	22	Dairy products
	23	Grain mill products, starches and starch products; other food products
	24	Beverages
	25	Tobacco products
	26	Yarn and thread; woven and tufted textile fabrics
	27	Textile articles other than apparel
	28	Knitted or crocheted fabrics; wearing apparel
	29	Leather and leather products; footwear
3		**OTHER TRANSPORTABLE GOODS, EXCEPT METAL PRODUCTS, MACHINERY AND EQUIPMENT**
	31	Products of wood, cork, straw and plaiting materials
	32	Pulp, paper and paper products; printed matter and related articles
	33	Coke oven products; refined petroleum products; nuclear fuel
	34	Basic chemicals
	35	Other chemical products; man-made fibers
	36	Rubber and plastic products

37 Glass and glass products and other non-metallic products n.e.c.
38 Furniture; other transportable goods n.e.c.
39 Wastes or scraps

4 METAL PRODUCTS, MACHINERY AND EQUIPMENT

41 Basic metals
42 Fabricated metal products, except machinery and equipment
43 General purpose machinery
44 Special purpose machinery
45 Office, accounting and computing machinery
46 Electrical machinery and apparatus
47 Radio, television and communication equipment and apparatus
48 Medical appliances, precision and optical instruments, watches and clocks
49 Transport equipment

5 INTANGIBLE ASSETS; LAND; CONSTRUCTION; CONSTRUCTION SERVICES

51 Intangible assets
52 Land
53 Constructions
54 Construction services

6 DISTRIBUTIVE TRADE SERVICES; LODGING; FOOD AND BEVERAGE SERVING SERVICES; TRANSPORT SERVICES; AND UTILITIES SERVICES

61 Wholesale trade services
62 Retail trade services
63 Lodging; food and beverage serving services
64 Land transport services
65 Water transport services
66 Air transport services
67 Supporting and auxiliary transport services
68 Postal and courier services
69 Electricity distribution services; gas and water distribution services through mains

7 FINANCIAL AND RELATED SERVICES; REAL ESTATE SERVICES; AND RENTAL AND LEASING SERVICES

71 Financial intermediation services, insurance and auxiliary services
72 Real estate services
73 Leasing or rental services without operator

8 BUSINESS AND PRODUCTION SERVICES

81 Research and development services
82 Professional, scientific and technical services
83 Other professional, scientific and technical services
84 Telecommunications services; information retrieval and supply services
85 Support services
86 Production services, on a fee or contract basis

87 Maintenance and repair services

9 COMMUNITY, SOCIAL AND PERSONAL SERVICES

91 Public administration and other services to the community as a whole; compulsory social security services
92 Education services
93 Health and social services
94 Sewage and refuse disposal, sanitation and other environmental protection services
95 Services of membership organizations
96 Recreational, cultural and sporting services
97 Other services
98 Domestic services
99 Services provided by extraterritorial organizations and bodies

Appendix C

THE CLASSIFICATION OF THE FUNCTIONS OF GOVERNMENT (COFOG)[24]

Tabulation categories	Division	Description
01		**GENERAL PUBLIC SERVICES**
	01.1	Executive and legislative organs, financial and fiscal affairs, external affairs other than foreign aid
	01.2	Foreign economic aid
	01.3	General services
	01.4	Basic research
	01.5	R&D general public services
	01.6	General public services n.e.c.
	01.7	Public debt transactions
	01.8	Transfers of a general character between different levels of government
02		**DEFENCE**
	02.1	Military defence
	02.2	Civil defence
	02.3	Foreign military aid
	02.4	R&D defence
	02.5	Defence n.e.c.
03		**PUBLIC ORDER AND SAFETY AFFAIRS**
	03.1	Police services
	03.2	Fire protection services
	03.3	Law courts
	03.4	Prisons
	03.5	R&D public order and safety
	03.6	Public order and safety n.e.c.
04		**ECONOMIC AFFAIRS**
	04.1	General economic and commercial affairs
	04.2	Agriculture, forestry, fishing and hunting
	04.3	Fuel and energy
	04.4	Mining, manufacturing and construction
	04.5	Transport
	04.6	Communication
	04.7	Other sectors
	04.8	R&D economic affairs

[24]The provisional COFOG was issued by the United Nations as part of the *Draft Classifications of Expenditure According to Purpose*, ST/ESA/STAT/SER.M/84, 24 November 1998.

04.9 Economic affairs n.e.c.

05 ENVIRONMENTAL PROTECTION

05.1 Waste management
05.2 Waste water management
05.3 Pollution abatement
05.4 Protection of biodiversity and landscape
05.5 R&D environmental protection
05.6 Environmental protection n.e.c.

06 HOUSING AND COMMUNITY AMENITIES

06.1 Housing development
06.2 Community development
06.3 Water supply
06.4 Street lighting
06.5 R&D housing and community amenities
06.6 Housing and community amenities n.e.c.

07 HEALTH

07.1 Prescribed medical products, equipment and appliances
07.2 Out-patient services
07.3 Hospital services
07.4 Public health services
07.5 R&D health
07.6 Health n.e.c.

08 RECREATIONAL, CULTURE AND RELIGION

08.1 Recreational services
08.2 Cultural services
08.3 Broadcasting and publishing services
08.4 Religious and other community services
08.5 R&D recreation, culture and religion
08.6 Recreation, culture and religion n.e.c.

09 EDUCATION

09.1 Pre-primary and primary education
09.2 Secondary education
09.3 Tertiary education
09.4 Education not definable by level
09.5 Subsidiary services to education
09.6 R&D education
09.7 Education n.e.c.

10 SOCIAL PROTECTION

- 10.1 Sickness and disability
- 10.2 Old age
- 10.3 Survivors
- 10.4 Family and children
- 10.5 Unemployment
- 10.6 Housing
- 10.7 Social exclusion n.e.c.
- 10.8 R&D social protection
- 10.9 Social protection n.e.c.

III. VALUATION IN I/O TABLE

3.1. The symmetric I/O model (SIOT) is assumed to measure production relationships on the basis of the technical structure of the economy. In order to reflect that basic assumption, model builders should try not only to maximize the homogeneity of establishments classified into the same ISIC, but also to use the same valuation for both goods and services supplied and used that eliminates the effects of government policies or costs of transactions on technical relationships. This chapter focuses on how to measure SIOT in the same price system.

A. Concepts of valuation

3.2. Goods and services may be valued in various ways. Following are the three ways in which they may be measured in the SNA:

Purchasers' price: "The purchasers' price is the amount paid by the purchaser, excluding any deductible VAT [value added taxes] or similar deductible tax, in order to take delivery of a unit of a good or service at the time and place required by the purchaser. The purchasers' price of a good includes any transport charges paid separately by the purchaser to take delivery at the required time and place."[1] It should be noted that in business accounts, "freight-in costs" are normally separated from the purchased value of goods if these costs are paid separately.

Producers' price: "The producer's price is the amount receivable by the producer from the purchaser for a unit of a good or service produced as output minus any VAT, or similar deductible tax, invoiced to the purchaser. It excludes any transport charges invoiced separately by the producer."[2]

Basic price: "The basic price is the amount receivable by the producer from the purchaser for a unit of a good or service produced as output, minus any tax payable, and plus any subsidy receivable, on that unit as a consequence of its production or sale. It excludes any transport charges invoiced separately by the producer."[3]

3.3. The relationship between different types of prices can be given as follows:

[1] *Ibid.*, para. 6.215.

[2] *Ibid.*, para. 6.205.

[3] *Ibid.*

	Purchasers' price
minus	Trade and transport margins
equals	Producers' prices
minus	Taxes on products (sales tax, manufacturers' excise tax, and/or non-deductible VAT)
plus	Subsidies on products
equals	Basic price

3.4. Trade and transport margins are the difference between the purchasers' price and the producers' price of a product. Because of the differences in trade and transport margins and taxes less subsidies on a given product, a product can be sold at different purchasers' prices. More concretely, purchasers' prices and producer's prices vary non-uniformly for the same product for the following reasons:

(a) Trade margins vary from one transaction to another depending on whether the goods are purchased directly from producers, wholesalers or retailers; they also vary by "class" of retail establishments (at high prices in establishments with higher-quality services and at lower prices at discount establishments with lower-quality services);

(b) Transport margins vary by mode of transport and the distance the goods have to be shipped;

(c) Policies on taxes on products are normally based on the purposes for which products are used (e.g., no taxes are imposed, or taxes are fully or partly deductible, on products used for production or export purposes);

(d) Who records the transaction: the seller may record it without transport cost while the buyer may record it with transport cost.

3.5. For all these reasons, basic prices are more homogeneous than producer's prices which in turn are more homogeneous than purchasers' prices.

3.6. Since the same goods and services can be measured differently in the market and since homogeneity is one of the most important underlying assumptions of input-output economics, the SNA recommends products to be measured as homogeneously or uniformly as possible in the SIOT, preferably in basic prices. When that is not possible, they can be valued at producers' prices instead. In the case of services, purchasers' and producers' prices are the same since the services are sold directly by producers to consumers. Basic prices of services are of course different from producers' prices since product taxes on services also do exist.

3.7. Because taxes are normally levied on products at the point at which they are sold by wholesalers and retailers for the convenience of government tax collectors, a large part of taxes on products is included in the trade margins. Consequently, some countries, when measuring output at producers' prices, have treated these taxes as taxes on the trade margins. This treatment is convenient but not very interesting since it is not possible to obtain directly taxes collected on each kind of commodity. The SNA recommends linking taxes on products with product output value as shown in the supply table 3.1. Information on taxes on each group of product as well as wholesale and retail trade margins can be obtained from the surveys of wholesale and retail trade.

3.8. Transport margins are treated as part of trade margins when transport costs are paid for by trade establishments and therefore are treated as their intermediate consumption. Where transport costs are paid directly by purchasers, they are treated as services consumed directly by them.

3.9. In the SNA supply and use tables (SUT) or in SIOT, it is important to note that trade margins can be presented in one row (representing trade activities as a whole), two rows (representing separate wholesale and retail activities), or many rows (each row representing a trading activity, either wholesale or retail, in one particular kind of product). The columns also have to be split accordingly. There is an advantage to doing this as each product may require a different trade margin, especially when products are weighty and have to be transported over great distances. The detailed breakdown of trade margins is however rarely done due to the need for detailed information and the large size of the resulting input-output tables.

B. Valuation and the tax system

3.10. The problem of valuation in the supply and use tables (SUT) is to organize data consistently using the same price system and finally to arrive at tables in basic prices. Depending on the kind of tax system used, valuation will be approached slightly differently. In non-VAT countries, it is easily to convert all elements of SUT into one price system: either producers' values or basic values. In VAT countries, the conversion of SUT into one price system using basic values is as simple as the non-VAT case. However, the conversion of SUT from mixed to producers' prices is a lot more complicated, particularly with regard to the net treatment of producers' prices. Thus it is important to summarize again the definition of non-VAT and VAT before the treatment of valuation in SUT is explained.

1. Non-VAT taxes

3.11. A non-VAT system is one of sales taxes on products which are normally assessed at the final stages of transactions on final purchasers and, unlike VAT, not deductible. These taxes are mainly imposed on goods and services for final consumption. They are usually not imposed on goods and services for intermediate consumption, capital formation and sometimes exports. Non-deductible taxes on products at the factory gate usually called manufacturers' excise taxes should be treated similarly.

2. Value added taxes (VAT)

3.12. Value added taxes are imposed on every stage of transaction but are usually deductible - although a non-deductible part may occur - when they are used for intermediate consumption, capital formation or exports. However, VAT are not usually charged on exports.

3.13. When taxes are deductible, a producer deducts those he paid on the intermediate and capital goods he purchased, from the VAT he invoices to the purchasers of his products before transferring the difference to the Government.

3.14. In a VAT country, some form of sales taxes such as excise tax on liquor, gasolines, cigarettes, etc. may also be applied. These taxes are not deductible. Further discussion of the VAT system is left for part E of this chapter.

C. The derivation of the supply and use tables (SUT) at basic prices, VAT and non-VAT

3.15. With SUT fully discussed in chapter II, their presentation will not be repeated here. The emphasis in this part is on the derivation of the supply and use tables at basic prices universally applicable to either non-VAT, VAT or mixed systems. Compilers need only read part C and ignore part E if they decide to derive SUT or SIOT in basic prices which are recommended by this Handbook.

3.16. However, a few comments are needed on the presentation of supply table 3.1 and use table 3.2:

- The total supply of every product at purchasers' prices in column 11, table 3.1, is equal to its total use at purchasers' prices of the same product in column 9 of table 3.2.

- The industry outputs at basic prices in row 6 of table 3.1 are the same as shown in row 11 of table 3.2.

- Uses in table 3.2 are at purchasers' prices excluding deductible VAT but including all other non-deductible taxes on products so as to make the costs in the use table represent actual costs to producers or consumers (see exhibit B, para. 3.28 below).

- Gross value added at basic prices in row 9 of table 3.2 (i.e. 196) is the sum of compensation of employees, other taxes less subsidies on production, consumption of fixed capital and mixed incomes.

- Total gross value added or GDP (row 8) is equal to gross value added at basic prices plus total taxes less subsidies on production and imports. Thus, total gross value added = GDP = 196 + 20 = 216.

- Total final demand is equal to total final household final expenditures + total government final expenditures + gross capital formation = 153 + 50 + 10 = 203.

- The GDP should also be equal to total net final demand. Thus, total net final demand = total final household final expenditures (which also include final expenditures of NPISHs in the example) + total government final expenditures + gross capital formation + total exports f.o.b. - total imports f.o.b. = 153 + 10 + 40 + 38 - 25 = 216.

- In the supply table, table 3.1, product 2 includes both goods and all services except trade and transport services. Thus in the column of c.i.f./f.o.b. adjustment, -1 is entered in row 2 as the value of insurance services on imported goods rendered by residents and non-residents.

- In table 3.1 the total value of row 3 (column 11) is the transport services that are directly purchased by producers and final consumers because trade and transport margins (-60) are subtracted from the total supply of trade and transport services. These directly purchased transport services are shown in the use table, table 3.2, as purchased by the household sector, mainly passenger transportation but possibly also for goods transportation. However, they can also be purchased directly by industries and other sectors.

- In use table 3.2, row 4 does not appear so that a row of taxes less subsidies on products can be inserted at basic prices while keeping the same row index numbers for all elements in tables 3.2, 3.4 and, 3.5.

3.17. The derivation of the use table at basic prices is fully shown in table 3.3. Shown there is the breakdown of the value of every use at purchasers' prices, in rows 1 to 3 of table 3.2, into three parts: value at basic prices, trade and transport margins and taxes less subsidies on products. In table 3.3, the values at basic prices are shown in rows 1 to 3 in the same position as in table 3.2, with their trade and transport margins in rows 1' and 2', and the taxes less subsidies paid on these products in rows 1" to 3".[4] For example, the value of product 1 at purchasers' prices used by households as final goods which is 100 in table 3.2 is split into:

- 71, the basic value shown in table 3.3 in row 1, column 6;

- 20, transport and trade margins shown in row 1', column 6 and;

- 9, taxes less subsidies shown in row 1", column 6.

3.18. Total uses at purchasers' prices in row 7 of table 3.3 are the same as those shown in row 7 of table 3.2. The final result is shown in table 3.4 in which all product uses are measured at basic prices. Row 3 in table 3.4 is the sum of rows 3, 1' and 2' in table 3.3 and row 4 of table 3.4 is the sum of rows 1", 2" and 3" in table 3.3.

3.19. The final use and supply tables in basic prices can be combined to produce the symmetric I/O table (SIOT). Table 3.5 shows imports as part of the use table which is the presentation that is needed to carry out I/O modelling. In this table, imports are entered as negative values. Because of this, column 11 shows total use of domestic products only. These are the same values of total domestic production as in column 4 of table 3.1.

3.20. To conclude the discussion on the derivation of SUT at basic prices, it should be pointed out that the presentation in table 3.3 is only for the purpose of illustration. In practice, a table of trade and transport margins and a table of taxes less subsidies on products are separately compiled using the same structure as the use table in purchasers' prices. The values in these tables are then deducted from the corresponding values in the table at purchasers' prices 3.2. Then, the row of column sums of the table of trade and transport margins (rows 1' and 2' of table 3.3) is added back to the row of trade and transport services. Similarly, an extra row of taxes less subsidies is created in table 3.4 which takes the values of the row of the column sums of the table of taxes less subsidies shown in row 1" to row 3" in table 3.3.

D. The derivation of SUT at producers' prices

3.21. The discussion below presents only the method of deriving SUT without VAT and the implications of using this system. No discussion on the net system of SUT is presented because, as discussed in part E, this system serves no purpose unless SUT assumes that every industry produces only one product, which

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[4]Rows with signs, e.g.1', 1", are split from row 1.

means that the system is symmetric. If that is the case, the derivation can be easily obtained on the basis of the previous discussion of VAT.

3.22. The tables presenting SUT at producers' prices are 3.6-3.10. These tables are structurally similar to tables 3.1-3.5 of the system at basic prices. They also contain values that are consistent with those in tables 3.1-3.5. The derivation of the use table at producers' prices is similar to the derivation of the use table at basic prices discussed previously so it will not be repeated here. However, there are some important differences that need to be pointed out:

- Unlike output of industries at basic prices in table 3.1, output of industries at producers' prices in table 3.6 includes taxes less subsidies on products. These taxes are, of course, not deductible.

- Since output supplies are measured in producers' prices, imports must be too. The equivalent value of imports in producers' prices is the ex-customs value which is the sum of the value of imports c.i.f. and import duties shown in supply table 3.6. Similarly, trade and transport margins must include sales taxes less subsidies on goods and services sold by wholesalers and retailers including those assessed on their margins.

- In table 3.7, taxes less subsidies on products payable by producers are included in row 9 and columns 1-3. As can be seen in this example, a large amount of taxes less subsidies on products is paid by wholesalers and retailers shown in row 9, column 3. This amount includes sales taxes on goods sold by them and taxes assessed on their own outputs, i.e. trade and transport margins. The taxes less subsidies on products shown in row 9 lose the direct link to specific products. At row 9 and column 4, the total import duties are entered so that row 9 contains all taxes less subsidies on production and imports.

- Gross industry value added at basic prices is calculated as residuals by subtracting total intermediate uses at purchasers' prices and taxes less subsidies on products from industry output at producers' prices. If one wants to get gross industry value added at producers' prices, one can deduct total intermediate uses at purchasers' prices from industry output at producers' prices, or simply the sum of gross value added at basic prices and taxes less subsidies on products. Gross value added at producers' prices is not shown in table 3.7 but it is equal to 213.

- The total gross value added or GDP is equal to the total gross value added at basic prices plus the total taxes less subsidies on production and imports, i.e. GDP = 216 = 196 + 20. The GDP can also be obtained by adding the total gross value added at producers' prices to import duties, i.e. GDP = 213 + 3.

- The GDP should also be equal to total net final demand (see table 3.7). Total net final demand = total final household final expenditures + total government final expenditures + gross capital formation + total exports f.o.b. - total imports f.o.b. = 153 + 10 + 40 + 38 - 25 = 216.

- In table 3.8, the derivation of the use table at producers' prices is similar to that of table 3.3, but here only a table of trade and transport margins is needed. Trade and transport margins in table 3.8 differ from those in table 3.3 because they include taxes assessed on the trade and transport margins and taxes that are collected on products sold by wholesalers and retailers and then transferred to the Government.

Table 3.9 is the final use table at producers' prices. Table 3.10 is the form of the use table which after being transformed to become a product-by-product table is the I/O symmetric model that is used for modelling. In this table, imports are entered in negative values. Because of this, column 11 shows the total use of domestic products only. These values are the same as those in column 4 of table 3.6. Column 12 entitled *total economy* is moved to the extreme right so that it is easier to show total taxes less subsidies on imports.

3.23. With the system measured at producers' prices, it is much harder to analyse the impact of tax policy since there is no direct linkage between the output of a product and the tax rates. The system measured at basic prices is better in this respect.

E. The supply and use tables with VAT

1. Definitions

3.24. The derivation of SUT in basic prices from SUT in mixed prices with VAT was discussed in part C of this chapter. The discussion here focuses only on the derivation of SUT with VAT in producers' prices. To that end, it is important to mention the following SNA definitions on VAT terminology:

Invoiced VAT: This VAT is payable on the sales of a producer and it is shown separately on the invoice from the producer to the purchaser;

Deductible VAT: This VAT is payable on purchases of goods or services intended for intermediate consumption, gross fixed capital formation or for resale which a producer is permitted to deduct from his own VAT liability to the Government in respect of VAT invoiced to his customers;

Non-deductible VAT: This VAT is payable by a purchaser and is not deductible from his own VAT liability;

Net VAT on product is the net total of taxes the Government collects on a product. It is equal to the VAT invoiced on the product output produced by various industries minus the deductible VAT on the same product when it is used either as intermediate input, for capital formation, or for export by all purchasers. Thus the net VAT on a product is the aggregate concept that is derived for a particular product.

2. Producers' prices, gross and net treatment of VAT and basic prices

3.25. The following example will explain the difference between gross and net treatment of VAT when one producer produces one product, i.e. SUT has to be symmetric. The example also assumes:

(a) No trade and transport margins and no non-VAT taxes on products so that producers' prices will equal purchasers' prices;

(b) Invoiced VAT is equal to 10% of values at purchasers' prices.

In the example, a producer sold product X for $200 (see exhibit A.1) and spent $50 on intermediate goods and services to produce the product. When selling, the producer invoiced $20 of VAT on the product he sold to his customers, deducted $5 of VAT invoiced on the goods and services he purchased for his production operation and turned over $15 (= 20 - 5) to the Government: $15 is payable VAT. Thus the actual cost of intermediate inputs, i.e. intermediate consumption valued net of deductible VAT, is only $45 (50 - 5). The amount of $200 is called producer's price, gross treatment. The basic price which is equal to the producers' price -- gross treatment less invoiced VAT on output sold is $180 (= 200 - 20).

3.26. The production account of the producer in the example with VAT can be presented in producers' price-gross treatment, producers' price-net treatment and basic price.

3.27. The producers' price-gross treatment is shown in exhibit A.1 and in the form of the use table in exhibit A.2. This gross treatment, though simple, is impractical because business accounts normally report sales excluding invoiced VAT, i.e. at basic prices, and also goods and services used in production are recorded excluding deductible VAT. The gross system was tried in some countries, Norway for example, but had to be abandoned partly for the reason mentioned and partly to conform with the convention set by the international community (such as the European Union) for the sake of international comparability.

Exhibit A.1. Producers' prices - gross treatment

Sale value (output at producers' price - gross treatment				200
Less Intermediate consumption				-50
Equal Value added at producers' price - gross treatment				150
	Equal Value added at basic price		135	
	Plus Payable VAT		15	
		Equal invoiced VAT on output sold	20	
		Less deductible VAT on intermediate consumption	5	

3.28. The basic value of the product sold is equal to the output at producer's prices-gross treatment less invoiced VAT. It is $180 = 200 - 20. The components that make up the output at basic prices are shown in exhibit B.1 and the presentation of the production and use of product X at basic prices in the use table is shown in exhibit B.2. In the use table, the deductible VAT must be excluded from intermediate consumption and final uses. Finally, in order to equate supply and demand, a column of negative net VAT on product must be added. The net VAT on product (see definition in para. 3.24) is equal to the total VAT invoiced on the product less the VAT paid on product but deductible ($16=20-(1+3)).

3.29. The system of producers' prices-net treatment is similar to the case of output measured at basic prices shown in exhibit B.2. Intermediate consumption of goods and services and final uses are valued at purchasers' prices excluding the deductible VAT, which means that only the non-deductible VAT is included. However, there is one important difference between the valuation at basic prices and the valuation at producers' prices-net treatment. In the former, production and consumption can be looked at from the points of view of both producers and consumers. In the latter, production is looked at from the point of view of producers, i.e. output at basic prices, but consumption is looked at from the point of view of consumers. In exhibit C.2 total of 196 is the total cost to consumer but in exhibit B.2, 180, the total output at basic prices, is the total value received by producers. The addition of 16, net VAT on product, to output at basic prices is needed to balance total supply and total use. The totals in the column and the corresponding row now reflect the point of view of consumers. It is also important to remind readers that in the exhibit C.2 example, only one type of product is assumed to be produced by a producer.

Exhibit A.2. The use table in producers' price - gross treatment

	Industry X	Other industries	Final consumption	Gross capital formation	Others	Total
	At purchasers' prices including invoiced VAT					
Product X	10 (1)*		160 (16)*	30 (3)*	0	200
Other products	40 (4)*					
Value added at basic prices	135					
Invoiced VAT	20					
Deductible VAT on inputs	-5					
Output at producers' price- gross treatment	200					

* Parenthesized numbers are invoiced VAT which is assumed to be with 10% of purchased values. In this example, only the invoiced VAT, on intermediate consumption (1 for product X) and capital formation (3 for product X) is deductible.

Exhibit B.1. Basic prices

Intermediate consumption at purchasers' prices excluding deductible VAT		45
Gross value added at basic prices		135
Output at basic price		180
Equal Output at producers' price - gross treatment (sale value)	200	
less VAT invoiced on the output sold	-20	

3.30. In exhibit C.2, which describes the recent practice in many European countries with VAT, the net system is used but with symmetric I/O tables (SIOT) in which one industry is assumed to produce only one product. If a producer produces many products as described in SUT, the net VAT on them can only be obtained after allocating the net VAT for each one. The value of net VAT on products obtained in this way does not even serve the purpose of balancing the supply-and-use tables as in the case of the symmetric I/O table because the output of an industry need not be equal to the value of the principal product it produces. Thus, in SUT with VAT, the system in basic prices should be adopted. The *European System of Accounts 1995* (ESA) (Eurostat, Brussels, Luxembourg, 1996) has decided to use only basic prices for valuation.

Exhibit B.2. The use table in basic prices

	Industry X	Other industries	Final consumption	Gross capital formation	Others	Net VAT on products	Total
	At purchasers' prices excluding deductible VAT		At purchasers' prices excluding deductible VAT				
Product X	9		160	27	0	-16	180
Other products	36						
Value added at basic prices	135						
Output at basic prices	180						

Exhibit C.1. Producers' price, net treatment in the use table

Intermediate consumption at purchasers' prices excluding deductible VAT	45
Gross value added at basic price	135
Output at basic price	180
Net VAT on product*	16
Total, net treatment	196

*20-4 (with 4 the deductible VAT on product X).

Exhibit C.2. The use table at producers' price - net treatment

	Industry X	Other industries	Final consumption	Gross capital formation	Others	Total
	At purchasers' prices excluding deductible VAT		At purchasers' prices excluding deductible VAT			
Product X	9		160	27	0	196
Other products	36					
Value added at basic prices	135					
Net VAT on products	16					
Total	196					

Table 3.1. Supply of products at basic prices

		Output of industries			Total economy	Imports c.i.f. (total f.o.b.)	C.i.f./ f.o.b. adj.	Total product supply at basic prices	Trade and transport margins	Taxes less subsidies on products		Total supply at purchasers' prices
										Import duties	Other taxes less subsidies on products	
		(1)	(2)	(3)	(4)=(1)+.+(+3)	(5)	(6)	(7)= (4)+.+(6)	(8)	(9)	(10)	(11)= (7)+.+(10)
(1)	Product 1	156	24	0	180	15		195	33	2	11	241
(2)	Product 2	9	80	0	89	8	-1	96	27	1	6	130
(3)	Transport services directly purchased	0	0	62	62	1	-1	62	-60	0	0	2
(4)	C.i.f./f.o.b. adjustment					-2	2	0				0
(5)	Direct purchases abroad by residents					3		3				3
(6)	Total industry output at basic prices (1)+.+(5)	165	104	62	331							
(7)	Other column total					25	0	356	0	3	17	376

Table 3.2. Use of products at purchasers' prices

		Intermediate consumption of industries			Total economy	Exports f.o.b.	Household final expenditures*	Government final expenditures	Gross capital formation	Total use of products at purchasers' prices
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)=(1)+.+(8)
(1)	Product 1	25	35	13		28	100		40	241
(2)	Product 2	32	20	10		9	49	10	0	130
(3)	Transport services directly purchased					0	2		0	2
(5)	Direct purchases abroad by residents						3			3
(6)	Direct purchases at home by non-residents					1	-1			0
(7)	Total uses at purchasers' prices (11)+.+(6)	57	55	23		38	153	10	40	376
(8)	Total gross value added/GDP				216					
(9)	Gross value added at basic prices (11)-(7)	108	49	39	196					
(10)	Taxes less subsidies on production and imports				20					
(11)	Industry output at basic prices	165	104	62	331					

Other relationships in the supply and use tables are shown below with U_{ij} standing for entry in row i and column j in this table and S_{ij} in the supply table 3.1:

$GDP = U_{8.4} = U_{9.4} + U_{10.4}$
Taxes less subsidies on production and imports $= U_{10.4} = S_{7.9} + S_{7.10}$.

* Including final consumption expenditures of NPISHs.

Table 3.3. Derivation of use of products at basic prices

		Intermediate consumption of industries			Total economy	Exports f.o.b.	Household final expenditures*	Government final expenditures	Gross capital formation	Total use of products at basic prices
	Product at basic prices	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)=(1)+.+(8)
(1)	Product 1	19	28	10		27	71		40	195
(2)	Product 2	29	18	8		8	23	10		96
(3)	Transport services directly purchased						2		0	2
(1')	Trade and transport margins on product 1	5	5	2		1	20		0	33
(2')	Trade and transport margins on product 2	2	2	1		1	21		0	27
(1")	Taxes less subsidies on product 1	1	2	1		0	9		0	13
(2")	Taxes less subsidies on product 2	1	0	1		0	5		0	7
(3")	Taxes less subsidies on product 3						0			0
(5)	Direct purchases abroad by residents						3			3
(6)	Direct purchases at home by non-residents					1	-1			0
(7)	Total uses at purchasers' prices (1)+.+(6)	57	55	23		38	153	10	40	376
(8)	Total gross value added/GDP				216					
(9)	Gross value added at basic prices (11) - (7)	108	49	39	196					
(10)	Taxes less subsidies on production and imports				20					
(11)	Total industry output at basic prices	165	104	62	331					

Other relationships in the supply and use tables are shown below with U_{ij} standing for entry in row i and column j in this table and S_{ij} in the supply table 3.1:

$GDP = U_{8.4} = U_{9.4} + U_{10.4}$

Taxes less subsidies on production and imports $= U_{10.4} = S_{7.9} + S_{7.10}$.

*Including final consumption expenditures of NPISHs.

Table 3.4. Use of products at basic prices

		Intermediate consumption of industries			Total economy	Exports f.o.b	Household final expenditures*	Government final expenditures	Gross capital formation	Total use of products at basic prices
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)=(1)+.+(8)
(1)	Product 1	19	28	10		27	71		40	195
(2)	Product 2	29	18	8		8	23	10		96
(3)	Trade and transport services**	7	7	3		2	43		0	62
(4)	Taxes less subsidies on products	2	2	2		0	14		0	20
(5)	Direct purchases abroad by residents						3			3
(6)	Direct purchases at home by non-residents					1	-1			0
(7)	Total uses at purchasers' prices (1)+.+(6)	57	55	23		38	153	10	40	376
(8)	Total gross value added/GDP				216					
(9)	Gross value added at basic prices (11) - (7)	108	49	39	196					
(10)	Taxes less subsidies on production and imports				20					
(11)	Total industry output at basic prices	165	104	62	331					

Other relationships in the supply and use tables are shown below with U_{ij} standing for entry in row i and column j in this table and S_{ij} in the supply table 3.1:

$GDP = U_{8.4} = U_{9.4} + U_{10.4}$
Taxes less subsidies on production and imports $= U_{10.4} = S_{7.9} + S_{7.10}$.

* Including final consumption expenditures of NPISHs.

** Trade and transport services are equal to trade and transport margins plus transport services directly purchased.

Table 3.5. Use of products at basic prices: the conventional form of I/O model

		Intermediate consumption of industries			Total economy	Household final expenditures*	Government final expenditures	Gross capital formation	Exports f.o.b.	Imports c.i.f. (total f.o.b.)	c.i.f./f.o.b. adj.	Total use of domestic products at basic prices
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)=(1)+.+(10)
(1)	Product 1	19	28	10		71		40	27	-15		180
(2)	Product 2	29	18	8		23	10		8	-8	1	89
(3)	Trade and transport services**	7	7	3		43		0	2	-1	1	62
(4)	Taxes less subsidies on products	2	2	2		14		0	0			20
(5)	Direct purchases abroad by residents					3				-3		0
(6)	Direct purchases at home by non-residents					-1			1			0
(7)	C.i.f./f.o.b. adjustment									2	-2	0
(8)	Total uses at purchasers' prices (1)+.+(7)	57	55	23		153	10	40	38	-25	0	351
(9)	Total gross value added/GDP				273							
(10)	Gross value added at basic prices (12) - (8)	127	77	49	253							
(11)	Transport services directly purchased				20							
(12)	Total industry output at basic prices	165	104	62	331							

Other relationships in the supply and use tables are shown below with U_{ij} standing for entry in row i and column j in this table and S_{ij} in the supply table 3.1:

$GDP = U_{8.4} = U_{9.4} + U_{10.4}$
Taxes less subsidies on production and imports $= U_{10.4} = S_{7.9} + S_{7.10}$.

*Including final consumption expenditures of NPISHs.

**Trade and transport services are equal to trade and transport margins plus transport services directly purchased.

Table 3.6. Supply of products at producers' prices

		Output of industries			Total economy	Imports at ex-customs value			Total product supply at producer prices	Trade and transport margins including sales taxes	Total product supply at purchasers' prices
						Imports c.i.f. (total f.o.b.)	c.i.f./ f.o.b. adj.	Import duties			
		(1)	(2)	(3)	(4)=(1)+.+(3)	(5)	(6)	(7)	(8)= (4)+.+(7)	(9)	(10)= (8)+(9)
(1)	Product 1	161	25	0	186	15		2	203	38	241
(2)	Product 2	9	82	0	91	8	-1	1	99	31	130
(3)	Transport services directly purchased	0	0	71	71	1	-1	0	71	-69	2
(4)	c.i.f./f.o.b. adjustment					-2	2		0		0
(5)	Direct purchases abroad by residents					3			3		3
(6)	Total industry output at producer prices (1)+.+(5)	170	107	71	348						
(7)	Other column total					25	0	3	376	0	376

Table 3.7. Use of products at purchasers' prices

		Intermediate consumption of industries			Import duties	Total economy	Exports f.o.b.	Household final expenditures	Government final expenditures	Gross capital formation	Total use of products at purchasers' prices
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)=(1)+.+(9)
(1)	Product 1	25	35	13			28	100		40	241
(2)	Product 2	32	20	10			9	49	10	0	130
(3)	Transport services directly purchased						0	2		0	2
(4)	Direct purchases abroad by residents							3			3
(5)	Direct purchases at home by non-residents						1	-1			0
(6)	Total uses at purchasers' prices (1)+.+(5)	57	55	23			38	153	10	40	376
(7)	Total gross value added/GDP					216					
(8)	Gross value added at basic prices (10)-(6)-(9)	108	49	-32		196					
(9)	Taxes less subsidies on production and imports	5	3	9	3	20					
(10)	Industry output at producer prices	170	107	71		348					

Other relationships in the supply and use tables are shown below with U_{ij} standing for entry in row i and column j in this table and S_{ij} in the supply table (3.6).

GDP = $U_{7,5} = U_{8,5} + U_{9,5}$
Import duties = $U_{9,4} = S_{7,7}$
Taxes less subsidies on production and imports = $U_{9,5} = U_{9,1} + \ldots + U_{9,4}$.

Table 3.8. Derivation of the use table at producers' prices

		Intermediate consumption of industries			Import duties	Total economy	Exports f.o.b.	Household final expenditures	Government final expenditures	Gross capital formation	Total product uses at producer prices
	Product at producers' prices	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)=(1)+.+(9)
(1)	Product 1	20	30	11			27	75		40	203
(2)	Product 2	30	18	9			8	24	10		99
(3)	Transport services directly purchased							2		0	2
(1')	Trade and transport margins on product 1	5	5	2			1	25		0	38
(2')	Trade and transport margins on product 2	2	2	1			1	25		0	31
(4)	Direct purchases abroad by residents							3			3
(5)	Direct purchases at home by non-residents						1	-1			0
(6)	Total uses at purchasers' prices (1)+.+(5)	57	55	23			38	153	10	40	376
(7)	Total gross value added/GDP					216					
(8)	Gross value added at basic prices (10)-(6)-(9)	108	49	39		196					
(9)	Taxes less subsidies on production and imports	5	3	9	3	20					
(10)	Total industry output at producers' prices	170	107	71		348					

Other relationships in the supply and use tables are shown below with U_{ij} standing for entry in row i and column j in this table and S_{ij} in the supply table (3.6).

GDP = $U_{7.5} = U_{8.5} + U_{9.5}$
Import duties = $U_{9.4} = S_{7.7}$
Taxes less subsidies on production and imports = $U_{9.5} = U_{9.1} + ... + U_{9.4}$.

Table 3.9. The use table at producers' prices

		Intermediate consumption of industries			Import duties	Total economy	Exports f.o.b	Household final expenditures	Government final expenditures	Gross capital formation	Total product uses at producer prices
	Product at producers' prices	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)=(1)+.+(9)
(1)	Product 1	20	30	11			27	75		40	203
(2)	Product 2	30	18	9			8	24	10		99
(3)	Trade and transport services*	7	7	3			2	52		0	203
(4)	Direct purchases abroad by residents							3			3
(5)	Direct purchases at home by non-residents						1	-1			0
(6)	Total uses at purchasers' prices (1)+.+(5)	57	55	23			38	153	10	40	376
(7)	Total gross value added/GDP					216					
(8)	Gross value added at basic prices (10)-(6)-(9)	108	49	39		196					
(9)	Taxes less subsidies on production and imports	5	3	9	3	20					
(10)	Total industry output at producer prices	170	107	71		348					

Other relationships in the supply and use tables are shown below with U_{ij} standing for entry in row i and column j in this table and S_{ij} in the supply table (3.6).

$GDP = U_{7.5} = U_{8.5} + U_{9.5}$
Import duties $= U_{9.4} = S_{7.7}$
Taxes less subsidies on production and imports $= U_{9.5} = U_{9.1} + \ldots + U_{9.4}$.

*Trade and transport services are equal to trade and transport margins plus transport services directly purchased.

Table 3.10. The use table at producers' prices: the conventional form of I/O model

		Intermediate consumption of industries			Exports f.o.b.	Imports at ex-custom value			Household final expenditures	Government final expenditures	Gross capital formation	Total use of domestic products at producers' prices	Total economy
						Imports cif (total f.o.b.)	Import duties	c.i.f./f.o.b. adj.					
	Product at producers' prices	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)=(1)+.+(10)	(12)
(1)	Product 1	20	30	11	27	-15	-2		75		40	186	
(2)	Product 2	30	18	9	8	-8	-1	1	24	10		91	
(3)	Trade and transport services*	7	7	3	2	-1	0	1	52		0	71	
(4)	C.i.f./f.o.b. adjustment					2		-2				0	
(5)	Direct purchases abroad by residents					-3			3			0	
(6)	Direct purchases at home by non-residents				1				-1			0	
(7)	Total uses at purchasers' prices (1)+.+(6)	57	55	23	38	-25	-3	0	153	10	40	348	
(8)	Total gross value added/GDP												216
(9)	Gross value added at basic prices (11)-(7)-(10)	108	49	39									196
(10)	Taxes less subsidies on production and imports	5	3	9			3						20
(11)	Total industry output at producer prices	170	107	71									348

Other relationships in the supply and use tables are shown below with U_{ij} standing for entry in row i and column j in this table.

Taxes less subsidies on production and imports = $U_{10.12} = U_{10.1} + U_{10.2} + U_{10.3} + U_{10.6}$
Total gross value added/GDP = $U_{8.12} = U_{9.12} + U_{10.12}$.

*Trade and transport services are equal to trade and transport margins plus transport services directly purchased.

IV. CONVERTING SUPPLY AND USE TABLES INTO A SYMMETRIC I/O TABLE: TREATMENT OF SECONDARY PRODUCTS

A. Introduction

4.1. The present chapter takes as a point of departure the supply and use tables that define the SNA input-output framework that was reviewed in chapter II. It describes what methods could be used to convert the SNA I/O framework of supply and use tables to a symmetric I/O table in which each industry produces only one product, what conditions should be met to facilitate the conversion and/or its use in analysis and what statistical issues must be faced in the conversion.

4.2. Theoretically, an I/O coefficient table may be compiled directly, using engineering information, without first creating an input-output table in monetary values. To do so, one may ask detailed technical information on all production processes operating in an economy. If a product is produced by more than one process, an average input structure of those production processes would be created by weighing input columns with output values. As weights change, the average input structures would have to be frequently updated. With additional information on gross output, value added and final demand, it is possible to recreate a flow table using the I/O coefficient matrix and output prices and thus check the accuracy and compatibility of the engineering information with the data on value added and final demand, in the final balancing of the table. This construction of I/O tables in physical terms is not simple, since enterprises may be reluctant to reveal technical details of their production processes. Thus technical data may have to be collected through special surveys, independently of censuses, and this may be very expensive. This is why the compilation of I/O tables has relied mainly on data provided by censuses of establishments and special surveys. This information could be supplemented by engineering-type data but this is rarely done. In view of these difficulties and the existing practices, the present chapter will not deal with I/O tables in physical units.

4.3. The ideal situation for a symmetric I/O table is to have data that describe the input structure of every type of activity producing a single product in the economy. With such an ideal situation, the I/O table is almost symmetric and homogeneity in production function in the table is guaranteed, except for the cases of by-products or joint products that are linked technologically in a production activity. If homogeneity is not guaranteed, a distortion in analysis; particularly when total effects are calculated by the use of the Leontief inverse may result. For example, in order to assess the total effects of an increase in demand of electricity on the economy, reasonable estimates may not be obtainable if an I/O table only includes one industry producing electricity. This is because electricity is produced by different processes: gas, coal, oil, water power or windmill, etc., whereby each process requires a different set of inputs and consequently generates different impacts. The column of inputs used for electricity production in this case may possibly be an aggregate of different processes of electric generation. The assessment of the impact of an increase in electricity demand using the I/O model is meaningful only if that increase is met by the same mix of electric generation technologies that are shown as market shares of the technologies at the time the table is prepared. If the technology that is used to meet the increase in demand for electricity is known in advance, first the inputs needed for this particular type of technology have to be calculated, and then the indirect effects of the increased inputs have to be estimated. But even here, the question needs to be asked whether or not the inputs used to produce indirect demand of electricity are truly represented by the columns of the I/O table. Further exploration of the use of I/O table for analysis will be the focus in later chapters on applications. The above simply serves to emphasize the importance of the homogeneity property in input-output economics, i.e., each industry in an input-output table should be as homogeneous as possible when used as a tool for analysis. To improve the homogeneity property in analysis, it is important to maintain original data that are used in the construction of an average technology in order to facilitate the construction of a different average technology when needed. The present availability of computer power at low cost makes it feasible to maintain a huge database that can be recombined to construct an I/O for a specific need.

4.4. In contrast to the ideal situation, the SNA use and supply tables as an integrated framework for production statistics are designed to serve as the best statistical tool to compile national accounts aggregates and provide information for the compilation of the symmetric I/O table. However, SUT, if taken only as a tool for balancing supply and uses of products in the compilation of national accounts aggregates or institutional sector accounts, would not need to apply rigorously the homogeneity assumption, which certainly would require the identification of product production technologies. To extend this argument even further, SUT as a tool for balancing supply and use products may even be based on enterprises as statistical units. In this case, the derivation of the symmetric I/O table from SUT is purely a mathematical approximation. Even if an establishment is used as the statistical unit, the resulting supply matrix still contains many secondary products, though the derivation of the symmetric table is less an exercise in pure mathematical approximation. In order to eliminate the need to either carry out supplementary surveys or live with the problems of secondary products and resolve them by mechanical methods, I/O statisticians should engage in the planning of data collection by censuses. The strategy is, as much as possible, to define operationally a purer establishment, linking each product produced to an establishment. It is possible to design production censuses by asking business accountants using the cost accounting approach to allocate costs to a specific type of product produced by an establishment. Cost accounting is a common practice used by large enterprises in their pricing and general management policy. Allocation keys are used to assign costs to every kind of product produced by the enterprises. Some of the common allocation keys are work hours (for example, those spent by the personnel of the maintenance department in other departments are used to allocate maintenance costs), surface area for allocating rental, kilometres driven, percentage of administrative work done in each establishment to allocate central administration costs, etc.[1] In doing this, most secondary products will be eliminated from SUT. Mathematical methods which are basically mechanical will be used only as a last resort. The approach proposed above is feasible given the availability of inexpensive means of data processing at present. The database should make it possible to link a product technology to a specific establishment which, in turn, is identified with a specific enterprise.

4.5. Given the discussions in paragraph 4.4, the current chapter examines first the statistical approach for eliminating secondary products before mathematical methods are discussed. However, whether statistical or mathematical methods are usable depends on the types of secondary products produced.

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[1]See M. Francis Rousse and Vu Quang Viet, "Use of Business Accounts to Determine the Cost of a Particular Product in a Multi-product Establishment", chapter II of the *Handbook of National Accounting: Links between Business Accounting and National Accounting* (ST/ESA/STAT/SER.F/76).

B. Types of secondary products

1. Secondary products resulting from statistical practices

4.6. Secondary products may result from less refined statistical practices that do not adhere strictly to the SNA definition of an establishment (see chapter II, para. 2.55). Such practices may originate from a statistical policy to present production data as realistically as possible, and adopt the enterprise as the statistical unit.

4.7. If enterprises are used as statistical units and are multi-establishment, producing more than one product, the issue of secondary products arises, i.e. in the supply table more than one product will be recorded for the same industry.

4.8. Another example is when vertically integrated enterprises (or establishments) are not broken down into separate establishments, as recommended by the SNA.

4.9. Also the case may occur of a horizontally integrated enterprise operating at one location and producing different products for sale on the market. In this case, though, it may be obvious that each product is produced through a different technology, but production data may be collected in the aggregate, treating the enterprise as one establishment only.

4.10. Even when following the SNA recommendations, secondary products would still appear as long as activities producing them are not identified as separate establishments, though the implementation of the SNA recommendations will greatly reduce the scope of secondary products in input-output tables that are usually resolved mechanically later.

2. Secondary products resulting from production technology

4.11. By-products exist because certain technologies produce more than one product simultaneously, and similar products may also be produced elsewhere by other, quite different techniques of production. Three types may be distinguished:

(a) **Exclusive by-products** are products that are not produced separately anywhere, e.g., molasses linked to the production of sugar, new scrap in metal industries.

(b) **Ordinary by-products** are products that are technologically linked to the production of other products but are also produced separately elsewhere as main products. An example of this type is hydrogen produced as a by-product in petroleum refining establishments but also produced separately by other establishments in the chemical industry.

(c) **Joint products** are products that are more loosely linked technologically than ordinary by-products; the common costs shared by joint products are more significant in value than is the case for ordinary by-products. One example is milk and meat in the livestock industry which may be produced on a scale that depends on the demand for each product and the ratio of the two products may be varied in response to changing conditions of demand. One of the joint products may be produced separately elsewhere. Joint products cannot be easily distinguished from by-products.

C. Partitioning enterprises into units of homogeneous production

4.12. It is the enterprise unit that is able to provide statistics on productive activities, on incomes, profits and losses, and its assets and liabilities. But as an enterprise may be involved in more than one activity, e.g. an automobile company might produce airplanes, tanks and ammunition, trading activity or even computer services for sale, they should not be used as the statistical unit for production accounts of which input-output tables are a part because production technology of the enterprise is not homogeneous. In this case, the SNA recommends that the enterprise be partitioned into separate establishments, each of which engages in only one productive activity. An industry in an I/O table is then defined as a group of establishments engaged in the same kind of productive activities.

4.13. Partitioning enterprises into units of homogeneous production is an important task in the collection of production data and, as a consequence, the compilation of the symmetric I/O table. The best way to get inputs and outputs from the units of homogeneous production in an enterprise is to ask it to do so with clear instructions from data collectors so that there will be no need to use mechanical methods to separate them afterwards. Below are the SNA rules recommended for partitioning enterprises into units of homogeneous production.

1. General SNA rules for creating a separate establishment

4.14. An establishment defined as a production unit consists of either an enterprise or a part of one, which engages in a single kind of productive activity at a single location. To be an establishment, the unit must be able to provide the outputs produced and inputs used, the number of people employed, the fixed assets and changes in inventories used, consumed and put in place during the accounting period.[2] With respect to outputs, they need not be for sale and can be measured by imputation with the use of market prices for the same type of products on sale or at cost as in the case of producers of government and non-profit services.

4.15. If an enterprise uses a single production process at a single location and produces only one product, it is considered as one establishment. If the enterprise has many establishments, separate units of homogeneous production should be created for each establishment. The SNA definition of establishments allows for secondary activity producing secondary products.[3] The operational definition is, therefore, inexact. Furthermore, for I/O compilers of the symmetric table, secondary outputs and associated inputs must somehow be separated. As a consequence, the I/O table would be much more reliable if the separation were done at the source by business accountant who should be requested, whenever possible, to allocate costs to every product the establishment produces. Cost allocation for the sake of determining product prices is not alien to business accountants.

4.16. Most of the inputs used by each establishment and the outputs it produces can be itemized by the enterprise accountants. However there are other costs that are shared by all establishments within the enterprise. These costs are generated by ancillary activities, such as processing and communication of information, transportation, storage, purchasing, sales promotion, cleaning, maintenance, security which are needed to support the main productive activities of the enterprise. These activities cannot stand alone; they are usually services produced for internal intermediate consumption and normally can be found in almost all

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[2]See *System of National Accounts 1993*, para. 5.26.

[3]*Ibid.*, para. 5.21.

enterprises of similar type and therefore should be integrated with main activities by allocating the costs of these activities to each main activity (more on allocation later). They should not be separated as establishments but the inputs they use should be allocated to the establishments for which they provide services.

4.17. Certain types of activities, however, should never be treated as ancillary but should always be treated as productive activities and separated as establishments. They include:

(a) The production of goods for further processing within the same vertically integrated enterprise e.g. the production of cloth which is then manufactured into clothing, the extraction of crude oil which is then refined into petroleum, etc.;

(b) Own-account production of goods and own-account construction by households, Governments or enterprises;

(c) Mineral exploration in order to discover new deposits whether undertaken on own account by enterprises or by other enterprises, which are hired to do the job.

2. Separation of own-account construction and vertically integrated activities

4.18. The separation of secondary activities from main activities, for example the separation of own-account construction from other activities or of vertically integrated activities, as is the case of an integrated petroleum industry combining both crude oil extraction and petroleum refining, is normally done by valuing outputs at cost. In order to implement this separation in an input-output table, all costs pertaining to the activity have to be separated out. The operating surplus of the enterprise as a whole has to be distributed proportionally to each activity on the basis of value added minus operating surplus. Total costs plus operating surplus make up output values. Despite the practical difficulties involved in partitioning vertical integrated enterprises into establishments, the SNA recommends that when a vertical enterprise spans two or more headings at the first level of breakdown of the ISIC (see chapter II, para. 2.56 of this Handbook) at least one establishment must be distinguished within each heading.

3. Cost allocation of ancillary activities to establishments

4.19. When using establishments as the statistical units for production accounts, one has to deal with the issue of cost allocation of ancillary activities in multi-establishment enterprises. A difficult accounting problem arises within a multi-establishment enterprise when certain ancillary activities are carried out centrally for the benefit of all individual establishments which make up the enterprise. They may include activities such as marketing, sales, purchasing, accounting, data processing, computing, transportation, maintenance, and so on. The central unit, which is often also the head office, is likely to have its own separate location away from the establishments it serves. The costs of the ancillary activities are recommended by the SNA to be allocated over all the establishments for which they provide services. If there are cost accounting records showing how much of the central cost is attributable to the separate establishments, they should be allocated on this basis. In many countries, cost accounting is normally prepared in large enterprises. If the necessary information is not available, the cost of each type of input consumed by the central unit should be distributed over the establishments served in proportion to the value of the output of each establishment less the value of its intermediate costs excluding the costs of the ancillary activities themselves. If this method also proved to be too difficult to apply, the cost of each central input may be distributed simply in proportion to the value of the outputs of the establishments served. The approach proposed here in fact is not very different from that adopted in enterprise cost accounting.

4. Ancillary activities with sales

4.20. In addition to the above case which is clear-cut, there are areas that are not so clear-cut. In fact, there are enterprises that also sell part of the ancillary services to other enterprises. For instance, a computerized database, an accounting system or storage facilities may first be developed for internal use but later on attract customers. Should these activities continue to be treated as ancillary?

4.21. The SNA recommends that as ancillary units sell half or more of their outputs, they should be treated as separate establishments. The outputs used internally will be treated as services consumed with imputed values from the newly created establishment. When an ancillary unit is not classified as a separate establishment, though a part of its output is sold on the market in addition to the outputs of the main activity, secondary production shows up in the supply table. This secondary production reflects the output of the ancillary unit that is sold. Of course, if enterprises are used as statistical units for production accounts, more secondary products would appear in the supply table of the input-output framework. Thus, with the recommendation of establishments as statistical units, the SNA attempts to reduce the secondary product problem. At this point, it is important to note that the decision in the SNA to treat market output of ancillary activities as secondary products actually leaves the difficult question of dealing with secondary products to input-output statisticians and economists when they want to obtain symmetric input-output tables. The general practice is to either sweep it under the rug by aggregation or to use mathematical methods on the basis of some assumptions to reclassify the secondary outputs and their associated inputs. But this reclassification is nothing other than creating a separate establishment of the market output of ancillary units.

4.22. The separation of ancillary units when at least half of their outputs are sold to other enterprises could be complicated. If the entire output of an ancillary unit is separated as the output of a separate establishment, several statistical difficulties will be encountered. For instance, how should its output be valued? Should the entire output be valued at the price the output is sold to the market? Furthermore an additional operating surplus needs to be imputed for the non-market portion of output of the ancillary activity. Secondly, if the value of the non-market portion is based on costs plus an imputed operating surplus which is a portion of the operating surplus of the enterprise itself, the SNA recommendation on valuation to treat each product as a different product if it has a different price, is ignored.[4] Therefore the best approach when compiling input-output tables is to create only separate establishments for the market ancillary output while leaving the non-market output with the main activity of the establishment. Though this is not recommended by the SNA, it is better to remove secondary products by statistical rather than mathematical methods in the process of obtaining the symmetric I/O table. The allocation of costs is similar to the procedure described above. In this case, outputs of the same ancillary unit will be treated as different products since they are sold at different prices.

[4] "In economic theory it is generally assumed that whenever a difference in price is found between two goods and services which appear to be physically identical there must be some other factor, such as location, timing, conditions of sale, etc., which is introducing a difference in quality...In most cases, therefore, differences in prices at the same moment of time must be taken as prima facie evidence that the goods or services concerned, represent different qualities of the same general kind of good or service." (SNA, para. 16.110).

5. The redefinition method

4.23. The following example shows how the redefinition method operates. Let us take the example given in table 4.1(a) below where product 3 is, in fact, produced elsewhere but due to reported data, that activity has been aggregated as part of industry 1. Let us assume that we can find additional information on the input structure of that activity as follows:

Product 1	1
Product 2	2
Product 3	0
Value added	3
Total output	5

Then the additional information can be inserted as column 3 of table 4.1(a) and deducted from column 1.[5] This method is similar to the mathematical method which is based on the commodity technology assumption, which will be discussed later except that compilers may be directly involved in deciding which independent inputs are to be assigned to the secondary products.

4.24. Given that data are collected on an establishment basis and consist of secondary products which are not by-products or joint products resulting from production processes, it is still beneficial to collect input data independently for the secondary products of the same kind and use this information to estimate the inputs associated with the secondary products and transfer them out. For example, bicycle tyres may be a secondary product of both the bicycle industry and the automobile tyre production, while no bicycle tyre single-activity enterprises exist. The result is that in SUT no industry produces bicycle tyre. It is possible to use the mathematical method based on the commodity technology assumption to transfer out secondary outputs and their associated inputs, but the method may produce negative results. In this case, it is better to obtain independent information on bicycle tyre production and use it to estimate inputs of the secondary products and then transfer them out. In so doing, I/O compilers may be able to pass judgement on the quality of the information. This is the essence of the redefinition method though it requires additional information. Construction, which covers all kinds of activities with very different input structures, is also a secondary product of many industries. It is important to identify it by specific kind and apply the redefinition method. If the establishment is classified by activity at a detailed level in SUT, there would be more independent information on the inputs of a specific product that is not tainted by the existence of other secondary products.

D. Treatment of secondary products resulting from production technology[6]

4.25. In order to separate by-products as defined previously from the main products of an industry, they should be clearly identified in the product classifications that are used. Up to now there are no satisfactory solutions for the separation of by-products and joint products in input-output tables, and only second best solutions are offered here. Some of these solutions may be quite acceptable if the tables are desegregated and detailed enough, but this is rarely the case. On the other hand, the issue may be exaggerated somewhat because

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[5]This method is the same as the one suggested by P.J.A. Konijin in *The Make and Use of Commodities by Industries, on the Compilation of Input-Output Data from the National Accounts*, Enschede, The Netherlands, Faculteit Bestuurskunde, Twente University, 1994.

[6]This is partly based on "Practices in Input-Output Table Compilation" by Vu Quang Viet in *Regional Science and Urban Economics*, The Netherlands Vol. 24, No.1,1994.

by-products and joint products are not pervasive in any economy, and generally low in values as compared to principal products, and therefore second-best solutions are acceptable.

4.26. There are three types of methods in use to separate outputs and inputs of by-products and joint products. These are the so-called negative transfer method developed by Richard Stone in which only output is transferred, the aggregation or positive transfer method in which output and input of by-products remain included with the main product of the industry in which they are produced, and a third method in which both output and inputs are transferred to the by-products and joint products characteristically belong.

1. The negative transfer method

4.27. The negative transfer method developed by Stone is generally used for exclusive by-products. It is illustrated with fictitious data presented in table 4.1(a) and the solution is given in table 4.1(b).

4.28. In the example of table 4.1(b) product 3 is the by-product of the first industry. It is entered as negative input, so that the total output of the first industry is reduced from 115 to 110; the latter is equal to the output of product 1. As the by-product is used by the second industry, it is recorded there as intermediate input. As a result of this manner of recording, the output of the third industry representing the by-product is zero, and the input column of the industry of by-products contains only zeros.

Table 4.1(a). An example of secondary products

Use table	Intermediate consumption		Final demand	Product output
Product 1	10	20	80	110
Product 2	30	10	60	100
Product 3		5	0	0
Value added	75	65		
Industry output	115	100		
Supply table				
Product 1	110			110
Product 2		100		100
Product 3	5			5
Industry output	115	100		

Table 4.1(b) The negative transfer method for exclusive by-products

	Intermediate consumption			Final demand	Product output
Product 1	10	20	0	80	110
Product 2	30	10	0	60	100
Product 3	-5	5	0	0	0
Value added	75	65	0		
Product output	110	100	0		

4.29. The negative transfer method has implications for I/O analysis, which can be explained with the following I/O coefficient table and Leontief inverse that are derived from table 4.1(b).

The I/O coefficient table resulting from negative transfer method

$$\begin{bmatrix} .0909 & .2000 & .0000 \\ .2727 & .1000 & .0000 \\ -.0454 & .0500 & .0000 \end{bmatrix}$$

The Leontief inverse

$$\begin{bmatrix} 1.1786 & .2619 & .0000 \\ .3571 & 1.1905 & .0000 \\ -.0357 & .0476 & .1000 \end{bmatrix}$$

4.30. Assume that final demand of the second product increases from 60 to 100 while the demand of the first product remains the same. Since the by-product is required as input by the second industry, more by-product will need to be produced to satisfy the increase in final demand of the second product. At the same time, an additional amount of by-product (shown as negative inputs) would be required by an increase in the output of the first product. There is no mechanism in the model that will generate a net output of by-products equal to zero, as was the case in table 4.1(b) corresponding to a benchmark year. In the example, by multiplying the Leontief inverse by the new final demand vector of (80 100 0), a total gross output of (120.5 147.6 1.9) would be needed. This implies a 1.9 net increase of by-products which can either be met by additional imports of the by-product or increasing the production of the first product beyond what is needed for final demand.

4.31. If alternatively it is assumed that final demand of the first product increases more than the second product, for example (100 60 0), the required output vector will be (133.57 107.14 -.714). In this case, the value of the by-product is not zero but negative. This is obviously the amount of the by-product produced by the first producer but left unused.

4.32. When using the negative transfer method for ordinary by-products that are also produced elsewhere, the input column of the by-product must be aggregated with the inputs of identical products that are produced as principal products elsewhere. Assuming that the secondary product is also produced by the second industry, the results are shown in table 4.1(c). The negative transfer method applied in this case will result in similar distortions as were mentioned for exclusive by-products. In this case, changes may occur in the proportion of market shares between the by-product and the product identical to it which was produced elsewhere and in the relative weights between the output of the industry that produces the by-product and the outputs of industries that use the by-products as inputs.

Table 4.1(c) The negative transfer method for by-products when by-products are aggregated with similar products produced elsewhere

	Intermediate consumption		Final demand	Product output
Product 1	10	20	80	110
Product 2	30-5	10+5	60	100
Value added	75	65		
Product output	110	100		

4.33. Mathematically, the I/O coefficient matrix A_{cc} derived from the negative transfer method when by-products are aggregated with the same products produced elsewhere is as follows:

$$A_{cc} = (U - \check{V})\hat{V}^{-1}$$

where $\hat{V}$ denotes diagonalization by elimination of the off-diagonal elements of matrix V;
$\check{V}$ denotes off-diagonalization by elimination of the diagonal elements of matrix V
and U the intermediate matrix of the use table.

4.34. The above examples show that when using the negative transfer method much care should be taken in interpreting the final data after application of the Leontief inverse. They also show that this method will only be workable as a basis for analysis, as long as the industry of by-products is not aggregated with other industries. By identifying by-products and the corresponding industry separately, it will be possible to analyse changes in market shares more explicitly.

2. The aggregation or positive transfer method

4.35. The positive transfer method is practiced by some I/O compilers for exclusive by-products (see definition in para. 4.11). Following this method, exclusive by-products are treated as if they were primary products of the industry where they are produced. This treatment is illustrated in table 4.2.

Table 4.2 Treatment of exclusive by-products using the positive transfer method

	Intermediate consumption		Final demand	industry output
Product 1	10	20+5	80	115
Product 2	30	10	60	100
Value added	75	65		
Industry output	115	100		

4.36. In this case, output of the first industry also includes the by-product, and thus is 115 instead of 100. The third industry disappears in table 4.2 as compared to table 4.1(b) . The by-product is sold by the first industry to the second industry as though it were the principal product; this results in an increase of inputs of product 1 into industry 2 from 20 to 25, as compared to table 4.1. Again this method will only provide realistic outputs in I/O analysis if the proportion of product 1 to product 2 remains constant over time. If this method is used, it will not be possible to detect structural changes in the use of the by-product, as was the case with the negative transfer method, as the by-product is not separately identified. The method has a major defect, i.e. the input structure of the industry that produces these products as primary products is distorted by the inclusion of the fictitious purchase. As a result, whenever the demand for the product increases, so will the production of the industry that produces this product as by-products, which certainly is not true. To treat exclusive by-products, the negative transfer method is preferable.

3. Transfer of outputs and inputs

4.37. For ordinary by-products and joint products, compilers may apply the redefinition method for transferring out both outputs and inputs, if separate input information on similar products which are produced elsewhere is available. This method may be arbitrary since the assumption of similarity is wrong but until now no other method seems to be available to deal with ordinary by-products properly.

4.38. In the case of ordinary by-products there is an advantage in applying this procedure especially when the product in question is largely produced separately. The use of this procedure could be rightly criticized on the ground that by-products should not be separated from the principal product, since no additional inputs are required, as was the case in the examples presented in table 4.1(a). In reality, however, this is rarely the case, because at least some inputs specific to secondary products are required. Hydrogen as a by-product of petroleum refining needs at least to be bottled before delivery to the market. The more specific costs are needed for processing a by-product, the more reasonable the argument for allocating costs to the by-product. Furthermore, producers of the principal and by-products, when making production decisions, would always compare the revenues of the by-product with the corresponding costs.

4.39. There is no alternative to the separation of joint products into separate establishments by cost allocation. Since there already are costs that are specific to each product, only the costs that are common to all products need to be allocated. The allocation is similar to the allocation of ancillary costs or the redefinition method.

E. Transferring secondary outputs and associated inputs by mathematical methods

1. General

4.40. The recommended solution for separating secondary products from the sources by using more information which was discussed previously in paras. 4.4. and 4.24 is also based on the findings that until now no mathematical methods are able to satisfactorily derive the traditional symmetric input-output coefficient table that is the core of input-output economics, from both conceptual and practical points of view. These methods may still be needed as a last resort given that all possible information has been fully utilized. They will now be reviewed. There are two methods that are used for combining the make and use matrices[7] to derive the traditional input-output table. Before these methods are reviewed, some explanation is needed about the traditional symmetric input-output table.

4.41. It is commonly known that the supply and use tables do not have to be square. In fact, the number of products may be more than the number of industries (producers) and vice versa. In these cases, both the use and make tables are rectangular. However, a symmetric or square input-output matrix is required for input-output analysis, as only a square matrix can be inverted to obtain the Leontief inverse. A symmetric table can be a *product-by-product* or an *industry-by-industry* matrix. Both are mentioned in the SNA. In the first version a column in the intermediate matrix represents a product technology and a row represents the distribution of a product to intermediate inputs and as final use. In the industry-by-industry version a column represents an industry technology containing all inputs required by that industry, and a row represents the distribution of the industry output (which also contains secondary products) to all industries and to final consumers. The second type of I/O table is much less useful than the first one because an industry might represent a group of establishments, part of which may be artificially created by mathematical methods, and therefore does not reflect any "realistic" picture of the economy. It would be more useful if each industry represented a group of enterprises instead. One should also be careful to use the inverse of the industry-by-industry matrix when a significant time lag is involved because linear and fixed technical assumptions cannot be applied here. The inversion of this matrix should be done indirectly through the inversion of the product-by-product matrix so that whenever there are changes in market shares, a different industry-by-industry matrix is obtained, even though the product-by-product matrix remains the same.

4.42. There are basically two methods to combine the use and supply matrices mathematically to generate the traditional symmetric input-output matrix. These methods are based on either the industry technology assumption or the commodity technology assumption.

4.43. The industry technology assumption assumes that inputs are consumed in the same proportions by every product produced by a given industry, which means that principal and secondary products are all produced using the same technology, i.e. the same input structure. This assumption has been used by many countries on the basis of a recommendation made by the 1968 SNA mainly for two attractive reasons: first, the method always generates positive symmetric input-output tables; second, it is also applicable to the case of rectangular input-output tables. The method has since been found to break the fundamental economic rule that products with different prices at a given moment must reflect different costs or different technology. Therefore it cannot be considered acceptable.

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[7]The make matrix refers to the part of the supply table which describes domestic production. The use matrix refers to the part of the use table which describes intermediate consumption.

4.44. The commodity technology assumption assumes that the input structure of the technology that produces a given product is the same no matter where it is produced. This assumption though economically more reasonable than the industry technology assumption is not widely used because it tends to generate negative symmetric input-output tables and requires the make and intermediate matrices of the use table to be squared. In order to get rid of these negative coefficients, which are mostly small, additional methods have been used to adjust data in order to produce positive symmetric tables. The more prevalent methods are (i) setting all negative values to zero and using the RAS technique (which will be discussed in chapter IX) to balance the table and (ii) optimization such as minimization of variances under constraints to generate positive values. However, the latter is also questioned on other grounds such as an economic justification for a specific form of the objective function. Economically, the commodity technology assumption makes more sense than the industry technology assumption.

4.45. The two mathematical methods will be discussed in the following sections, based on the following notations and definitions.

Notations

m *number of products*

n *number of industries*

U_{mxn} *the intermediate matrix of the use table (product by industry)*

B_{mxn} *the use coefficient matrix (product by industry)*

M_{mxn} *the make matrix (product by industry),*
part of the supply matrix describing domestic production

Dsubnxm: the market share matrix (industry by product)

g_n *the vector of industry output*

q_m *the vector of product output*

$\hat{g}$ *the diagonal matrix of industry output*

$\hat{q}$ *the diagonal matrix of product output*

4.46. A matrix with a " ^ " it is a diagonal matrix version of the vector with the same notation; all off-diagonal elements are zeros. For example:

$$\hat{g} = \begin{bmatrix} g_1 & 0 & 0 \\ 0 & g_2 & 0 \\ 0 & 0 & g_3 \end{bmatrix}$$

Basic definitions:

$$(4.1) \qquad B = U\hat{g}^{-1}$$
$$(4.2) \qquad D = M'\hat{q}^{-1}$$

4.47. The numerical examples shown in table 4.3 below will be used to clarify the derivations of Leontief input-output coefficients on the basis of the make and use matrix.

2. The industry technology assumption

4.48. On the basis of this assumption, a product j can be produced by various industries k; each industry k needs b_{ik} of input i per unit of industry product j, where b_{ik}, i = i ... n represents the industry technology of an industry k; and each industry k has only a part of the market of product j. This market share of industry k in the production of product j has a notation d_{kj}. So all inputs i needed to produce one unit of product j by different producers can be written as follows:

$$(4.3) \quad a_{I,ij} = \sum_{k=1}^{n} b_{ik} \, d_{kj}$$

4.49. Thus, formula 4.3 shows that input i required for one unit of product j is a weighted average of the input structures of the producers where product j is produced; the weights are the market shares of each producer in the production of product j. In matrix form, equation 4.3 is written as:

$$(4.4) \quad A_{I,cc} = BD$$

where i refers to the industry technology and cc refers to the order of matrix A which is product by product.

4.50. As B is a product-by-industry matrix, D is an industry-by-product matrix, and the matrix $A_{I,cc}$ is a product-by-product matrix. Thus $A_{I,cc}$ is the I/O coefficient matrix that describes products directly required to produce other products.

4.51. The following example in table 4.3 which is the same example as in tables 3.1 and 3.5 of chapter III will show how all various matrices are calculated:

Table 4.3
An example of the use matrix and make matrix

	U use matrix		
	Industry		
Product	19	28	10
	29	18	8
	7	7	3
TX	2	2	2
VA	108	49	39
g	165	104	62

	M make matrix			
	Industry			q
Product	156	24	0	180
	9	80	0	89
	0	0	62	62
	165	104	62	

Industry outputs g = 165, 104, 62
Product outputs q = 180, 89, 62
Taxes less subsidies on products (on uses) TX = 2, 2, 2
Value added VA = 108, 49, 39

	$B = U\hat{g}^{-1}$		
	Industry		
Product	19/165	28/104	10/62
	29/165	18/104	8/62
	7/165	7/104	3/62
TX	2/165	2/104	2/104
VA	108/165	49/104	39/62

	$D = M'q^{-1}$		
	Product		
Industry	156/180	9/89	0/62
	24/180	80/89	0/62
	0/180	0/89	62/62

4.52. B normally refers to the product coefficient matrix only, i.e. the upper 3 rows and 3 columns. In equation 4.4, if B also includes the rows of taxes and value added, one can obtain the rows of taxes and value added by the production of each product. This can be observed in the resulting numerical example of $A_{I,cc}$ shown below. Unless otherwise specified later, B refers to a product-by-industry matrix, excluding the rows of taxes and value added. With the values of B and D given above,

$$A_{I,cc} = \begin{bmatrix} .1357 & .2536 & .1613 \\ .1754 & .1733 & .1290 \\ .0457 & .0648 & .0484 \\ .0131 & .0185 & .0323 \\ .6301 & .4897 & .6290 \end{bmatrix}$$

4.53. The basic equation 4.5 can be used to derive different types of symmetric I/O models:

- Product-by-product I/O model: this model calculates the impact of a final demand of products on the production of products.

- Industry-by-industry I/O model: this model calculates the impact of a final demand of industry outputs on the outputs of industries.

- Industry-by-product I/O model: this model calculates the impact of a final demand of products on the outputs of industries.

4.54. In order to show these different models that can be derived from the industry technology assumption, it is necessary to describe first the basic relationships in the use and supply tables in basic prices as shown in tables 3.1 and 3.5 of chapter III.

4.55. The basic relationship in the SNA use table 3.5 is:

(4.5) $q = Bg + YC$

where

YC: final demand of products which is the vector of 3 rows from 1-3 summing over columns 4 to 10 of table 3.5 of chapter III.

(4.6) $g = Dq$

(4.7) $YI = DYC$

(a) Product-by-product I/O model

4.56. Substituting equation 4.6 for g in equation 4.5 gives

(4.8) $q = BDq + YC$

then

(4.9) $(I\text{-}BD)q = YC$

4.57. Equation 4.9 can be used both to calculate the impact of YC on q and rearrange the I/O table 3.5 in chapter III.

4.58. Using the product-by-product matrix $A_{I,cc} = BD$ shown in both equations 4.9 and 4.4, one is able to calculate the flow of products, taxes and value added required for the product-by-product I/O table. Table 4.4 below presents the symmetric I/O table based on a product-by-product classification. It is the result of merging the supply table 3.1 and the use table 3.5 in chapter III.

(b) Industry-by-industry I/O model

4.59. By multiplying both sides of equation 4.5 by D and then replacing DYC and Dq by the relationships in equations 4.6 and 4.7, one obtains:

(4.10) $Dq = DBg + D\,YC$

(4.11) $g = DBg + YI$

(4.12) $(I-DB)g = YI$

4.60. This model can be used both to calculate the impact of a final demand for industry outputs on industry outputs and to rearrange use table 3.5 in chapter III. The I/O model based on equation 4.12 and tables 3.1 and 3.5 in chapter III is shown in table 4.5. This model is however of almost no interest to analysts since final demand is rarely in terms of industry outputs. In this model, imports continue to be classified by products.

(c) Industry-by-product I/O model

4.61. Substituting DYC for YI in equation 4.12 gives

(4.13) $(I - DB)g = DYC$

or

(4.14) $g = (I - DB)^{-1}\,DYC$

4.62. This model is a variation of the model shown in paragraph 4.59. It can be used to calculate the impact of a final demand for products, YC, on industry outputs. However, it cannot be used to arrange the flow I/O table in a meaningful manner because final demand is now classified by products and outputs classified by industries.

3. The commodity technology assumption

4.63. The basic premise of the commodity technology assumption is that a given product uses the same input structure irrespective of the industry where it is being produced. This can be written as

(4.15) $$u_{ij} = \sum_{k=1}^{n} a_{ik}\, m_{jk}$$

where u_{ij} is input i required by industry j, m_{jk} is product k produced by industry j and a_{ik} is the input i required to produce one unit of product k. Since an industry produces a number of products and each product requires a different set of inputs, the amount of inputs required by industry j will be the sum of the inputs i required for each of its products m_{jk}. Equation 4.15 can be written in the following matrix form:

(4.16) $U = A_{C,cc}\,M$

Table 4.4. I/O symmetric table at basic prices, product by product industry technology assumption

		Intermediate consumption of industries			Total economy	Household final expenditures	Government final expenditures	Gross capital formation	Exports f.o.b.	Imports c.i.f. (total f.o.b.)	c.i.f./f.o.b. adjustment	Total use of domestic products at basic prices
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)=(1)+.+(10)
(1)	Product 1	24	23	10		71		40	27	-15		180
(2)	Product 2	32	15	8		23	10		8	-8	1	89
(3)	Trade and transport services	8	6	3		43		0	2	-1	1	62
(4)	Taxes less subsidies on products	2	2	2		14		0	0			20
(5)	Direct purchases abroad by residents					3				-3		0
(6)	Direct purchases at home by non-residents					-1			1			0
(7)	C.i.f./f.o.b. adjustment									+2	-2	0
(8)	Total uses at purchasers' prices (1)+.+(7)	66	46	23		153	10	40	38	-25	0	351
(9)	Total gross value added/GDP				216							
(10)	Gross value added at basic prices (12) - (8)	114	43	39	196							
(11)	Taxes less subsidies on production and imports				20							
(12)	Total industry output at basic prices	180	89	62	331							

Table 4.5. I/O symmetric table at basic prices, industry by industry industry technology assumption

		Intermediate consumption of industries			Total economy	Household final expenditures	Government final expenditures	Gross capital formation	Exports f.o.b.	Imports c.i.f. (total f.o.b.)	c.i.f./f.o.b. adj.	Total use of domestic products at basic prices
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)=(1)+.+(10)
(1)	Industry 1	19	26	10		65	1	35	24	-15		165
(2)	Industry 2	29	20	8		29	9	5	11	-8	1	104
(3)	Industry 3	7	7	3		43		0	2	-1	1	62
(4)	Taxes less subsidies on products	2	2	2		14		0	0			20
(5)	Direct purchases abroad by residents					3				-3		0
(6)	Direct purchases at home by non-residents					-1			1			0
(7)	C.i.f./f.o.b. adjustment									+2	-2	0
(8)	Total uses at purchasers' prices (1)+.+(7)	57	55	23		153	10	40	38	-25	0	351
(9)	Total gross value added/GDP				199							
(10)	Gross value added at basic prices (12) - (8)	108	49	22	179							
(11)	Taxes less subsidies on production and imports				20							
(12)	Total industry output at basic prices	165	104	45	314							

Table 4.6. I/O symmetric table at basic prices, product by product commodity technology assumption

		Intermediate consumption of industries			Total economy	Household final expenditures	Government final expenditures	Gross capital formation	Exports f.o.b.	Imports c.i.f. (total f.o.b.)	c.i.f/f.o.b. adjustment	Total use of domestic products at basic prices
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)=(1)+.+(10)
(1)	Product 1	19	28	10		71		40	27	-15		180
(2)	Product 2	32	15	8		23	10		8	-8	1	89
(3)	Trade and transport services	7	7	3		43		0	2	-1	1	62
(4)	Taxes less subsidies on products	2	2	2		14		0	0			20
(5)	Direct purchases abroad by residents					3				-3		0
(6)	Direct purchases at home by non-residents					-1			1			0
(7)	C.i.f./f.o.b. adjustment									+2	-2	0
(8)	Total uses at purchasers' prices (1)+.+(7)	60	52	23		153	10	40	38	-25	0	351
(9)	Total gross value added/GDP				216							
(10)	Gross value added at basic prices (12) - (8)	120	37	39	196							
(11)	Taxes less subsidies on production and imports				20							
(12)	Total industry output at basic prices	180	89	62	331							

then

(4.17) $A_{C,cc} = U M^{-1}$

where C refers to the commodity technology assumption, cc refers to the order of matrix A which is product-by-product. As U is a product-by-industry matrix and M is a product-by-industry matrix then A must be a product-by-product matrix. The relationship in 4.17 implies a strong restrictiveness of the commodity technology assumption, i.e. M is invertible only if M is square or the number of industries must equal the number of products. This mathematical requirement is unrealistic since the number of industries needs not equal the number of products unless statisticians make it so by aggregation.

4.64. $A_{C,cc}$ can also be proved to be the same as BC^{-1} where:

(4.18) $C = M\hat{g}^{-1}$

The proof is as follows: insert ($g^{-1}g$), which is an identity matrix, into the middle of the right-hand side of equation (4.17), then:

$$
\begin{aligned}
(4.19)\quad A_{C,cc} &= U(\hat{g}^{-1}\hat{g})M^{-1} \\
&= (U\hat{g}^{-1})(\hat{g}\ M^{-1}) \\
&= BC^{-1} \\
\text{where}\quad C^{-1} &= \hat{g}\ M^{-1}
\end{aligned}
$$

4.65. Again the relation in equation 4.17 can be used to link directly product outputs and a final demand for products. Table 4.6 shows the resulting product-by-product symmetric table merging the supply table 3.1 and the use table 3.5 in chapter III.

4.66. In order to relate industry outputs to a final demand for products, one can replace q in equation 4.5 (para.4.55 above) with Cg (this relation is based on the commodity technology assumption[8] and obtain the following relationship:

(4.20) $g = C^{-1}Bg + C^{-1}\ YC$ or

(4.21) $g = (I - C^{-1}B)^{-1}C^{-1}\ YC$

Equation 4.21 is an alternative to equation 4.14 in paragraph 4.61.

4.67. As can be observed from equation 4.17, the inversion of matrix M requires that the number of products equal the number of industries. Thus a rectangular matrix is not applicable when the commodity technology assumption is used. This requirement, which is not as restrictive as it sounds, merely means that for any secondary product to be transferred out, there must be a producer that also produces this product elsewhere so that its inputs can be used to remove the inputs of the secondary products. Other products produced only as by-products have to be treated by aggregation as though they were part of the primary products.

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[8] $q =$ Cg may be obtained as follows: $g = \hat{g}i = (C^{-1}M)i = C^{-1}(Mi) = C^{-1}q$.

4.68. It is interesting to see the implication of equation 4.17 in the case of a two-industry economy with the first industry producing a secondary product:

$$where\ U = \begin{bmatrix} u_{11} & u_{12} \\ u_{21} & u_{22} \end{bmatrix} \quad and\quad M = \begin{bmatrix} m_{11} & 0 \\ m_{21} & m_{22} \end{bmatrix}$$

$$(4.22)\quad A_c = \begin{bmatrix} \dfrac{\left(u_{11} - \dfrac{u_{12}}{m_{22}} m_{21}\right)}{m_{11}} & \dfrac{u_{12}}{m_{22}} \\ \dfrac{\left(u_{21} - \dfrac{u_{22}}{m_{22}} m_{21}\right)}{m_{11}} & \dfrac{u_{22}}{m_{22}} \end{bmatrix}$$

For industry 2, there are the usual coefficients $a_{12} = u_{12}/m_{22}$ and $a_{22} = u_{22}/m_{22}$ but for industry 1 different ones apply, i.e.

$$(4.23)\quad a_{11} = \frac{(u_{11} - a_{12}m_{21})}{m_{11}}$$

and

$$(4.24)\quad a_{21} = \frac{(u_{21} - a_{22}m_{21})}{m_{11}}$$

4.69. The derived technical coefficients in 4.23 and 4.24 are net input over net output of an industry where net output is total industry output minus secondary products, and net input of an industry is equal to total input minus the input required by the secondary products produced by that industry. More importantly, from equations 4.23 and 4.24 one can see that as the inputs required for secondary products are removed from total input, the derived technical coefficient can be negative if one of the following occurs:

(i) There is over-specification of the secondary products, i.e. the output of the secondary product in the make matrix (the supply table), in our example, product 2 produced in industry 1, is misclassified;

(ii) The secondary product is not exactly the same as the product produced as a primary product elsewhere; it requires less inputs than assumed;

(iii) There are errors in data.

4.70. The commodity technology assumption may generate negative coefficients but economically these can be explained by one of the reasons cited in paragraph 4.69. More often, a given input is not required by an industry, but if secondary products require that input, the removal of secondary outputs and associated inputs will certainly generate negative value for the technical coefficient a_{ij}. The solution to the problem of negative coefficients is to recheck data themselves. Significant secondary products and their associated inputs must be transferred by using the redefinition method on the basis of the information provided by establishments producing only these kinds of secondary products or collected by special surveys. There is a need to emphasize again the original suggestion that, as much as possible, data should be processed with the application of separation rules and cost allocation from the sources.

4.71. In cases where negative coefficients are very small in comparison to other coefficients in the same columns, practitioners may set them to zero and balance the tables by the RAS method (see chapter IX).

4.72. The commodity technology has been practiced in a very few countries of which Germany is one. Germany applies the commodity technology assumption and then makes corrections for the coefficients that are negative[9] by transforming or obtaining a specific make matrix M to apply to the industry in question (this implies that the reason for the negative coefficients is reason (i) mentioned in paragraph 4.69. However, changes in matrix M would automatically change matrix A since A is calculated on the basis of U and M). The procedure can be explained by writing the flow intermediate matrix as follows:

$$\begin{aligned} F &= A_{C,cc}\, \hat{q} \\ &= UM^{-1}\hat{q} \\ &= UT^{-1} \\ \text{or } F_k &= U_k T^{-1} \\ \text{where } T &= \hat{q}^{-1}M \end{aligned}$$

T is the transformation, which is nothing more than the matrix of row coefficients of the matrix of product output. This means that a different T_k would be used for a different product k. Basically the transformation relies on available information to change manually the matrix M_k that would be used for the specific product k so that all $a_{k.}$ would be non-negative and to keep all the value $U_{k.}$ to be the same as in the kth row of matrix U. These relationships to be satisfied are shown in the table below:

	Industries				Row total
	$a_{k1}M_{11}$	.	.	$a_{k1}M_{1m}$	$= a_{k1}\, q_1$
Products	.	.	.	.	.
	$a_{k1}M_{11}$	.	.	$a_{k1}M_{1m}$	$= a_{k1}\, q_1$
Column total	U_{k1}	.	.	U_{km}	

[9]Carsten Stahmer, "Transformation Matrices in Input-Output Compilation" in *Input-Output Modeling*, edited by Smyshlyaev, Berlin, Springer, 1985.

4.73. The United States uses the redefinition method to separate secondary products for which additional data can be found with the rest of the secondary products treated by the industry technology assumption. Knonijn (see footnote 5) has tried to apply the redefinition method to the data for the Netherlands, with the rest of the secondary products treated by the commodity technology assumption.

4.74. Austria uses the hybrid technology assumption, i.e., some secondary products are treated by the commodity technology assumption[10] and some by the industry technology assumption. Rainer and Richter[11] argued that in the case of joint products, secondary output is produced by the typical technology of the respective industry and not by any commodity-specific technology. At least three cases can be found: (a) chemicals of different kinds produced by refineries, (b) pipeline services provided by the industry extracting natural gas, (c) production of electricity by the industry providing long distance heating.

4. Evaluation of the two assumptions

4.75. There are strong reasons to support the commodity technology assumption. The first one is that it is economically plausible. The second one is that the assumption fulfils all the criteria mentioned below[12]:

(a) Material balance: Total output is equal to total intermediate consumption plus final demand;

(b) Financial balance: For every industry, the price equation will hold when applied to revenues and costs of producers;

(c) Scale invariance: The derived symmetric coefficient matrix is also invariant to a scaling factor, i.e., if inputs and output of an industry in the original use and make matrices are increased by the same proportion, it is possible to derive the same coefficient matrix;

(d) Price invariance: If a new price base is applied to the data, the same derived symmetric input-output coefficient matrix A is obtained.

More explicit discussion of these criteria will be found in the appendix to this chapter.

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[10]The mathematics for combining the commodity technology assumption and the industry assumption can be found in the annex to chapter III of *A System of National Accounts* (ST/STAT/SER.F/2/Rev.3, Sales No. E.69.XVII.3, 1968) or T. Gigantes, "The Representation of Technology in Input-Output System" in A.P. Carter and A. Brody, *Contributions to Input-Output Analysis*, Amsterdam, North Holland, 1970. Since the I/O model is linear and additive, the application of hybrid technology can be implemented sequentially using the appropriate formulas discussed in this chapter. M is split into M_1 and M_2, each representing a given type of secondary products produced by a given technology. When M_1 is used, the other type of secondary products is treated as if it were primary.

[11]Nobert Rainer and Josef Richter, "Some Aspects of the Analytical Use of Descriptive Make and Absorption Tables", *Economic Systems Research*, vol. 4, No. 2, 1992.

[12] These criteria are formulated in a paper by Pieter K. Jansen and Thijs ten Raa, "The Choice of Model in the Construction of Input-Output Coefficients Matrices", *International Economic Review*, vol. 31, No. 1, Feb. 1990. The original paper in which problems with the technology assumption were first pointed out was, "An Alternative Approach of Negatives in Input-Output Analysis ", *Review of Economics and Statistics,* No. 66 (1984) by T. ten Raa, D. Chakraborty and J. A. Small.

4.76. On the other hand, the industry technology assumption has two distinct advantages:

(a) Matrix A_I is always positive because matrices B and D are always positive.

(b) B and D can be rectangular and the product matrix A_I is always square.

4.77. However, there are some fundamental problems with the industry technology assumption that may lead economists to reject it out of hand. The assumption that different products are produced with the same input structures of the industry in which they are produced is economically nonsensical. The reason is that if any two products having the same costs because they are produced by the same technology in a market where prices are always set equal to costs (this is the assumption in input-output economics and in a perfect competitive market), they cannot have different prices. But this is exactly what is required by this assumption which cannot be met except by coincidence. Besides that, the industry technology assumption requires that market shares be constant over time, which is unrealistic. The interaction between this assumption and the market shares has led to violations of three important criteria listed in para. 4.74, except the material balance criteria.

4.78. It is suggested that the negative transfer method without aggregation be used to treat exclusive by-products and the redefinition method be used in combination with the commodity technology assumption method to treat ordinary secondary products. The redefinition method should be utilized as far as additional information permits and especially for products that generate large negatives. Small negatives may be set to zeros and differences in column and row sums are settled by table balancing. If the industry technology assumption is used to calculate the symmetric I/O matrix, it is suggested that the redefinition method be used to transfer secondary products of significant value by fully utilizing the basic information available before it is applied. Some compilers[13] have argued that the question of whether an industry technology is valid or not is an empirical one and therefore cannot be excluded from theoretical considerations alone.

4.79. The redefinition method is necessary when the number of products is larger than the number of industries and when one wants to apply the commodity technology assumption which requires that the number of products equal the number of industries. Another reason for use of this method is the treatment of the use of own output within an establishment for intermediate consumption in the 1993 SNA. Let us assume that dairy establishments produce both cheese and milk. The production of cheese requires milk as an important input but because milk is produced and consumed within the same establishment, milk is not treated as input by the SNA, only materials and services that are used to produce the milk that is then used to produce cheese are shown as inputs. In this case, the dairy industry will produce cheese as secondary output. If cheese is also produced elsewhere as a primary product, then the use of the commodity technology assumption to separate cheese and milk products in the dairy establishments will generate negative input of milk for the productions of milk. In this special case, even the redefinition will also produce a negative input. The only way to prevent this is to treat milk explicitly as an input in the production process of the dairy establishment. In this way, output of milk in the input-output framework will be higher than in SUT.

[13]Denmark Statistik, *Commodity Flow Systems and Construction of Input-Output Tables in Denmark, 1986.*

Appendix

DESIRABLE PROPERTIES OF SYMMETRIC INPUT-OUTPUT COEFFICIENT MATRICES

4.80. This appendix discusses the criteria formulated by Jansen and ten Raa[14] to make judgements on desirable properties of the symmetric input-output coefficient matrix A derived by using various assumptions on secondary products. Their paper also shows that only the commodity technology assumption fulfils all their proposed criteria. Readers can see complete proofs in their paper; this appendix however will only present the criteria and show with examples that the industry technology assumption does not fulfil most of them. According to their proposal, any derived input-output coefficient matrix should satisfy the following balances:

1. Material balance

4.81. The material balance requires that total product output should match total input requirements.

$$(4.25) \quad q = A(U,M)\,q + y$$

where q is the vector of product output, y is the vector of final demand and A(U,M) is the input-output coefficient matrix that is derived from the make and use matrices U and M on the basis of a certain assumption.

4.82. Both the commodity technology and the industry technology assumptions satisfy this balance, but other methods such as the transfer method of output as negative input (the Richard Stone method) and transfer of output as positive input do not.

2. Financial balance

4.83. The financial balance requires that the value of a product be equal to its costs.

$$(4.26) \quad p' = p'A(U,M) + v'$$

where p is the product price vector and v is the vector of value added by product. The product prices calculated in 4.26 must also hold when applied to the balance of revenues and costs of producer k. It is important to remind readers that all elements of p' will be 1 (see chapter I for explanation). Producer k in producing a share m_{jk} of product j will receive a revenue $p_j\, m_{jk}$. The costs of this share will be the element j^{th} of the following vector $(p'A + v')$ multiplied by m_{jk}. When all revenues are summed over all products j produced by k, these revenues must also be equal to their costs:

$$(4.27) \quad p'M_{.k} = p'A(U,M)\,M_{.k} + v'M_{.k}$$

[14]See footnote 12 for references.

where $M_{.k}$ stands for column k of matrix M which shows all outputs produced by producer k. In equation 4.27, the left side shows the revenues earned by producer k; the first term of the right side shows intermediate input costs and the second term shows value added of producer k. This value added by producer k can also be calculated straight from the U and M matrices as $v'M_{.k} = e'M_{.k} - e'U_{.k}$ where e stands for the vector in which all elements are equal to 1 and $U_{.k}$ stands for column k of matrix U. This last calculation is simply the difference between the sum of outputs produced by producer k and its intermediate costs. Substituting the new value of $v'M_{.k}$ into 4.27, the financial balance for producer k is obtained:

$$(4.28) \quad e'\,A(U,M)\,M_{.k} = e'\,U_{.k}$$

4.84. Thus in order to satisfy the financial balance, the derived matrix A has to satisfy equation 4.28. The balance for all producers is written as follows:

$$(4.29) \quad e'\,A(U,M)\,M = e'\,U$$

4.85. It is interesting to know that only the commodity technology assumption satisfies this balance.

4.86. Using the examples listed at the end of the appendix, the applicability of the industry technology assumptions can be tested:

$$A_I = BD$$

$$A_I = \begin{bmatrix} \frac{1}{4} & 0 \\ \frac{1}{2} & \frac{1}{2} \end{bmatrix} x \begin{bmatrix} 1 & \frac{1}{2} \\ 0 & \frac{1}{2} \end{bmatrix} = \begin{bmatrix} \frac{1}{4} & \frac{1}{8} \\ \frac{1}{2} & \frac{1}{2} \end{bmatrix}$$

The left side of 4.29 becomes

$$(1 \quad 1)\, x \begin{bmatrix} \frac{1}{4} & \frac{1}{8} \\ \frac{1}{2} & \frac{1}{2} \end{bmatrix} x \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} = \begin{pmatrix} \frac{11}{8} & \frac{5}{8} \end{pmatrix}$$

The right side of 4.28 is

$$(1 \quad 1)\, x \begin{bmatrix} \frac{1}{2} & 0 \\ 1 & \frac{1}{2} \end{bmatrix} = \begin{pmatrix} \frac{3}{2} & \frac{1}{2} \end{pmatrix}$$

4.87. This example shows that the financial balance is not fulfilled by the industry technology assumption. Readers could test the commodity technology as an exercise. Values of the A matrix derived from the commodity technology assumption and other relevant values are given in the example at the end of the appendix.

3. Scale invariance

4.88. This property requires that the derived matrix A remain unchanged when the outputs of a producer and its associated inputs are increased by the same proportion, i.e.

$$A(Us,sM) = A(U,M)$$

where diagonal matrix s stands for the scales.

4.89. This criterion is not fulfilled by the industry technology assumption either, but it is by the commodity technology assumption.

Let us take the case in which

$$s = \begin{bmatrix} 2 & 0 \\ 0 & 1 \end{bmatrix}$$

This means that the values of outputs and associated inputs of the first producer are assumed to double and those of the second producer remain unchanged.

4.90. When this scale matrix is applied to the make-and-use matrices, the A matrix derived on the basis of the technology would not remain the same. The new A matrix would be

$$A_I = \begin{bmatrix} \frac{1}{4} & \frac{1}{6} \\ \frac{1}{2} & \frac{1}{2} \end{bmatrix}$$

which is not the same as the value of A shown in 4.86.

4. Price invariance

4.91. This property requires that when the use and make matrices are rebased on a different price base, the derived A matrix must remain the same, i.e.

$$A(pU, Mp) = pA(U,M)p^{-1}$$

where p is the diagonal matrix in which each element corresponds to the new price index, for example:

$$p = \begin{bmatrix} 2 & 0 \\ 0 & 1 \end{bmatrix}$$

4.92. This criterion is also met by the commodity technology assumption but not by the industry technology assumption. For the industry technology assumption, the derived A_I matrix is different:

$$A_I = \begin{bmatrix} \frac{1}{3} & \frac{1}{6} \\ \frac{1}{3} & \frac{1}{12} \end{bmatrix}$$

PART TWO

COMPILATION OF SNA SUPPLY AND USE TABLES

V. COMPILATION OF PRODUCTION ACCOUNTS OF INDUSTRIES

A. Introduction

5.1. Outputs, intermediate inputs (or intermediate consumption) and value added for each industry or kind of economic activity are normally compiled together because conceptually they are linked together as parts of the production function of an establishment or activity, and also because the main sources of information for most nonfinancial activities are normally the same, particularly for the benchmark years with more detailed information from the censuses. Annually, information comes from annual surveys, tax returns, business accounts, and other secondary sources such as trade and producers' associations, etc. Outputs, total intermediate inputs and total value added calculated residually, as a rule serve as total controls for the further detailing of the components of inputs of goods and services used in production. For these reasons, they will be discussed together in this chapter. To link production account by industry or establishment to production account by institutional sector, it is necessary to link every establishment to the institutional sector it originates from (see table 2.5 in chapter II).

5.2. Inputs can be observed from two points of view. From the production point of view, i.e. along the columns of the use table, information for inputs comes from business accounts and production surveys. From the marketing or distribution point of view, i.e. along the rows of the use table, information for inputs comes from marketing boards, agencies that track the supply and uses of special products. Many products such as grains, petroleum, other minerals, electricity, microcomputers, etc. are tracked from the distribution point of view. These pieces of information are broad in scope, covering group of industries, and therefore need to be broken down and reconciled with information from the production point of view. They are normally valued in either basic or producers' prices, in contrast to production inputs that are valued in purchasers' prices. In this case, they must be transformed into purchasers' prices for reconciliation. General aspects of outputs, intermediate inputs, and value added from the production point of view are discussed below before a more detailed discussion of the compilation of specific activities or industries. Chapter VII will discuss final demand from the distribution point of view. However, it is important to recognize that the compilation of gross capital formation, a component of final demand, should be carried out simultaneously with the compilation of production outputs because not only are the same sources of information used but gross capital formation needs to be classified by industry so as to provide information to estimate capital stocks by industry if their time series is of adequate length and available.

5.3. The discussion of SNA concepts in this chapter may be more extensive than needed by national accountants. However, this is justified in two ways: (a) it frees input-output compilers from going through the whole 1993 SNA unless it is really needed; (b) it illustrates more clearly SNA concepts that were newly introduced in the 1993 SNA.

B. General remarks on compilation of production accounts

1. Outputs

5.4. Compilation of industry output and product output is an important task in the construction of the input-output framework, i.e. the use and supply tables. Though the number of industries and products in the final supply and use tables may be no larger than 100, the initial number of industries for which outputs are prepared and the number of goods and services (or products) are normally much larger and should be as large as information allows. The detailed elaboration allows compilers to use more reliable information from censuses and secondary information as well as "expert" knowledge. With detailed product outputs, which some countries extend to a few thousand products, the use of the commodity flow approach (which will be discussed in chapter VIII) will also make it much easier to distribute outputs to various intermediate and final users. For instance, in a highly desegregated form in countries like the United States, Canada and those of Western Europe where coffee beans are entirely supplied from abroad, these imported products are utilized as inputs to either the industry that makes roasted coffee or to households final consumption. However, if coffees are aggregated with other agricultural products into one industry, we will not be able to use the above-mentioned "expert" knowledge. More detailed elaboration also allows compilers a better selection of more appropriate proxies on the basis of "expert" opinions for input structures of the industries under consideration. For instance, within a given industry in which there are a few sub-sectors and out of which only one sub-sector is significant in output value in comparison with outputs of other sub-sectors, we may try our best to obtain information on the input structure of the most significant sub-sector and be satisfied with some rough approximation for other insignificant sub-sectors if we do not have financial resources to survey input structures of all sub-sectors. The distribution of product output in conjunction with input structure surveyed will fill up the supply and use shown below in table 8.1 of the commodity flow method in chapter VIII which becomes basic information for the SNA input-output framework.

2. Intermediate consumption

5.5. Intermediate consumption includes all non-durable goods and services with an expected life of under one year which are used up in the process of production by industries. Small tools of low value, though durable, should also be treated as intermediate goods.

5.6. In input-output tables, we are looking for input structures that best describe technical relationships in production techniques. It is therefore best always to classify activities in as much detail as possible and, if aggregation is necessary, only activities with similar input structures should be aggregated. The main reason is that if an industry in an input-output table is an aggregate of many activities, each with a different set of inputs, then when the shares of outputs of each type of activities change, the aggregate input structure of the industry changes, even though the input structures of the component activities remain unchanged.

5.7. In production, we should distinguish between *uses* and *purchases*. An establishment may purchase materials and semi-finished products for use as inputs but what it purchases does not necessarily match the inputs actually used in production. Part of the purchases may remain in inventories or inputs may be withdrawn from inventories if stock of necessary inputs is available for withdrawals. In input-output statistics, information on uses is primary data to estimate input coefficients. Information on sales, such as from marketing boards or associations of producers, must be used with care and adjusted to accommodate changes in stocks. From business accounts that are made public as legally required, it is possible to obtain the total cost of goods and services used after adjusting for changes in inventories. Detailed information on goods and services used as inputs can only be obtained with the cooperation of business accountants of enterprises. From their cost accounting, it is possible to assign manufacturing costs to each kind of products they produced. General administrative costs may be allocated in proportion to product outputs.

5.8. Statistics on outputs and inputs for non-financial activities are collected by many countries through censuses for the benchmark years and supplemented annually by annual surveys. Censuses have more complete and detailed information on outputs and inputs and components of value added such as compensation of employees, capital consumption (or depreciation) and other taxes on production. Annual surveys normally cover only total output, total input and components of value added. Censuses and particularly industrial censuses normally follow the recommendations in *International Recommendations for Industrial Statistics*.[1] However, intermediate consumption in input-output tables and national accounts is broader in concept than the same definition used in the publication mentioned above. The latter concept includes only agricultural and industrial goods and services. Industrial services include only payments for contract, commission, repair and maintenance work and freight charges. Thus in order to arrive at the SNA concept of intermediate consumption, it is necessary to add the cost of non-industrial services such as bank and financial charges, patent and license user fees, insurance charges, storage or warehousing charges, advertising, legal, accounting, consulting services, printing costs, cost of travelling, entertainment, meetings, motor-vehicle running expenses, cleaning costs, postal, telephone and telegraph charges, and elements of labour cost that cannot be considered as compensation of employees such as vocational training, work clothes, workers' transport, cost of cultural, recreational services to employees, etc. Censuses are normally carried out for mineral and manufacturing industries, electric, gas and water establishments, construction establishments, wholesale and retail trades, service industries, government departments, etc. Since information from censuses of industrial activities is not comprehensive, it must be supplemented by additional special surveys and technical knowledge from experts on specific fields.

5.9. Another source of information is business accounts of enterprises. Inputs reported in business accounts that are in the public domain are rarely detailed enough for the purpose of input-output compilation. Even if a more detailed business account is obtained, it contains only broad categories of inputs since only they are of interest to business managers. For example, the category of office supplies is reported instead of the detailed information such as paper, clips, pens, etc. In these cases, it is necessary to make separate supplementary surveys to break down these aggregate items. A useful approach is to assume a common content of goods or services within a given generic group of goods or services. For example, office supply expenses may be such a group, which can be assumed to contain the same proportion of content of papers and paper products, pens, pencils, diskettes, etc. Normally, it is not possible to survey all establishments due to cost constraints so that only selective surveys of a limited number of establishments which are believed to be representative of the broad group of industries under study have to be carried out because it is reasonable to assume that the details of office supplies may be the same by type of activities such as manufacturing, trade services, banking, business, government services, etc. Other broad groups of expenses that can be approached in a similar way are business travel expenses, expenditures on office furniture, utility expenses, maintenance of fixed assets, purchases of buildings (the last one must be split into the cost of the real estate and other service costs such as legal services and taxes).

5.10. Another problem with business accounts, particularly of manufacturing and trade establishments, is that only purchased materials, fuels and supplies to be matched with sales are reported after deducting

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[1]United Nations, ST/ESA/STAT/SER.M/48/Rev.1. Sales No. E.83.XVII.8.

changes in stocks of materials, fuels and supplies. Compilers must adjust for changes in stocks for each kind of goods purchased in order to arrive at inputs used to match outputs produced. Unless establishments are asked to do the adjustments themselves, some rough allocation rules may have to be used to assign changes in stocks to various inputs. The rule may be as simple as allocating changes in stocks in proportion to values of input. The balancing of the use and supply tables will contribute to the correction of errors later.

5.11. Inputs may also be used to check the outputs of the industries that use them. One example is cement which is mainly connected with the construction industry. The use of cement is a useful indicator to check the output of the construction industry, which is also an important part of capital formation.

5.12. Because small establishments with few employees are usually not covered by industrial statistics, supplementary surveys on their inputs are needed; otherwise the input structure of large establishments may be applied to them.

3. Value added at basic prices

5.13. The SNA recommends the separation of value added at basic prices into six categories (a to f below) which have been defined in chapter II:

(a) **Compensation of employees** (including members of the armed forces) which includes:

(1) Wages and salaries in cash which include regular payments of wages and salaries, payments by results and piecework; special allowances for working overtime, at night, on weekends, away from home or in hazardous circumstances, expatriation allowances for working abroad; supplementary allowances for housing or travel to and from work; wages or salaries payable to employees away from work for short periods, e.g. on holiday or as a result of a temporary halt in production; ad hoc bonuses; commissions, gratuities and tips;

(2) Wages and salaries in kind which include the following most common types of goods and services provided without charges or at reduced prices to employees and their families: remuneration of products such as free meals and drinks including those consumed when travelling on business; free housing; free uniforms or special clothing that can be worn outside of the workplace; services of vehicles or other durable provided for the personal use of employees; goods and services produced as outputs; sports, recreation or holiday facilities; transportation to and from work, free parking; creches for the children of employees, the value of interest forgone by employers when they grant loans at reduced rates;

(3) Employers' actual social contributions which include their contribution to social security funds, insurance enterprises or other institutional units responsible for the administration and management of social insurance schemes;

(4) Employers' imputed social contributions which include social benefits employers provide directly to employees, former employees, or dependents out of their own resources without involving a social scheme or institution such as children's, spousal, family, education or other allowances in respect of dependents, payments

to workers absent from work because of illness, injury or maternity leave, severance payments and unfunded pension payments.

(b) **Other taxes on production which include**:

(1) Taxes on payroll or work force;

(2) Recurrent taxes on land, buildings and other structures;

(3) Business and professional licenses;

(4) Taxes on the use of fixed assets or other activities;

(5) Stamp taxes;

(6) Taxes on pollution;

(7) Taxes on international transactions.

minus

(c) **Other subsidies on production which include**:

(1) Subsidies on payroll and workforce;
(2) Subsidies to reduce pollution.

(d) **Consumption of fixed capital**;

(e) **Operating surplus**; and

(f) **Mixed incomes.**

5.14. To arrive at the GDP, taxes less subsidies on products must be added to the total value added at basic prices. Major components of taxes on products and subsidies on products are listed below:

(a) **Taxes on products** include:

(1) Value added type taxes (VAT);

(2) Taxes and duties on imports excluding VAT which include import duties, general sales taxes, excise duties, taxes on specific services, profits of import monopolies, implicit taxes on imports resulting from multiple exchange rates;

(3) Export taxes which include export duties, profits of export monopolies, implicit taxes on exports resulting from multiple exchange rates;

(4) Other taxes on products which include general sales or turnover taxes, taxes on specific services, taxes on financial and capital transactions, profits of fiscal monopolies.

(b) **Subsidies on products** include:

(1) Import subsidies which include direct subsidies on imports, losses of government trading organizations involved in imports, implicit subsidies on imports resulting from multiple exchange rates;

(2) Export subsidies which include direct subsidies on exports, losses of government trading organizations involved in exports, implicit subsidies on exports resulting from multiple exchange rates;

(3) Other subsidies on products which include subsidies on products used domestically, losses of government trading organizations involved in domestic trades, subsidies to public corporations and quasi-corporations.

5.15. The total value added at basic prices of industries should be calculated first to serve as total control. The value added at basic prices of an industry is equal to its output at basic prices minus its intermediate consumption. Sources of information for calculating value added are censuses of production. However, as pointed out previously, census value added is not the same as national account value added.[2] Census value added in an industry is equal to output minus cost of materials and industrial services consumed. Thus the costs of other services such as accounting, advertising and other overhead costs which are paid at the company level and not allocated to the establishment level are included in census value added. National account value added is normally smaller than census value added. Table 5.1 shows the value of national account value added as a percent of census value added for the United States. The difference between census value added and national account value added may be much smaller in other countries. But, in order to obtain national account value added for the use table, it is necessary to calculate intermediate consumption by adding other service costs to the cost of materials and industrial services consumed.

Table 5.1. National account value added and census value added in the United States[3]

	National account value added as percent of census value added	
	1982	1987
Manufacturing	77	73
Nondurable goods	74	71
Durable goods	79	75

[2]*Ibid.* For the definition of census value added and its difference from the concept of value added in national account.

[3] United States Department of Commerce, Bureau of the Census Bureau, *1987 Census of Manufactures, General Summary.*

5.16. Without integrating data collection for both enterprises and establishments, it is not easy to allocate systematically non-industrial services paid by enterprises to their constituent establishments. In many countries, statistics on establishments are collected by censuses independently of enterprise statistics, so that the allocation of non-industrial services to manufacturing establishments is only an approximation. If statistics on establishments are collected together with statistics of parent companies, it is possible to ask for non-industrial services paid and consumed by the companies and then to distribute them to component establishments. It will be recalled that national account value added may be calculated only on a consolidated company-industry basis and then converted to an establishment-industry basis. Value added on a company-industry basis is calculated either as the sum of income payments (e.g. wages, profits, and interest) and other cost (e.g. depreciation and other production taxes) or as the difference between output (value of shipment plus change in inventories) and cost of all materials and services consumed. Data on components of value added on a company-industry basis can be obtained from annual surveys and income tax returns. The difference between company-industry classification and establishment-industry classification can be used as one of the factors for allocating non-industrial services to different I/O industries. Additional surveying of non-industrial service uses may also be necessary for the allocation purposes if enterprise (e.g. company) statistics are not available.

5.17. **Taxes and subsidies:** Data on taxes on products and other taxes on production are available from government sources. Other taxes on production which are classified by kind of activity of the establishments that pay the taxes are available in production censuses such as the census of manufacturing. Some other taxes on production may be paid by the enterprise instead of its component establishments. These taxes must be allocated. Only other taxes on production enter into the calculation of value added of a single establishment-industry in the use table. Since output is valued at basic prices, taxes on products are to be allocated by kind of product in the supply table. Turnover taxes, manufacturers' excise taxes, which may vary by kind of product, are normally paid and reported by establishments so that it is possible to estimate taxes paid by kind of product. Import and export duties can be easily identified and estimated by kind of products. Other product taxes (VAT, sales taxes) which are collected by types of producers and mostly by types of wholesalers and retailers are not easily identifiable with products on which taxes are assessed, and it may be necessary to use detailed statistics and tax rates on products sold in wholesale and retail trade to estimate product taxes by kind of product. Since taxes on products are by definition proportional to either values or quantities of products, given that taxes on a product are identified, these taxes are then simply distributed proportionally to products on the basis of either value or quantity as appropriate. Subsidies on products should be distributed in a similar way. It should be emphasized again that SUT provides an excellent framework to estimate and allocate taxes on products.

5.18. **Compensation of employees:** Compensation of employees is often available from both production censuses and annual surveys, frequent labour-force or employment surveys, financial reports of Government and non-profit organizations. In some cases, only employment and hours worked are available so that wages must be estimated separately through household surveys, which also provide statistics on payments in kind. Data on compensation of employees should be supplemented by data from tax and social security reports, and from reports of pension funds, and insurance companies. Social security records often provide the best current information on wages and salaries paid since contributions are usually proportional to wages.

5.19. **Consumption of fixed capital:** "The value of a fixed asset to its owner at any point of time is determined by the present value of the future rentals (i.e., the sum of the discounted values of the stream of future rentals) that can be expected over its remaining service life. Consumption of fixed capital is therefore measured by the decrease, between the beginning and the end of the current accounting period, in the present value of the remaining sequence of rentals."[4] "The calculation of consumption of fixed capital is a forward looking measure that is determined by future, and not past events....Unlike depreciation as usually calculated in business accounts, consumption of fixed capital is not, at least in principle, a method of allocating the costs of past expenditures on fixed assets over subsequent accounting periods."[5] Because it is not easy to estimate the stream of future values, the most commonly used method to estimate consumption of fixed capital is to estimate it together with gross capital stocks by the perpetual inventory method (PIM). Gross capital stocks were built up by "gross fixed capital formation undertaken in previous years [but] have survived to the current period. Average service lives, or survival functions, based on observations or technical studies may be applied to past investments for this purpose. Fixed assets purchased at different prices in the past have then to be revalued at the prices of the current period."[6] "The value of the capital consumption on a fixed asset may be estimated by applying either the linear or geometric depreciation formula to the actual or estimated or current purchaser's price of a new asset of the same type."[7, 8] To estimate consumption of fixed capital, it is necessary to know for every industry its stock of capital assets by type, the historical values of these assets, their dates of purchase and their expected useful life which can be collected through benchmark surveys. The replacement cost can be estimated on the basis of price movements on capital goods. With benchmark surveys and information on annual capital formation and price movements for capital goods, consumption of fixed capital can be estimated annually. The perpetual inventory method requires data on capital formation by type over 30-40 or more years which may not be available in many developing countries. Though the SNA does not recommend the use of business depreciation in place of consumption of fixed capital, in case of difficulty in estimating consumption of fixed capital, it suggests that "if data on depreciation are used, they must, at the very least, be adjusted from historic costs to current prices."[9] Unlike the 1968 SNA, the revised SNA also recommends the calculation of consumption of fixed capital for roads, bridges and railway tracks. Depletion of natural assets such as mineral deposits, reserves of oil, gas, etc. is not covered by consumption of fixed capital; it is treated as "other changes in volume of assets."[10]

5.20. **Gross operating surplus:** This by definition is calculated as residual. It is the difference between industry output and the sum of intermediate input, compensation of employees and net taxes on products and production. If consumption of fixed capital is known, then the operating surplus is also calculated residually

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[4]*System of National Accounts 1993*, para. 6.182.

[5]*Ibid.*, para. 6.183.

[6]*Ibid.*, para. 6.189.

[7]*Ibid.*, para. 6.198.

[8]For the estimation of fixed capital stock and consumption of fixed capital, see Vu Quang Viet, "Measurement of Fixed Capital Stock and Consumption of Fixed Capital" in the *Handbook on Linking Business Accounts to National Accounts for the Non-financial Corporation Sector*, United Nations, ST/ESA/STAT/SER.F/76, or the handbook on *The Measurement of Capital* by Michael Ward, OECD, 1976; *Stock of Fixed Assets in Industry in the Community Member States: Toward Greater Comparability*, Studies of National Accounts No. 2, Eurostat, 1983.

[9]*System of National Accounts 1993*, para. 6.184.

[10]*Ibid.*, paras. 12.29 and 12.30.

as the difference between gross operating surplus and consumption of fixed capital. Consumption of fixed capital has to be estimated by the perpetual inventory method. For many developing countries, the calculation of consumption of fixed capital may be difficult because data are not available. If such a calculation is not possible, the gross operating surplus which is the sum of the operating surplus and consumption of fixed capital should be calculated as a residual.

4. Statistical sources

5.21. Major sources for input-output and production statistics for non-financial activities come from various censuses:

- Census of mineral industries;
- Census of agriculture;
- Census of manufactures;
- Annual surveys of enterprises or establishments;
- Census of trade;
- Census of services;
- Census of transportation;
- Census of construction industries;
- Census of Governments and/or annual administrative records and accounts of government bodies, either central or local;
- Survey of household expenditures;
- Survey of business capital formation;
- Foreign trade statistics;
- Balance of payments.

5.22. All these censuses and annual surveys are supplemented by annual statistics from various government departments and private agencies, professional associations, business associations on specific areas, financial reports of major corporations, banks, insurance companies, pension funds, etc. Taxes and incomes, besides being provided by censuses, can be found in documents of tax authorities and national budgets. The survey of household incomes and expenditures is useful for the estimation of personal consumption expenditures as well as outputs and incomes from own-account production that are not covered by any other sources. For more information on other sources on outputs and inputs, readers are advised to consult the United Nation publication, *Handbook of National Accounting: Accounting for Production:*

Sources and Methods.[11] Sources of information and specific methods of compilation for all industries cannot be adequately covered in this publication because of the substantial richness of the subject matter.

5.23. For financial activities, information comes mainly from the central bank which is set up to regulate and monitor financial activities. In many countries, insurance companies are also under its supervision, unless an independent agency is set up to regulate them. General information on inputs may be obtained directly from public business accounts of financial companies. This information must be supplemented by limited surveys in order to detail some input components reported in business accounts. The number of financial companies is relatively small for many countries, so the use of all their business accounts for compilation is possible.

C. SNA production concepts reviewed

1. Production boundary

5.24. In the SNA, output is measured only for production activities within its production boundary. Thus it is necessary to define the production boundary of the SNA and the output to be measured within it.

5.25. "Economic production may be defined as an activity carried out under the control and responsibility of an institutional unit that uses inputs of labour, capital, and goods and services to produce outputs of goods and services... A purely natural process without any human involvement or direction is not production in an economic sense."[12] However, not all human activities are included in the production boundary by the SNA and the following will clarify the borderline cases:

(a) All activities by households that produce *goods*, whether they are sold in the market or used for own final consumption or own capital formation, or whether they are legal or illegal, are *included* in the production boundary. Household activities producing goods include the production of agricultural products, gathering of uncultivated fruit, wood cutting and firewood collecting, hunting, fishing, mining, water supplying, storing of agricultural goods, processing of agricultural products,[13] making of cloth, leather, footwear, pottery, utensils, furniture, etc. Goods produced by households for intermediate consumption and excluded from production boundary are, for example, own-produced seeds used in agricultural cultivation.

(b) All "do-it-yourself" activities by households that produce *services* for own use such as taking care of children and other members of the family, cooking, cleaning, home repairs, repairs of personal objects including own vehicles, etc. are *excluded* from the production

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[11]United Nations, Sales No. E.86.XVII.11, ST/ESA/STAT/SER.F/39. The publication, though obsolete in respect of recent changes in the 1993 SNA, is still a valuable source of information on production accounts for compilers.

[12]*System of National Accounts 1993*, para. 6.15.

[13]Storing and processing of agricultural goods are treated within the production boundary as an extension of goods-producing activities.

boundary. However, this rule of exclusion does not apply to the own-account production of housing services.

(c) Domestic services by paid domestic servants are within the production boundary and classified in the unincorporated (or household) sector in which compensation of employees is the only cost of production. These services are for own final use.

(d) Only activities of the establishments that produce goods and services that are intended for exchange with, or sold to, other establishments, even within the same enterprise, are treated as belonging to the production boundary. Excluded are goods and services produced for own intermediate consumption within the same establishments.

(e) Own-capital formation of any sector must always be included in the production boundary.

2. Scope of output

5.26. The output of an establishment or institutional unit is the result of a production activity within the production boundary defined by the SNA and may either be a *market product* or *own final use* or *other non-market product*. A producer may be classified as market, own final use or other non-market producer depending on whether his output is mainly for the market, his own final use or other non-market use.

5.27. **Market output**: Market output is output that is sold or otherwise disposed of on the market or intended to be disposed of on the market at prices that are economically significant. Market output should consist of the total value of:

(a) Goods and services sold;

(b) Goods and services bartered;

(c) Goods and services used for payments in kind, including compensation in kind;

(d) Goods and services supplied by one establishment to another belonging to the same market enterprise, to be used as intermediate inputs;

(e) Changes in inventories of finished goods and work-in-progress intended for one or other of the above uses.

5.28. **Own final use**: Own final use output is output that is retained for own final use by the owners of enterprises, either as own final consumption by unincorporated enterprises (incorporated enterprises by definition do not incur final consumption) or own gross capital formation. Examples of own final consumption output are agricultural goods and services, and owner-occupied housing which are provided and used by members of the same households. Domestic services provided by paid servants are included. Own capital formation includes own-constructed housing, machine tools produced for their own use by engineering enterprises, etc. Own final use output should consist of the total value of:

(a) Goods and services produced by household enterprises and consumed by the same households;

(b) The fixed assets produced by an establishment that are retained within the same enterprises for use in future production (own-account gross capital formation, for instance the computer hardware and software that are produced by, and used within, the establishment (products that are retained within the establishment and used as intermediate inputs are not considered output by the SNA));

(c) Changes in inventories of finished goods and work-in-progress intended for one or another of the above uses.

5.29. **Other non-market**: Other non-market output includes the total value of the following goods and individual or collective services produced by non-profit institutions serving households (NHISHs) or Government:

(a) Goods and services supplied free, or at prices that are not economically significant, to other institutional units, either individually or collectively;

(b) Goods and services supplied by one establishment to another belonging to the same non-market producer, to be used as intermediate inputs;

(c) Changes in inventories of finished goods and work-in-progress intended for one or another of the above uses.

5.30. Ancillary activities such as administration, purchasing, sales, communication, accounting, data processing, etc., supporting main activities are not classified as separate establishments and therefore their costs must be allocated to the production costs of the establishments within the enterprise (see also chapter IV for allocation methods). If ancillary activities involve own-account capital formation such as construction, the value of own-account capital formation should be allocated to every establishment in the enterprise using the same allocation method used in allocating costs of ancillary activities. In table 5.5 following paragraph 5.52, own-account capital output of ancillary activities has not been allocated. But if it was, then gross establishment outputs would be greater than those shown in column 10. In case ancillary activities sell part of their products - for example, accounting or data processing services - to other enterprises, this market output should also be allocated to every establishment of the enterprise to be consistent with the SNA valuation of output. If the market output of ancillary activities makes up more than 50% of their costs, a separate establishment must be created for the outputs that are sold.

5.31. Establishment output is equal to the sum of products produced for sale, exchanged with other establishments, put in inventories or used for own capital formation. Industry output is equal to the sum of outputs of all establishments belonging to the industry.

3. Output and input valuation

5.32. Market output is measured at market prices. The output for own final use should also be measured at comparable market prices; for instance agricultural, fishing and forestry products can be measured in prices at farm or communal markets. When comparable prices are not available, output for own final use may be measured at production costs. Other non-market outputs are measured at production costs.

5.33. However, market output, except output of financial intermediaries, is often measured indirectly as the sum of sales of produced products, other uses (including items b-d in paragraph 5.27 above and a-b in paragraph 5.28 and changes in the stock of products produced.

(1) Output = Sales net of discounts, returns, VAT and sales taxes + other uses + changes in inventories[14]

5.34. The above formula is the conventional one to calculate output because businesses report data in terms of value of sales and changes in inventories. However, the SNA definition of changes in inventories is different from the practice in the business world. Thus, changes in inventories of business accounts cannot, in principle, be used for SNA changes in inventories except when the prices of goods stored are stable (see appendix A below for a detailed description of various methods used in inventory valuation and output calculation according to the SNA). In practice, "so many different methods are liable to be used in business accounts, it is impossible to suggest algorithms, or rules of thumb, which would be generally applicable for the purposes of transforming data on inventory changes in business accounts to the data required by the System. Each case has to be treated individually, depending upon the precise way in which the business accounts have been drawn up."[15]

5.35. Outputs of other non-market goods and services are measured at production costs which include the following items:

(a) The value at market prices of the goods and services consumed as intermediate inputs;

(b) The value of the compensation of employees payable;

(c) The value of consumption of fixed capital;

(d) The value of other taxes on production (if any) less other subsidies on production (if any).

5.36. **Inputs or intermediate consumption** must also be valued at market prices and specifically at purchasers' prices in the use table. They are not information that can be collected directly from business accounts. From business accounts, inputs of materials (or goods) must be derived by the following formula:

(2) Materials used in production = Materials purchased net of discounts and returns - changes in inventories

The valuation of inventories is important in the calculation of both materials used and outputs.

[14]Changes in inventories = Ending inventories - beginning inventories.

[15]*Ibid.*, para. 6.71.

4. Work-in-progress

5.37. Work-in-progress (sometimes called work put in place) consists of inventories of goods held by an establishment or enterprise which have been produced as output but require further processing and are not yet in a form in which they can be suitably delivered or sold to purchasers. Work-in-progress is recorded under the general heading of *changes in inventories* and usually happens to products that take more than one year or accounting period to complete. Examples are construction of buildings, dams, ships, other large capital goods, and production of some agricultural products. Output of work-in-progress in an accounting period, like output of non-market goods and services, is to be measured by the costs actually incurred in its production during that accounting period.

5.38. However, at the accounting period in which the project is completed and the sale takes place, the reduction in work-in-progress must be recorded. It is equal to the value of work-in-progress accumulated in previous periods valued at the prices or costs prevailing at the moment the sale occurred.

Table 5.2 (a). Calculation of output of work-in-progress

	Basic data				
	Period 1	Period 2	Period 3	Period 4	Year
Sales	0	0	0	2,500	
Intermediate consumption	50	83	102	220	
Capital consumption	15	22	33	60	
Compensation of employees	60	95	130	260	
Total production costs	125	200	265	540	

Table 5.2 (b). Calculation of output of work-in-progress

	At the prices and wage rates of period 4				
	Period 1	Period 2	Period 3	Period 4	Total
Sales	0	0	0	2,500	2,500
Intermediate consumption	250	260	210	220	940
Capital consumption	75	69	66	60	270
Other taxes less subsidies on production	0	0	0	0	0
Compensation of employees	310	290	255	260	1,115
Total production costs	635	619	531	540	2,325

Table 5.2 (c). Calculation of output of work-in-progress

	At the prices and wage rates of period 4				
	Period 1	Period 2	Period 3	Period 4	Total
Sales	0	0	0	2,500	2,500
Addition to inventories	125	200	265	540	1,130
Withdrawals from inventories	0	0	0	-2,325	-2,325
Change in inventories	125	200	265	-1,785	-1,195
Output	125	200	265	715	1,305
Holding gains realized on work-in-progress in period 4 [16]	510	419	266	0	1,195

5.39. The work-in-progress should also include the value of the addition to it since it was stored, which is due not to the effects of general price inflation but to the improvement in the physical quality of the good over time (such as wines) or to seasonal factors affecting supply and demand for the good, such as preserved summer vegetables sold in winter. When there is a reduction in value not due to general price deflation, reduction in the work-in-progress must also be introduced. So in table 5.2(c), period 4, output (715) is equal to sales (2,500) + addition to inventories (540) - withdrawals from inventories (-2,325). In general,

Output = Finished products sold or bartered;
Plus Addition to inventories;
Less Withdrawals from inventories;
Plus Finished products used by their producer for his own final use.

5.40. Tables 5.2(a), (b) and (c)[17] show how output of work-in-progress should be calculated. Table 5.2(a) shows the basic data, table 5.2(b) shows the production costs revalued at the prices of the period 4. The general price indexes used for period 1 to period 4 are consecutively equal to 20, 32, 50, 100. Table 5.2(c) shows how work-in-progress should be treated in the SNA. In the last table, the value of inventories withdrawn in period 4 (-2,325) when the final product is sold, is equal to the sum of production costs incurred by work-in-progress during the production process revalued to the prices and wages of period 4 shown in table 5.2(b) i.e. -(635+619+531+540).

5. The treatment of second-hand goods and old scraps in input-output table

5.41. The output of establishments involving the transaction of second-hand goods is measured in a fashion similar to the treatment of wholesalers and retailers, i.e. it is equal to the difference between revenues received from selling the goods and the cost of restocking these goods. The value of second-hand

[16]Calculated by the increase in production costs due to the application of prices and wages of period 4 to the basic data. For example, for period 1, holding gains are 510 = 635 - 125.

[17]The examples are taken from Peter Hill, *Handbook on Inflation Accounting.*

goods is entered as a positive value to the industry that buys them and as a negative value to the industry that sells them. If capital goods are sold by enterprises, a negative value must enter the column "gross capital formation" of enterprises. If current goods are sold, a negative value may enter either the column *change in inventories* or the column *final household consumption*. The treatment of goods bought is treated similarly but in an opposite way. Following are examples that will be used to demonstrate the different treatments of second-hand goods depending on the nature of those goods and where they are utilized.

Revenue for selling the second-hand good	60
Cost of restocking the same good	40
Trade margin	20

(a) **Case 1**: The second-hand goods are sold by the household sector for household final consumption uses. The treatment is shown in table 5.3. Only the output of trade margins is created, the sale of second-hand goods cancels their purchase.

Table 5.3. Second-hand goods sold for final consumption

	Intermediate consumption			Household final consumption	Output
	Industries	Trade margins	Second-hand goods		
Industries					
Trade margins				20	20
Second-hand goods				+40-40	0
Total		20		20	20

(b) **Case 2**: The second-hand goods are used as intermediate inputs. The treatment is similar to the first case but a positive value of 40 is entered in row 3, column 1, as intermediate inputs and a negative value is entered in the household final consumption, row 3, if the goods are sold by the household sector or entered as negative value in the column "change in inventories" (not shown in table 5.3) if the goods are sold by enterprises. Also in the first column and second row, 20 is entered as intermediate consumption of industries.

(c) **Case 3**: The second-hand goods are capital goods that are sold from one sector (enterprises, households or Government) to the same or other sectors. Gross capital formation of the purchasing sector increases by the value of trade margins. The same treatment applies in selling old homes but in this case, real estate services instead of trade services are provided and include legal services, banking services and taxes involved in the transaction (one may also break down real estate services into separate flows and enter them separately in the column of "gross capital formation"). In case second-hand goods are capital goods sold by enterprises or government to households (i.e. automobiles or other consumable durable goods such as refrigerators, air-conditioners, etc.), there is a reduction in gross capital formation of the sellers and an increase in household final consumption.

Table 5.4. Second-hand goods as capital goods

	Intermediate consumption			Gross capital formation	Output
	Industries	Trade margins	Second-hand goods		
Industries					
Trade margins				20	20
Second-hand goods				+40-40	0
Total		20		20	20

5.42. Old scraps (e.g. waste and scrap and materials for recycling such as paper, glass, cans, bottles) can be treated the same way as second-hand goods in case 2 since old scraps may often be used as intermediate inputs into the production of new products. The margins for old scrap collecting units are classified under version 1.0 of the United Nations *Central Product Classification* (ST/ESA/STAT/SER.M/77) as part of retail trade services. Besides trade margins that need to be calculated, the value of old scraps used for intermediate consumption may be balanced by a negative change in inventories (if sold by business) and negative final consumption (if sold by households and Governments). Also as in case 2, trade margins are entered as intermediate consumption of industries that recycle scraps.

5.43. New scraps such as metal scraps produced as secondary products of the steel-making process are treated as secondary products and not as second-hand goods as discussed above. New scraps can be treated as a separate product in the supply table (or make matrix). However, given that they are not independently produced anywhere else, they later can probably be better aggregated with the main product as, for example, steel scraps being aggregated with steel.

6. Operating leasing versus financial leasing

5.44. Operating leasing refers to the renting out of machinery or equipment for varying periods of time but not for the entire expected service life of the equipment during which the owner, or lessor, is responsible for maintaining and repairing it as part of the service to the lessee and may also have to replace the equipment in the event of a serious or prolonged breakdown. Rentals paid by the lessee to the lessor are treated as the output of leasing companies similar to the renting of dwellings.

5.45. "In contrast to operating leasing, financial leasing is not itself a process of production. It is an alternative to lending as a method of financing the acquisition of machinery and equipment. A financial lease is a contract between a lessor and a lessee whereby the lessor purchases machinery or equipment that is put at the disposal of the lessee and the lessee contracts to pay rentals which enable the lessor, over the period of the contract, to recover all, or virtually all, of his costs including interest. Financial leases may be distinguished by the fact that all the risks and rewards of ownership are, de facto, transferred from the legal owner of the good, the lessor, to the user of the good, the lessee. In order to capture the economic reality of such arrangements, a change of ownership from the lessor to the lessee is deemed to take place, even though legally the leased good remains the property of the lessor, at least until the termination of the lease when the legal ownership is usually transferred to the lessee. The lessor is treated as making a loan to the lessee which enables the latter to finance the acquisition of the equipment. The rentals are then treated as covering repayments of the loan and interest payments."[18] For financial leases, the 1993 SNA treats them as a purchase with a loan from the lessor. Rentals are divided into two parts: the repayment of principal and interest payment. Both of these payments would not appear as costs in production accounts. In fact, the payment of interest is part of value added of the lessee and the repayment of principal is part of his financial account. There are some "incidental services ...provided by the lessor in the process of arranging the lease,... but the value of these services is very small compared with the total rentals paid."[19] However, the SNA does not specify any method to estimate the output of these incidental services. We may try to estimate implicit service charges on interests which are treated as the output of the lessor and also as intermediate consumption by the lessee. The estimation is not easy since an enterprise may have both operating leasing and financial leasing and the interests payable and receivable which relate directly to financial leasing are not easy to separate out except with detailed information from financial leasing companies.

5.46. In practice, national account compilers have to rely on business accounts and therefore can only apply the SNA principle if business accountants apply the principle of treating financial leasing differently from operating leasing. In fact, many countries have applied business accounting principles on leasing like those advocated by the SNA.

7. Treatment of entertainment, literary and artistic originals and copyrights

5.47. "The production of books, recordings, films, software, tapes, disks, etc. is a two-stage process of which the first stage is the production of the original and the second stage the production and use of copied of the original. The output of the first stage is the original itself over which legal or de factor ownership can be established by copyright, patent or secrecy."[20] The output of the first stage is treated as own-account gross capital formation, an intangible fixed asset, of the originator if the asset is not sold. If the original is sold, its output is measured by the price paid. If it is not sold, its value is measured by production costs plus a mark-up. The value of the mark-up is the discounted value of the future expected receipts from licensing its use. This creates uncertainty in assigning a value to the original. If we are uncertain about future value of the original, the mark-up may be given no value.

5.48. The second stage is the use or reproduction of originals. "The owner of the asset may use it directly or to produce copies in subsequent periods. Consumption of fixed capital is recorded in respect of the use of the asset in the same way as for any other fixed asset used in production."[21] "The owner may also license other producers to make use of the original in production.... In these cases, the owner is treated as providing services to the licensees that are recorded as part of their intermediate consumption. The payments made by the licenses may be described in various ways, such as fees, commissions or

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[18] *System of National Accounts 1993*, para. 6.118.

[19] *Ibid.*, para. 6.119.

[20] *Ibid.*, para. 6.143.

[21] *Ibid.*, para. 6.145.

royalties, but however they are described they are treated as payments for services rendered by the owner."[22]

5.49. There is a special category of originals and patents, which is called *scientific originals and patents*, the production of which is treated by the SNA as outside the production boundary. Scientific originals and patents such as inventions, new drugs, new processes, etc. must be understood in the context of expenditures on research and development (R&D) which may yield benefits long after being undertaken and are considered by most economists as gross capital formation. However, the 1993 SNA treats R&D only as output that is consumed by the unit that produces it as intermediate consumption. In practice, scientific originals may be produced which must be assets from an economic point of view but they are not recognized by the SNA. There is no category of scientific originals" under intangible fixed assets, though patents may be taken out which establish legal ownership over non-existent assets. The SNA tries to get around this by recognizing a category of asset called patented entities" which are part of non-produced intangible assets. Payments of royalties to patent owners for the use of these patented entities are treated as property income like interest or dividends. They are not part of the production boundary and therefore not an output.

D. Allocation of production activities of institutional units to establishments

1. Production activities of corporate and quasi-corporate enterprises

5.50. Output of an enterprise is usually compiled according to the procedure shown in table 5.5 below.

5.51. In table 5.5, an example of the statistics for a corporate or quasi-corporate enterprise is given to show what outputs should be accounted for. In this example, the enterprise consists of two establishments, a research and development activity and ancillary activities serving the two establishments. These two establishments are classified as market producers since most of their output is intended for sale at economically significant prices. Two additional establishments are imputed: one to research and development activities and the other to own-account capital formation. Own-capital formation is assumed to be carried out separately by establishments 1 and 2 including ancillary units (see para. 4.15) with research and development treated as carried out outside these two establishments. Imputed outputs of R&D and own-account capital formation are not counted as part of the outputs of establishment 1 and 2. R&D activities may be classified as for the market, for own use or for other non-market use depending on whether a major part of the services are sold in the market, internally used or provided as free government and non-profit services. A non-market part of the output of R&D is then treated as intermediate consumption and not as gross capital formation. In this example, own-account capital formation is shown as a single establishment, but in actual compilation, this establishment may have to be subdivided depending on the number of capital products the enterprise produces. Normally, only own-account construction is produced. The producers identified as establishments may simultaneously produce market output, output for final use and possibly other non-market output, as defined below. Table 5.5 helps classify outputs into separate categories. Each product produced by an establishment may be used for different purposes and therefore must be classified accordingly.

[22] *Ibid.*, para. 6.146.

5.52. Surveys of establishments are the conventional method used to collect production statistics. A separate establishment is normally identified by a physical production location belonging to an enterprise. If all activities happen in one location, the enterprise is normally treated as an establishment. Conceptually, each product produced, assuming there are no by-products, is best identified as an establishment. Surveys may be designed to ask for outputs as well as associated inputs used in producing each output separately. However, costs are not always linked directly to a specific establishment producing a specific product within an enterprise. There are general costs at the enterprise level that do not apply specifically to an establishment, such as general administration, insurance, interests receivable and payable. There should be guidelines to instruct respondents how to allocate these costs to various establishments. A rule may be as simple as allocation on the basis of sales or value added.[23] This type of rule is not alien to business accountants as they have to apply cost accounting methods to prepare production costs associated with each product in order to price their products in the market. This is also a practice of the Malaysian Department of Statistics in its establishment surveys. In Malaysia, even bank charges, interest and dividend payments and receipts, and insurance premiums are assigned to separate establishments. This information will be useful in calculating bank and insurance service charges as intermediate inputs of establishments. This topic will be covered later in this chapter. The allocation of costs to separate establishments and to products, if feasible, would avoid the mechanical application of methods in treating secondary products.

2. Production of government units and non-profit institutions serving households

5.53. Outputs or products produced by governmental agencies to serve the society at large or by non-profit institutions serving households supplied without charge or at prices which are not economically significant (see table 5.6) are normally the first three items of the following list, although in many countries the last items are also included as parts of output of government services:[24]

(a) Market goods and services that are sold at economically significant prices and normally supplied by non-profit schools, colleges, universities, clinics, hospitals, etc. including publications sold by government offices or reproductions sold by non-market museums (the part that is sold is treated as market and the residual is treated as non-market);

(b) Non-market goods and services such as health and educational services that are provided free or almost free;

(c) Other non-market services that are collective services such as public administration and defense, etc.;

(d) Research and development that must be treated as a separate establishment;

(e) Own-account construction that also must be treated as a separate establishment.

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[23]To see how to link business accounting of non-financial enterprises to the SNA, see Vu Quang Viet, "Compilation of National Accounts from Business Accounts: Non-financial Corporations" in *Handbook of National Accounting: Links between Business Accounting and National Accounting*, (ST/ESA/STAT/SER.F/76).

[24]In I/O analysis, it is preferable that R&D and own-account capital formation, particularly construction be separated from pure government services. To do this, associated inputs must also be estimated and separated out.

Table 5.5. Production statistics of a non-financial or financial enterprise with secondary products

	Products of specified establishments, characteristic and secondary and ancillary activities of an enterprise										Establishment output
	Product 1						Product 2		Product 3 Research and Development	Prod. 4 Own-account capital formation	
	Market output at basic prices			Non-market	Other non-market	Total	.	Total			
	(1)	(2)*	(3)	(4)*	(5)*	(6)	.	(7)	(8)*	(9)*	(10)*
	Output sold	Other uses	Total (1)+(2)	Own final use (capital goods)	Other non-market	(3)+.+(5)					(6)+(7)+(8)
Establishment 1	17		17	2	1	20		8		(4)	28
Establishment 2	9	3	12			12		4		(2)	16
Research & Development establishment									2		2
Ancillary activities	x		x	x	x	x	x	x		(2)	
Own-account capital formation										(8)	8
Total enterprise	26	3	29	2	1	32		12	2	8	54

*Columns:

(2) Other uses include products that are bartered with other enterprises, used in other establishments within the same enterprise and delivered to employees as remuneration.

(4) Own final use includes only products (i.e durable goods) that are used as capital goods. In the case of unincorporated enterprises which belong to the household sector, these products are classified as final consumption expenditures.

(5) Other non-market includes output that is distributed free or sold at not economically significant prices to non-profit institutions serving households.

(8) Costs of R&D should be separated from other costs of the establishment that generates R&D and imputed as the output of a separate imputed establishment. This output is then imputed as intermediate consumption of R&D of the establishment that generates R&D.

(9) Own-account capital formation such as construction, development of software and other originals which can be used for more than a year should also be separated from other costs of the establishment that produces them and each activity is imputed as the output of a separate imputed establishment. This output is then imputed as gross capital formation of the establishment that produces it. In fact, there is no such output as own-account capital formation; column 9 is an aggregate of many capital products for the sake of abbreviation. Ancillary activities may also produce capital products. In this case, these capital products have to be allocated to other establishments. The values are entered into parentheses to show that they do not enter as establishment output in column 10. Own final use in column 4, which shows the products, such as microcomputers, produced but internally used as capital goods should be later included with own-account capital formation.

(10) For the grand total for the enterprise, 8 has to be included.

x Means that nothing should be included.

Table 5.6. Production statistics of a government or non-profit unit serving households enterprise with secondary products

	Products of specified establishments, characteristic and secondary and ancillary activities of an enterprise					Establishment output
	Other non-market output measured at costs	Non-market output measured at costs	Market output at basic prices Output sold	Research and Development	Own-account construction	
	(1)	(2)	(3)	(4)*	(5)*	(6)
Establishment 1	200				(14)	200
Establishment 2		40	17		(3)	57
Research & Development establishment				10		10
Ancillary activities			x		(2)	0
Own-account construction						19
Total enterprise	200	40	17	10	(19)	286

*Columns: (4) Research and Development is treated like own-account constructions (see next note) though in the sample, R&D is separately provided.

(5) Own-account construction must be treated as separate establishments and not as part of the outputs of establishments 1 and 2. They are therefore parenthesized and treated as output of a separate establishment. Output of own-account construction is measured at costs. Here costs must be transferred out of the costs of establishments 1 and 2.

5.54. The outputs of government units and NPISHs are normally measured by costs as previously discussed. These outputs net of sales make up either collective or individual final consumption, so it is important that they be prepared in conjunction with the compilation of final consumption which will be discussed in detail in chapter VII where an example is given of how output of government services and government final consumption are compiled from data on government budget.

3. Production activities of unincorporated enterprises of households

5.55. Production within the household institutional sector takes place in enterprises that are directly owned and controlled by members of a household or shared with other households. These production units are called unincorporated enterprises. In the input-output framework, activities in an unincorporated enterprise are classified into different ISIC categories depending on the nature of its activities and thus may be separated into different establishment units similar to those shown in table 5.5. Members of households who work as employees for corporations, quasi-corporations, government or non-profit institutions serving households contribute to the production activities outside the household sector.

5.56. Similar to the corporate sector, each activity (or establishment) can be classified into market or own-use producers and their output can also be classified accordingly.

5.57. **Household market producers** include all unincorporated enterprises that produce goods and services for sale. The value of the products for sale must be at least 50% of their total output. Table 5.6 can also be used to calculate output of the household market producers.

5.58. **Household non-market producers** include:

(a) Subsistence farmers, fishermen, woodcutters, etc.;

(b) Households engaged in the construction of dwellings for their own use or in major structural improvement or extension of their dwellings;

(c) Households engaged in communal construction projects such as bridges, roads, schools, water supplies, irrigation works, etc.;

(d) Households engaged in the production of other goods for their own consumption such as cloth, clothing, furniture, other household goods, fuel materials for cooking and heating, foodstuffs (other than meal preparation), etc.;

(e) Imputed services of owner-occupied housing;

(f) Domestic services produced by paid employees.

5.59. For communal construction projects by household non-market producers, when no comparable market prices are available to value them, their values as previously discussed can be measured at production costs. Since a major part of the work is done by unpaid voluntary labour, wage rates paid for similar kinds of work on local labour market should be used to estimate labour costs.

E. Compilation of production accounts of selected industries

5.60. Elaboration of methods, contents of output and inputs, and sources of information for most industries, particularly non-financial industries can be obtained from the United Nations publication, *Handbook of National Accounting: Accounting for Production: Sources and Methods* mentioned previously. This part will mainly elaborate on the calculation of outputs only and only sometimes on inputs of the industries deemed to be conceptually complicated or whose definitions in the 1993 SNA are not the same as the 1968 SNA.

1. Agriculture, forestry and fishery

5.61. The SNA recommends that, in order to have a concept of production that is consistent with other economic activities, the managed growth of crops, standing timber or other trees and fish and livestock reared for food, under the control of institutional units, have to be treated as a continuous process of production whose output consists of work-in-progress -- that is, output that is not yet sufficiently processed to be marketed or used to produce other goods and services. "Assume the process of production takes several periods (months, quarters, or years, as the case may be) to complete. The value of the output produced in each period can then be measured as work-in-progress by distributing the value of the finished agricultural products (harvested crops, slaughtered animals, etc.) in proportion to the costs incurred each period."[25] The measurement of output of work-in-progress in each period can be seen in paragraphs 5.37-5.40 of this chapter. The only difference in application here is that work-in-progress of agriculture, forestry and fishing is not a production cost in each period but the value of finished goods allocated on the basis of production cost.

5.62. The output of agriculture, forestry and fishery is normally not estimated by using sale values but is based on the quantities and prices that are estimated separately. For crops, for instance, quantity is estimated by sampled cultivated areas and their corresponding yields, losses and seeds.[26] One point that needs clarification is the definition of agricultural output in the 1993 SNA which excludes from output and inputs the output that is used as intermediate consumption within the establishment. This means that the products that are produced by a household and then used as seeds will be excluded from agricultural output and inputs. Only seeds that are obtained from the market are included. Conceptually, value added of agricultural activities does not change whether non-marketed seeds are included or excluded. Thus, if I/O practitioners wish to include seeds in both output and inputs in order to see clearly the inputs required, the method should be footnoted so that no misunderstanding may occur. Agricultural statistics, however, use concepts of output that are different from that of the SNA. The main reasons given are: (i) the SNA concept does not provide the information needed to prepare a seed replacement plan; (ii) it is difficult to gather data required for intermediate uses of harvested output within the same establishments. The relationship of the different concepts[27] is shown below:

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[25]*System of National Accounts 1993*, para. 6.96.

[26]For detailed instructions on how to compile the output of agriculture, forestry and fishing, see *A System of Economic Accounts for Food and Agriculture*, FAO, 1996.

[27]*Ibid.*, page 75.

	Harvested output
less	Losses (wastage) on producing farm between harvest and the use or storage of the output. In such cases output covers both the principal product and by-products
equals	Total output
less	Intermediate uses of harvested output, principal product or by-products within the producing farm (establishment) itself
equals	Output (SNA)

2. Wholesalers and retailers

5.63. The output of wholesalers and retailers is "measured by the total value of the trade margins realized on the goods they purchase for resale. A trade margin is defined as the difference between the actual or imputed price realized on a good purchased for resale and the price that would have to be paid by the distributor to replace the good at the time it is sold or otherwise disposed of. The margins realized on some goods may be negative if their prices have to be marked down. They must be negative on goods that are never sold because they go to waste or are stolen."[28] The reason the output of wholesalers and retailers is measured by trade margins is because their productive activity is construed to be the provision of services in transporting and storing goods, displaying the goods in an informative and attractive way and then packaging them according to the requirement of an individual customer. The goods themselves are not regarded as being significantly transformed in this process and are therefore not treated as intermediate input into the distributor's own process of production.

5.64. The output of wholesalers and retailers would include delivery costs if it is included in the cost of the goods sold. If the delivery cost is billed separately, it will be treated separately as output of transport services. In the latter case, the trader performs two separate services: trade and transport.

5.65. The output of wholesale and retail trade, or trade margins, is calculated by the SNA by the following formula:

(3) Trade margins = Sales - value of goods purchased for resale + changes in inventories

5.66. Table 5.7 illustrates how trade margins are calculated given three methods of valuing inventories. Its structure is similar to that of table 5.10 in appendix A, except that production is replaced by purchases for resale as a reason for inventories to increase. Another difference is that goods produced are valued at the prices at which they may be sold in the market. Thus, the unit cost for production and sales are the same in table 5.10. In table 5.7, additions to inventories are valued at purchasers' prices of goods bought for resale at the time goods are entered into inventories, and withdrawals from inventories are valued at purchasers' prices of good bought for resale at the time goods are withdrawn. By this treatment, trade margins may be calculated by subtracting cost for purchases from sales at the prices of the accounting period. They reflect trade mark-up at the time of selling.

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[28] *System of National Accounts 1993*, para. 6.110.

Table 5.7. Example describing the calculation of trade margins given different methods of inventory valuation

	SNA			LIFO			FIFO		
Period	1	2	Year	1	2	Year	1	2	Year
1. Beginning inventories									
Unit	0	60	0	0	50	0	0	50	0
Value	0	300	0	0	250	0	0	250	0
2. Purchases									
Unit	60	5	65	60	5	65	60	5	65
Unit cost	5	7		5	7		5	7	
Value	300	35	335	300	35	335	300	35	335
3. Addition to inventories									
Unit	60	5	65	60	5	65	60	5	65
Unit cost	5	7		5	7		5	7	
Value	300	35	335	300	35	335	300	35	335
4. Sales									
Unit	10	40	50	10	40	50	10	40	50
Unit cost	6	8		6	8	0	6	8	
Value	60	320	380	60	320	380	60	320	380
5. Withdrawal from inventories									
Unit	-10	-40	-50	-10	-40	-50	-10	-40	-50
Unit cost	5	7		5	7&5[29]		5[30]	5&7[31]	
Value	-50	-280	-330	-50	-210	-260	-50	-200	-250
6. Changes in inventories									
Unit	50	-35	15	50	-35	15	50	-35	15
Value	250	-245	5	250	-175	75	250	-165	85
7. Ending inventories									
Unit	50	15	15	50	15	15	50	15	15
Value	250	5	5	250	75	75	250	85	85
8. Output calculated as sales - purchases for resales + changes in inventories									
Value	10	40	50	10	110	120	10	120	130

[29]LIFO withdraws the last 5 units of incoming inventory first, values them at the unit cost of 7 (i.e. last in, first out). The other 35 units withdrawn are valued at the unit cost of 5.

[30]FIFO values the 10 units withdrawn at the unit cost of 5 (i.e. first in, first out).

[31]FIFO withdraws the 40 units that enter inventories first. They are valued at the unit cost of 5.

5.67. The trade margin calculated by the SNA method for period 1 is 10, which is equal to the unit sold (10) multiplied by the market mark-up prevailing at the time the goods are sold (6 - 5 = 1), and for period 2 it is 40, with a quantity sold of 40 and the market mark-up of 1 (8 - 7). This valuation rule in the SNA applies even when prices change within the same period. Thus, to approximate trade margins by the SNA method, one may take the product of quantity sold and average mark-up during the accounting period. As long as there is a mark-up, the minimum value of output of trade margins is zero even when no sale takes place.

5.68. The estimates of outputs by the LIFO and FIFO methods are higher than the SNA's because the former also contain capital gains on the units sold while they are in inventories because the inventories withdrawn are not all valued at the prevailing replacement prices. The significant differences in outputs estimated by the three methods shown in table 5.7 are due to the large ratio of inventories over sales and the large change in prices given in the example. In countries with inflation under control and a normal ratio of inventories,[32] the differences should not be large.

3. Transport services

5.69. Transport services move people and goods, with the latter called transport margins. Transport margins can appear in three different forms: (i) margins paid as part of the price of goods, i.e. no bills on transport services are issued to consumers, (ii) margins paid as separate bill to traders who will arrange for the transport, and (iii) margins provided by purchasers either as own-account transport or as hire from the transport industry. There are two methods of treating transport services, and depending on which method is adopted in the input-output framework, the output of the sector could be different.

5.70. The first method aimed at presenting data as they are actually transacted is recommended by the SNA as follows:

(a) Transport services provided by producers, wholesalers, retailers or third parties will be treated separately as transport margins only if they are billed separately from the values of goods to their customers. If bills are issued separately, customers buy not only the goods, but also transport services from producers, wholesalers, retailers or third parties. These transport services are then treated as secondary product of the trade enterprise, producers or third parties. However, if they are not billed separately, but included in purchasers' prices of the goods bought, they become part of the trade margins or values of the goods (in the case of producers) and the transport costs become their intermediate consumption;

(b) Own-account transport services consumed within the establishments which, by SNA rule, are treated as own-account goods consumed.should not be treated as part of the output of the establishments but as their operating costs, and therefore do not form part of the transport outputs.

5.71. The second method adopted by some input-output practitioners who want to treat transportation as a functional concept would always remove transport services billed or not billed to customers from trade margins and include them into the output of the transport industry. They would also apply the same method to own-account transportation. The second method always produces higher output value of transport services than the

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[32]In the United States, inventory-sales ratios for most goods were below 2, except for a few durable goods. In 1995 and 1996, the average ratio for manufacturing goods was below 1.4.

first one. Outputs of own-account transport services, if based on the second method, are usually estimated by simple rule, such as by multiplying the total number of trucks with the estimated average output per truck. When doing this, inputs associated with own-account transport must also be removed from the mother activity and these costs are replaced by the consumption of transport services equal to the sum of values removed. To be fully consistent with the SNA, the second method should not be used in the SNA input-output framework. It could be introduced as a satellite study of the transportation industry like a study of a tourist industry that will be discussed in chapter X. In the SNA, the transport industry contains only services that are billed separately or consumed outside of the establishments.

5.72. The complications in deciding output of transport services involving mobile equipment such as ships, aircraft, railways, etc. that operate outside the economic territory in which the units are resident will be discussed in chapter VI on treatment of imports.

4. Owner-occupied housing services and government-subsidized housing

5.73. The SNA assumes that owner-occupied dwellings provide housing services for their owners. These services are part of the output of the unincorporated enterprises sector. The output of these services can be approximated by market rents for the same kind of housing, taking into account factors such as location and amenities as well as the size and quality of the dwelling itself. In countries where no market rents are available, the output of the services of owner-occupied housing can be measured at least as the value of depreciation of the dwelling measured at current market value or current replacement cost. Remember that do-it-yourself repairs are not within the SNA production boundary and thus do not enter as part of the housing services. Expenses paid for housing repairs are treated as household final consumption.

5.74. To be compatible with the treatment of owner-occupied housing, the output of government subsidized housing should also be measured at equivalent market rents. The difference between market rents and subsidized rents is treated as social benefits in kind provided by Governments, which is part of the individual final consumption of government.[33] Assuming the market rents are 100, but renters pay only 80, then output should be 100 of which 80 goes to household final consumption and 20 goes to individual final consumption of government (see definitions of final consumption in chapter VII). If the subsidized housing is government-owned and the output estimated by equivalent market rents is higher than the subsidized rent, then the difference between output estimate and the subsidized rent should also be imputed as social benefits in kind.

5. The output of financial intermediaries and its treatment in the input-output framework

5.75. Many financial intermediaries like money-market funds, trusts, and stock brokers, charge their customers for their services. However, others such as banks and the like do so for only a very few services, while major ones rendered to their customers in channelling funds from depositors and savers to borrowers are not charged explicitly. Charges for these services are implicit in the difference between interest received from borrowers and interest paid to depositors. As a consequence, the implicit service charges of financial intermediaries are measured by the difference between interests received and interests paid. Interests received

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[33]This is based on the interpretation of the Inter-Secretariat Working Group on National Account, "...that payments by governments to market producers for goods and services should be treated as social benefits in kind and not subsidies on products if those market producers provide those products directly and individually to households in the context of social risks or needs and to which the households are legally entitled." *SNA News and Notes,* No. 3, January 1996, United Nations Statistics Division (UNSD).

should exclude those received from lending own funds. The total output of financial intermediaries is equal to the sum of explicit and implicit service charges. The output of the central bank is measured like that of other financial institutions. However, if its gross output fluctuates widely, or is negative, a second-best approach of measuring output by cost may be adopted.[34] Below is a review of conceptual issues. Measurement issues are discussed in appendix B since until now there are no internationally agreed standards for treating them.

Conceptual issues

5.76. In the 1968 SNA, implicit service charges are not distributed directly among the users of the services provided by the financial intermediaries but are assumed to be consumed by a fictitious industry representing all industries. Since this is a fictitious industry that is supposed to produce zero output, a negative value which is equal to the value of implicit service charges has to be entered as the value added of the fictitious industry in order to make the output of this section equal to zero. The treatment is aimed at avoiding allocating implicit service charges to every consumers. It creates two problems:

(a) It is not possible to compute the input-output coefficients of the fictitious industry. As a consequence, this fictitious industry has to be aggregated to the financial intermediary industries;

(b) Given that all industries and the household sector as well as the Government use the services of financial intermediaries, not imputing these implicit service charges to the intermediate consumption of individual industries or to the final consumption of final consumers will increase the value added of the individual consuming industry. Overall, imputing to the value added of the fictitious industry a negative value which is equal to the total implicit service charges reduces the GDP since the final consumption of bank services by the household and government sectors is treated as intermediate consumption by industries.

5.77. Though not rejecting the 1968 method, the 1993 SNA recommends an alternative, i.e. the distribution of implicit service charges to all consumers, including industries as intermediate input and final consumers as final consumption. In this case, when measured as final expenditures, the GDP will increase in comparison to the 1968 SNA treatment by the amount of implicit service charges allocated to final consumption. The value added of each individual industry will be lower than before but the total value added, i.e. the GDP, will be higher since less than a full amount of implicit service charges is allocated as input to industries.

5.78. Table 5.8 shows how banking service charges are treated in the old 1968 SNA and table 5.9 shows how they may be treated in the 1993 SNA. The total explicit service charges are assumed to be 5 and the total implicit service charges are assumed to be 15. In the 1968 SNA the full value of implicit service charges are assumed to be consumed by the fictitious financial industry. In the 1993 SNA, 7 is allocated to be consumed by industries and 8 allocated to final demand. The GDP in the 1968 SNA is equal to the total value added or total final demand which is 59 while the GDP in the 1993 SNA is higher and equal to 67. The difference in GDP is equal to the implicit banking services allocated to final demand, which is 8 in our example.

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[34]According to the decision by the Inter-Secretariat Working Group on National Accounts. *Ibid.*

Table 5.8. The treatment of imputed bank service charges in the 1968 SNA

	Intermediate consumption			Final demand	Output
	Other industries	Banking industry	Fictitious industry		
Others	35	6		59	100
Banking	5		15	0	20
Fictitious	0			0	0
Value added	60	14	-15		
Output	100	20	0		

Table 5.9. The treatment of imputed bank service charges in the 1993 SNA

	Intermediate consumption		Final demand	Output
	Other industries	Banking industry		
Others	35	6	59	100
Banking	5+7		8	20
Value added	53	14		
Output	100	20		

5.79. The distribution of explicit service charges, in principle, is easy as long as banks and other financial intermediaries keep records of their revenues supplemented by records of expenditures by industries, government and the household sector. The distribution of implicit service charges is quite complicated. The SNA recommends the use of a proxy to represent pure interest rate, which is called the *reference rate*. The estimation of the reference rate will be discussed later. Borrowers will have to pay a rate higher than the pure interest rate. The difference between the rate borrowers pay and the pure interest is the implicit service charge. Depositors also have to pay for service charges, and therefore they receive an interest payment less than the pure interest. Pure interest may differ from one class of consumers to another. This is particularly true for financial transactions in foreign financial instruments because of differences in inflation rates and other factors such as government control measures among countries.

5.80. Overall, for an economy, interest payments by borrowers (i_b) are equal to pure interest (i) plus implicit service charges to borrowers (S_b); and interest receipts by depositors (i_d) are equal to pure interest (i) minus implicit service charges (S_d) to depositors, or:

$$i_b = i + S_b$$
$$i_d = i - S_d$$

The difference between interest payments and interest receipts must be equal to total implicit service charges.

$$i_b - i_d = (i + S_b) - (i - S_d) = S_b + S_d$$

From the equations above, implicit outputs of financial intermediaries, which are indirectly measured and abbreviated as FISIM (Financial intermediation services indirectly measured) equal $i_b - i_d$. Service charges on borrowers are $S_b = i_b - i$ and service charges on depositors are $S_d = i - i_d$. The amount of service charges on borrowers and depositors is dependent on where the pure interest rate i is located between i_b and i_d.

5.81. The *pure* interest rate (i), or reference rate, for borrowers and depositors in the domestic market can be approximated by the average inter-bank lending rate which has the advantage of not incorporating risk premiums and intermediation services. Given banks' interest receipts and payments, broken down by institutional sector, and statistics for outstanding bank deposits and loans in the balance sheet of banks, broken down by institutional sector, we can easily calculate imputed service charges consumed by each sector. The charges involve the calculation of *pure* interest flows on the basis of the *pure* interest rate and sectoral bank deposits and loans.

6. Production accounts of insurance enterprises

5.82. Activities of insurance companies are similar to those of financial intermediaries. Insurance companies collect premiums from units that buy insurance against specified events, manage these funds and pay out claims to the same units when the specified events occur. Besides receiving premiums, insurance companies also receive property income from the investment of their technical reserves. Technical reserves are necessary because there is a time lag between the time when premiums have to be paid, which is at the start of the insurance period, and the time claims are paid out.

5.83. The output of insurance companies should be the value of services rendered by them for protection against specified events.

(a) Life insurance

5.84. The value of the output of life insurance establishments is calculated as follows:

Formula 1

(a)		Gross premiums earned
(b)	+	Net income from investment of the insurance technical reserves
(c)	-	Total claims due
(d)	-	Increase in the actuarial reserve that excludes allocation of capital gains and losses to the reserves which are treated as revaluations in the balance sheets outside of the input-output framework.

5.85. Item (b) includes:

(i) Property incomes receivable less property income payable
(ii) Rentals and other incomes

Item (ii) covers secondary products of insurance companies as most of them are normally involved in real estate and some other business services. The output calculated by formula 1 should include the primary product which is insurance services and the secondary products, i.e. rentals and other incomes.

5.86. Item (a) must relate only to the accounting period the insurance policy covers and must include all premiums paid in the current or previous periods which cover the risks incurred during the current accounting period and exclude late payment of premiums for previous periods and prepayment of premiums for the coming periods. Item (c) must cover claims which become due for payment during the accounting period though they might not have been paid yet. Net income from investment and capital gain or loss of the insurance enterprise's own capital are excluded from items (b) and (d). Therefore the following relationships should be observed when one calculates the insurance output:

Gross premiums earned = Premiums receivable - change in the reserve due to prepayment
Claims due = Claims payable + change in the reserve against outstanding claims.

In fact, there are three types of reserves: reserve due to prepayment, reserve against outstanding claims, and the actuarial reserve against future claims. Because insurance companies may use different technical terms for the three reserves it is important to understand the nature of each one. Since many insurance companies report on premiums receivable and claims payable rather than premiums earned and claims due, the following formula can be used to calculate life insurance output:

Formula 2

(a)		Gross premiums receivable
(b)	+	Net income from investment of the insurance technical reserves
(c)	-	Total claims payable
(d)	-	(Increase in the reserve due to prepayment + increase in the reserve against outstanding claims + increase in the actuarial reserve).

In calculating changes in reserves, it is important to exclude capital gains/losses from the value of total reserves in the subsequent period. These capital gains/losses are treated as revaluations in the balance sheets outside of the production framework. In business balance sheets, reserves are revalued mainly for investments in financial assets and rarely for investments in fixed assets.

(b) Non-life insurance

5.87. Either formula 1 or 2 can also be used to calculate the output of non-life insurance, except that change in the actuarial reserve is zero since non-life insurance companies do not have the actuarial reserve. However, they should have the other two reserves: the reserve due to prepayment and the reserve against outstanding claims.

5.88. Sometimes, there is a reserve that is not directed to any of the purposes of the three reserves mentioned above. A change in this reserve, which may be called contingency reserve, should be considered part of the operating surplus that has not been distributed as dividends.

5.89. On the basis of the experiences of some countries, it is likely that the insurance output and consequently the insurance value added may fluctuate widely from one year to the next It is also possible that value added is negative. These problems may happen even if insurance companies are healthy and growing. The instability of output and value added makes the use of I/O analysis useless as the latter has to rely on the stability of I/O coefficients. There are two solutions to this problem: (a) spread output and value added over a number of years so that claims may be spread out, or (b) calculate output from costs. Solution (a) can only cover the years before the year for which national accounts need to be prepared in order to release national accounts statistics on time. Even with that, the resulting output does not necessarily move along with cost of production. Solution (b) clearly deviates from the SNA but may be needed for the use of the I/O coefficient matrix in economic modelling.

7. Production accounts of privately funded pension funds

5.90. Pension funds for which output is calculated must be separate funds established for the purpose of providing income on retirement for specific groups of employees. They are organized and run by private or public employers or jointly by the employers and their employees. Pension funds that are not independent are treated as part of the operation of the companies that run them and, payments would be treated as normal compensation of employees. Pension funds should not include compulsory social security schemes imposed, controlled or financed by the Government.

5.91. The output of privately funded pension funds is taken to be a service charge to the beneficiaries equal to:

(a)		Total actual contributions earned
(b)	+	Total imputed contribution supplements[35]
(c)	-	Benefits due
(d)	-	Increases (plus decreases) in pension reserves.

The new method is different from the 1968 SNA. In the 1968 version, since pension funds are assumed not to be organized for profit-making purposes, their output is measured by the cost of operating them. This includes intermediate costs, compensation of employees, other taxes on production and consumption of fixed capital. If pension funds are also organized for profit making, the measurement of output by costs is not accurate. However, the new method is more complicated in the sense that an increase in reserves, which is basically an increase in the funds, must exclude capital gains/losses in the investments of the funds.

8. Production accounts of research and development

5.92. Since the 1993 SNA treats all expenses on research and development (R&D) incurred by enterprises as part of their outputs they should be classified in separate establishments belonging to the enterprises. The new ISIC also allows for this classification. However, as in the 1968 SNA, research and development output for the enterprise's own consumption is treated as intermediate consumption by the establishments within the enterprises. The allocation of the intermediate consumption of research and development to other establishments in the enterprise may be based on the proportion of value added or output of each establishment as in the allocation of ancillary activities. The output of research and development services for its own use in an enterprise may be measured by the total costs of production including the imputed rentals on its own buildings. In the case of specialized commercial research laboratories and institutes, their output can be measured by receipts of sales, commissions, fees, etc. After detailed inputs consumed by R&D are singled out, it is important to deduct them from the inputs of the industries that consume them and in their places, only a single value of expenditures on R&D is included as input.

[35]These are equal to investment income from invested pension reserves.

9. Production accounts of mineral exploration

5.93. The output of mineral exploration is measured by the total expenditures on mineral exploration. However, unlike research and development which are treated as intermediate consumption, mineral exploration is treated as gross fixed capital formation.

10. Production accounts of producers of government services and of non-profit organizations serving households (other non-market output)

5.94. Producers of government services and of non-profit organizations' services serving households consist of all agencies providing collective services such as public administration, regulation, the maintenance of law and order, defence, non-profit services and also non-collective services that are supplied free or at nominal prices to individual households. Examples of the latter that are mostly supplied on a non-market basis are education, health and housing.

5.95. The output of all other non-market producers, whether providing collective services or individual goods and services should be, according to the SNA, valued on the basis of their total costs of production and not by prices of similar goods or services charged on the market, because of the difficulty of obtaining suitable prices in practice. Thus, the outputs of producers of government services and of non-profit organizations are measured by the sum of:

- Intermediate consumption
- Compensation of employees
- Other taxes less subsidies on production
- Consumption of fixed capital.

The net operating surplus is zero by convention. As the above value covers the whole of the output of a non-market producer, receipts from any incidental sales of goods and services are ignored for the calculation of output, while incidental sales determine which part of the output is consumed (incurred) in other sectors.

5.96. In an input-output table, producers of government services or of non-profit organizations' services serving households do not appear as only two sectors but as many separate sectors classified by distinctive economic activities. For example, government services consist of general public administration as well as education, health, electricity, sewage and refuse disposal, library, radio and television services, etc. These government activities may be split and grouped with similar ones provided by the private sector and by non-profit organizations serving households.

Appendix A

VALUATION OF INVENTORIES IN OUTPUT CALCULATION

5.97. Business accounting does not concern itself with the concept of output. Its focus is on sales and the cost of goods sold in order to measure net income. National accountants need to use business accounts in order to derive the SNA concept of output. Output of non-financial activities is measured as follows:

Output = Sales net of discounts, returns, VAT and sales taxes + other uses + changes in inventories

Thus the valuation of inventories is quite important to the measurement of output, intermediate consumption, gross capital formation and finally GDP in the SNA. Different values of inventories would produce different output values. For this reason, this note will discuss in depth why business inventories should be revalued according to the SNA concept.

5.98. In business accounting, many methods are used in valuing inventories at cost. The most frequently used ones are: FIFO (first in, first out), LIFO (last in, first out), average cost method. While LIFO best matches revenues and cost of goods sold, especially when there has been a prolonged period of inflation or deflation, it is not best suited for measuring the current balance sheet: FIFO is better in this regard as the value of ending inventories is closest to current market values. Table 5.10 shows the valuation methods of the SNA, LIFO and FIFO using the perpetual inventory method of recording (PIM), instead of the periodic method of recording. The PIM recording method is similar to the method recommended by the SNA and also adopted by some business firms. Under PIM, sales and purchases of each item are recorded continuously. With the availability of powerful micro-computers, PIM is increasingly adopted by business in replacing the periodic recording method. From the illustration in table 5.10, it is possible to derive some basic ways to approximate the SNA method in measuring non financial output. Table 5.10 divides the annual accounting period into sub-periods in order to see the accuracy of the methods used in measuring output. In the table, products produced are entered immediately into inventories and remain there until they are withdrawn for sale. Differences in valuation methods lie in the valuation of inventories withdrawn.

5.99 The SNA method values addition to inventories at the basic prices prevailing at the time of entry and withdrawal at the prices at which they are then sold. The SNA method, however, values ending inventories (assets) at market prices (which are basic prices) at the time of valuation. This revaluation is not introduced in table 5.10.

5.100. **The LIFO method** values incoming inventories similarly to the SNA but withdrawals at the cost of the last items entered into inventories.

5.101. **The FIFO method** values incoming inventories as do the other methods but values withdrawals at the cost of the first items acquired.

5.102. The output calculated by the SNA method is 335, which matches the actual output assumed in the example. The output calculated by LIFO is 345 which is more than the actual output. The output by FIFO is 355 which is farther away from the actual output than LIFO. The difference, or error, is capital gains due to inflation. When prices are declining, FIFO gives an output value that is closer to the actual one than LIFO. Changes in inventories calculated according to the SNA include all capital gains (or loss) on the inventories sold and therefore the output calculated by the SNA eliminates all capital gains from sales.

Table 5.10. Example describing output calculation of goods production activities using different methods of inventory valuation

	SNA			LIFO			FIFO		
Period	1	2	Year	1	2	Year	1	2	Year
1. Beginning inventories									
Unit	0	60	0	0	60	0	0	60	0
Value	0	300	0	0	300	0	0	300	0
2. Production									
Unit	60	5	65	60	5	65	60	5	65
Unit cost	5	7		5	7		5	7	
Value	300	35	355	300	35	335	300	35	335
3. Addition to inventories									
Unit	60	5	65	60	5	65	60	5	65
Unit cost	5	7		5	7		5	7	
Value	300	35	355	300	35	335	300	35	335
4. Sales									
Unit	0	10	10	0	10	10	0	10	10
Unit cost	5	7		5	7		5	7	
Value	0	70	70	0	70	70	0	70	70
5. Withdrawal from inventories									
Unit	0	-10	-10	0	-10	-10	0	-10	-10
Unit cost	5	7		5	7&5[36]		5[37]	5[38]	
Value	0	-70	-70	0	-60	-60	0	-50	-50
6. Changes in inventories									
Unit	60	-5	55	60	-5	55	60	-5	55
Value	300	-35	265	300	-25	275	300	-15	285
7. Ending inventories									
Unit	60	55	55	60	55	55	60	55	55
Value	300	265	265	300	275	275	300	285	285
8. Output calculated as sales + changes in inventories									
Unit	60	5	65	60	5	65	60	5	65
Value	300	35	335	300	45	345	300	55	355

[36] LIFO withdraws the last 5 units of incoming inventory first and values them at the unit cost of 7 (i.e. last in, first out). The other 5 units withdrawn are valued at the unit cost of 5.

[37] FIFO values the 10 units withdrawn at the unit cost of 5 (i.e. first in, first out).

[38] *Idem*.

5.103. In terms of evaluating changes in inventories and ending inventories, which are used in the balance sheet, the SNA values all inventories at current market prices. Therefore changes in inventories and the ending inventories must be revalued at the unit cost of 7. The ending inventories, after revaluation, are equal to 385 (table 5.11), which is higher than the ending inventories in table 5.10 by 120. This difference is the capital gain for goods remaining in inventories. The results in the table also show that, in case of inflation, FIFO produced a value of ending inventories that is closer to market price than with LIFO.

5.104. There is no easy and accurate short-cut to convert LIFO and FIFO values of inventories to SNA values without detailed information as shown in table 5.10. The revaluation is, in fact, better done by business accountants than by national accountants at the last stage of data collection. It would be significant for national accounting if business accountants agreed to value inventories as the SNA recommends, but it is highly unlikely because banks and financial analysts always want to value inventories in the most conservative manner, i.e. at either cost or market value, whichever is lower.

5.105. However, as long as prices do not change, whatever method used in valuation, output and inventories would be the same. Errors will be great if prices increase or decrease rapidly.

5.106. "This suggests that even when prices are changing a good approximation to the PIM may be obtained by taking the difference between the quantities of goods held in inventory at the beginning and the end of the accounting period and valuing this difference at the average prices prevailing within the period. This method, which may be described as the "quantity" measure, is widely used in practice and is sometimes mistakenly considered to be the theoretically appropriate measure under all circumstances. The quantity measure will be the same, or virtually the same, as the perpetual inventory method measure not only when prices are constant but also when the quantities of goods held in inventory rise or fall at a steady pace throughout the period. Conversely, the conditions under which the quantity measure may provide only a poor approximation to the PIM are when prices are rising or falling and when inventory levels fluctuate within the accounting period."[39]

5.107. Change in inventories as an approximation as suggested by the SNA can be split into two parts: volume (or quantity) changes and nominal holding gains.

Volume changes in inventories at current market prices = VPC = $(q_t - q_{t-1})\, p_t$
Nominal holding gains = IVA = $(p_t - p_{t-1})\, q_{t-1}$

where q stands for quantity, p stands for price and t stands for time. The above equations are used to calculate volume change in inventories at current prices and nominal holding gains which, given the information in table 5.10, are shown in table 5.11. When the PIM method of recording inventories is used, as shown in table 5.11, the volume changes in inventories at current market prices will approximate SNA value of change in inventories. In this example, they are exactly the same. Changes in inventories in the balance sheet (table 5.11, row 4) are equal to volume change in inventories at current prices plus nominal holding gains at the end of every period and of the year (rows 6 and 7).

[39] *System of National Accounts 1993*, para. 6.68.

Table 5.11. The calculation of output, volume change and holding gains of inventories

	Period	0	1	2	Year
1.	Quantity of inventories	0	60	55	55
2.	Prices	5	5	7	
3.	Balance sheet values	0	300	385	385
4.	Change in inventories (SNA balance sheet values)		300	85	385
5.	Volume change in inventories		60	-5	55
6.	Volume change in inventories at current prices (VPC)		300	-35	265
7.	Nominal holding gains (IVA)		0	120	120
8.	Sales		0	70	70
9.	Volume change in inventories at current prices (VPC)		300	-35	265
10.	Output		300	35	335

5.108. In practice, inventories of many products may not be recorded by using the PIM as shown in tables 5.10 and 5.11 with full information on quantities and prices, but valued only at the beginning and end of the accounting period and an approximation of the method shown in table 5.12 may have to be used. Practices may vary among countries in treating inventories. Below only the Canadian practice is given as an example.[40] The practical calculation in Canada follows eight steps:

(1)	B	Book values as reported
(2)	D	Deflators
(3)	K = B/D	Constant dollar book values
(4)	$DK\$ = K_t - K_{t-1}$	Constant dollar value of volume change
(5)	R	Revaluers
(6)	VPC = R*DK$	Current dollar value of volume change
(7)	$CB = B_t - B_{t-1}$	Change in reported book values
(8)	IVA = CB - VPC	Nominal holding gains (which in Canada is called inventory valuation adjustment).

5.109. On the basis of the *turnover period,* the average length of time that a good spends in inventory, an appropriate price deflator is set which reflects the costs of goods entering inventory during the turnover period of the reference period. For example, with a 2.3-month turnover period, the fourth quarter deflator would be the sum of the December price index for November and 0.3 of October, divided by 2.3. For

[40]This part is based on a paper by Kishori Lal, titled "Recording of Change in Inventories in the SNA and in the Business Accounts - A Case Study of Canadian Practices" in the United Nations *Handbook of National Accounting: Links between Business Accounting and National Accounting,* Series F, No. 76.

revaluers (R), monthly reference price series are used reflecting the average costs of the inventories during the period; quarterly revaluers are simple averages over the quarter. And VPC is the value of changes in inventories used as part of gross capital formation. Annual changes in inventories, if calculated directly, in principle are equal to the sum of quarterly changes. But in practice, they differ because the underlying principles of aggregation are not met in an inflationary situation. There is no solution to this problem yet.

5.110. The same example in table 5.11 calculated according to the Canadian method is shown in table 5.12 below:

Table 5.12. The calculation of volume change and holding gains in inventories by the Canadian method

Period / Steps	0	1	2	Year=sum of 2 periods	Year, calculated given yearly data
B	0	300	385	385	385
D	1.0	1.0	1.4		
K=B/D	0	300	275	275	275
$DK=K_t-K_{t-1}$	0	300	-25	275	275
R	1.0	1.0	1.4		
VPC=R*DK	0	300	-35	265	330[41]
$CB=B_t-B_{t-1}$	0	300	85	385	385
IVA=CB-VPC	0	0	120	120	55

The last column shows that holding gains calculated by using the revaluer as an average price index of the year distorts the true value of holding gains. The method is less distortional with a monthly or at least quarterly calculation.

[41] This is the simple average of price indexes in two periods (=(1+1.4)/2=1.2).

Appendix B

MEASURING OF OUTPUT OF FINANCIAL INTERMEDIARIES

5.111. The indirect measurement of financial intermediation services (FISIM), or implicit output of financial intermediaries is not straightforward. Until now, there are no internationally accepted methods of measurement. Below are a few alternative methods of measurement that are proposed or attempted by some countries. In order to show how FISIM are calculated and allocated, an example shown in table 5.13, representing a realistic set of data, will be used. Table 5.13 shows the balance sheet of all financial intermediaries including, on one side, assets with the corresponding interest receivable from them and, on the other side, liabilities with their corresponding interest payable. In this table, securities include bonds, bills, etc. Own funds should be equal to net worth and shares, and can be calculated as the difference between total assets and other items other than own funds on the liability side. In practice, as we can observe from the table, loans are not equal to deposits because financial intermediaries raise funds not only from deposits but also their own funds or by incurring liabilities such as selling securities. They earn revenue not only from making loans but also from buying securities.

Table 5.13. The balance sheet of financial intermediaries and their interest incomes and expenses

Assets				Liabilities			
		Stocks	Interest receivable			Stocks	Interest payable
A	Fixed assets, shares and accounts receivable less payable, insurance technical reserves, shares and other equity	6,162		C	Own funds (net worth and shares)	3,741	
B1	Securities other than shares	13,349	1,102	D1	Securities other than shares	10,935	568
B2	Loans	62,004	4,634	D2	Deposits	69,467	3,453
	Interbank	9,288	402		Interbank	7,188	287
	Residents	6,188	247		Residents	6,188	247
	Non-residents	3,100	155		Non-residents	1,000	40
	Others	52,716	4,232		Others	62,279	3,166
	Residents	51,975	4,226		Residents	62,279	3,166
	Non-residents	741	6		Non-residents	0	0
B3	Others (currency and deposits)	4,298	85	D3	Other liabilities	1,670	36
	Total	85,813	5,821			85,813	4,057

Canada

5.112. Canada[42] calculates FISIM by taking all interests receivable (from either loans or securities) less all interests payable (to depositors or other liability holders), less the interests generated by the part of own funds which is lent out. The formulas it adopts are as follows:

$$FISIM = R_A B - R_L D - [C - (A+B3-D3)] \times (R_A B + R_L D) / (B + D)$$

Where $B = B1 + B2 + B3$, $D = D1 + D2 + D3$
R_A = Actual average interest rate on assets
R_L = Actual average interest rate on liabilities

If [C-(A+B3-D3]) is positive, part of own funds is lent out

If [C-(A+B3-D3)] is negative, fixed and other similar assets are funded from non-owners' funds

5.113. In the formula of FISIM above the third item shows a deduction of the interest on the part of own funds, C-(A+B3-D3) lent out, which is not supposed to generate FISIM. The interest rate on the own funds lent out is estimated by the average interest rate on B and D.

R_A = (interest on B)/B = 5,821/79,651 = .073
R_L = (interest on D)/D = 4,057/82,072 = .049

$$\begin{aligned} FISIM &= (.073 \times 79{,}651) - (.049 \times 82{,}072) - [3{,}741 - (6{,}162+4{,}298-1{,}670)] \times (.073 \times 79{,}651 + .049 \times 82{,}072) / (79{,}651 + 82{,}072) \\ &= 1{,}764 - (-308) = 2{,}072 \end{aligned}$$

5.114. Canada does not use a reference rate representing the pure interest rate to allocate FISIM to borrowers and depositors. It allocates FISIM by the ratio between deposits and loans including securities other than shares, i.e., with borrowers the ratio B/(B+D) is used and with depositors the ratio D/(B+D) is used. The advantage of the Canadian approach is that FISIM allocated to borrowers and lenders are always positive.

5.115. For imports and exports of FISIM, the average domestic FISIM rate FISIM/((B+D) will be applied to the total of deposit assets abroad plus the loan liabilities of the country.

[42]Statistics Canada, *"Calculating and Allocating FISIM: Canadian Approach"*, a paper submitted to the Working Party on National Accounts of Eurostat, Luxembourg, 26 June 1996.

European Union proposal

5.116. Though the final form of the European Union proposal[43] is not certain at the time of this writing, it seems that it will be close to the one described below. The European Union's proposal calculates FISIM by taking only interests receivable from loans less interests payable to depositors, and then allocates FISIM to borrowers and depositors by reference rates. The separate calculations of FISIM on loans and deposits are as follows:

FISIM on loans to residents = interest receivable on residents - (loan stocks to residents x *internal* interbank reference rate)

FISIM on deposits with resident financial institutions = (deposit stocks by residents x *internal* interbank reference rate) - interest payable by residents.

5.117. *Interest reference rate* applied only to loans to residents and deposits with resident financial institutions is calculated by the ratio of interest receivable on interbank loans over stock of interbank loans. In table 5.14 (see row 2) this internal reference rate is 247/6,188 = .04. Thus,

FISIM on loans to residents	=	(4,226+247) - ((51,975+6,188) x .04)) = 2,146
FISIM on deposits by residents	=	((62,279+6,188) x .04)) - (3,166+247) = -675
Total FISIM on residents	=	2,146 + (-675) = 1,471.

5.118. In comparison to the Canadian approach, the European Unions's FISIM proposal is much lower because it takes only interests on loans and deposits into account.

5.119. Exports and imports of FISIM are calculated for loans granted to non-residents and for deposits of non-residents. The formulas used are similar to those used for residents, except that "internal reference rate" is replaced by "external reference rate".

5.120. The external reference rate is calculated as the average rate weighted by the levels of stocks in "loans to non-resident financial institutions (FIs)" and "deposits by non-resident financial institutions (FIs)". In table 5.14, these are transactions with interbank non-residents.

External reference rate = (155+40)/(3,100+1,000) = .048. Thus,

FISIM on loans to non-residents	= (155+6) - ((3,100+741) x .048) = -23
FISIM on deposits by non-residents	= (1,000 x .048) - 40 = 8
Total exports of FISIM	= -23 + 8 = -15.

5.121. Imports of FISIM will use the same formulas as exports with the same external reference rate, except that one needs to use loans granted by non-resident FIs and deposits with non-resident FIs. This information may be obtained from the balance of payments.

[43]Eurostat, *"Proposal for a Council Regulation on the Allocation of Financial Intermediation Services Indirectly Measured* (FISIM)", a paper submitted to the Working Party on National Accounts of Eurostat, Luxembourg, 26 June 1996.

5.122. The total FISIM will be the sum of FISIM on residents plus exports of FISIM = 1,471 + (-15) = 1,456. This value is also shown in column (5) bottom row of table 5.14.

5.123. The problem with the European Union's proposal is that the estimated pure interests payable and receivable will not be equal because total loans are not the same as total deposits. From the calculation shown above, the estimated pure interests receivable on loans are equal to interest receivable on loans (4,634) less FISIM on loans to residents (2,146) shown in paragraph 5.117, less FISIM on loans to non-residents (-23) shown in paragraph 5.120, and similarly the estimated pure interests payable by residents are 3,453 + (-675+8) = 2,786. Even taking into account other interests receivable and payable shown in table 5.13, rows B1, B2, D1 and D3, which are pure interests, total pure interests receivable on loans (=2,511+1,102+85=3,698) are not equal to total pure interests payable by depositors (=2,786+568+36=3,390). To make the pure interests on both sides equal, some adjustment is necessary. For instance, the difference can be allocated proportionally to borrowers and depositors on the basis of their shares of estimated reference interests.

5.124. The use of a reference rate does not always yield positive service charges if it does not lie in between the deposit rate and the lending rate. In the example above, depositors are "paid" by financial institutions to use their services. The reason is that, while the lending average (4,226/51,975)= .0813) is higher than the average deposit rate (3,166/62,279 = .051), the deposit rate is higher than the "internal reference rate" (=.04). This problem happened in many countries, at some particular time.

Malaysia

5.125. The Malaysian method for calculating total FISIM is similar to the Canadian method except in the allocation of FISIM to borrowers and depositors. The reason for taking in all interests receivable and payable, except from own funds, is that many financial companies raise intermediated funds by deposits but invest them in securities, not loans to generate income, and those securities should generate some output.

5.126. The definition of the references rate is similar to the European proposal but the estimation is different. The reference rate is taken as a simple average interbank rate during the accounting period. It is based on the type of loan commonly used, which for Malaysia was a three-month interbank rate. The reason for this decision is that the internal calculation of a reference rate as proposed by Eurostat may be biased as interests paid are incurred throughout the accounting period but interbank loan stocks reflect only the value at the end of the accounting period, particularly when interbank loans are only a small amount of total loan stocks. In 1987, when the average interbank rate was very low (3%), the internally calculated rate was much higher (6%). The interest rates paid by borrowers and received by depositors are, however, calculated internally as other loans are larger in value and therefore do not have the bias problem faced by the internally calculated reference rate. The internally calculated interest rates paid and received are calculated as follows:

$i_b = (4{,}226/51{,}975) = .08$
$i_d = (3{,}166/62{,}279) = .05$
$r = .04$ (This rate in the example is not based on table 5.14 but supposed to be the simple average of most commonly used interbank rate)

5.127. FISIM is, however, allocated only to depositors and borrowers as follows:

To borrowers: $(i_b\text{-}r)/(i_b\text{-}i_d)$
To depositors: $(r\text{-}i_d)/(i_b\text{-}i_d)$

Where i_b: actual average interest rate paid by borrowers
i_d: actual average interest rate received by depositors
r: reference rates
i_b, i_d are calculated directly from a table similar to table 5.13.

Table 5.14. Allocation of FISIM to borrowers and depositors

Allocation of FISIM to borrowers					
	Stocks	Interest receivable	Reference rate	Reference interest (estimated pure interest)	Estimated FISIM
	(1)	(2)	(3)	(4)=(1)x(4)	(5)=(2)-(4)
Interbank	9,288	402		396	6
Residents	6,188	247	0.04	247	0
Non-residents	3,100	155	0.048	149	6
Others	52,716	4,232		2,115	2,117
Residents	51,975	4,226	0.04	2,079	2,147
Non-residents	741	6	.048	36	-30
Total 1		4,634		2,511	2,123
Allocation of FISIM to depositors					
	Stocks	Interest payable	Reference rate	Reference interest	Estimated FISIM
	(1)	(2)	(3)	(4)=(1)x(3)	(5)=(4)-(2)
Interbank	7,188	287		295	8
Residents	6,188	247	0.04	247	0
Non-residents	1,000	40	0.048	48	8
Others	62,279	3,166		2,491	-675
Residents	62,279	3,166	0.04	2,491	-675
Non-residents	0	0	0.048		0
Total 2		3,453		2,786	-667
Total FISIM = Total 1 + Total 2					1,456

5.128. The two proportions are always added to 1.0. The reason for a negative proportion is that the reference rate does not lie between the interest payable by borrowers and that receivable by depositors. This problem is similar to that faced by the European proposal but this method will yield the equality of the total of estimated pure interests receivable and the total of estimated pure interests payable (see the last row of table 5.15).

Table 5.15. The balance sheet of financial intermediaries and their interest incomes and expenses by the Malaysian method

Assets					Liabilities				
		Interest receivable	FISIM	Pure interest			Interest payable	FISIM	Pure interest
A	Fixed assets, shares and accounts receivable less payable, insurance technical reserves				C	Own funds (net worth and shares)			
B1	Securities other than shares	1,102	0	1,102	D1	Securities other than shares	568	0	568
B2	Loans	4,634	2,756	1,878	D2	Deposits	3,453	-684	2,769
	Interbank	402	0	402		Interbank	287	0	287
	Others	4,232	2,756	1,476		Others	3,166	-684	2,482
B3	Others (currency and deposits)	85	0	85	D3	Other liabilities	36	-684	36
	Adjustment for interest on own funds			308[44]					
	Total	5,821	2,756	3,373			4,057	-684	3,373

Implication for I/O compilers

5.129. The calculation of FISIM as discussed above may not be fully relevant to I/O compilers as long as the output of financial intermediaries is prepared by national accountants. However, it is important to understand the process in order to allocate the output to intermediate and final consumption correctly. In as much as we know stocks of loans and deposits by the institutional sectors (such as non-financial corporations, financial corporations, government, households, rest of the world), we can easily allocate FISIM to these sectors.

5.130. The distribution of FISIM to each industry, i.e. each establishment, is a lot more difficult. Similar to the problem of distributing head-office administration costs of an enterprise to its component establishments, loans and deposits cannot be linked to a specific establishment. The decision of depositing or borrowing is made by the enterprise and not by establishments. For this reason, only ad hoc methods can be used to distribute bank service charges to establishments. Preferably, FISIM should be distributed to each

[44]308 is the value of the third item in formula (b).

establishment on the basis of its share of capital stock, but this information may not be available, in which case FISIM may be distributed on the basis of its share of the enterprise output. Another difficulty in distributing FISIM to individual establishments is the data itself. Banks keep information on their loans to and deposits from their customers but are unlikely to reveal it except in aggregate form that only serves the purpose of distributing the information among institutional sectors, and broad groups of economic activities such as agriculture, construction, manufacturing, services, etc. Then, survey of industries in relation to interest receipts and payments will be needed to estimate service charges paid by industries.

5.131. For the household sector owning unincorporated establishments and owner-occupied housing, it is important to divide it into the unincorporated sector and the household sector itself because for the former service charges are intermediate inputs and for the latter they are final consumption services and therefore will have a different impact on the GDP.

5.132. For bonds issued by banks, their whole return could be treated as *pure* interest, that is, no implicit services are rendered in respect of bonds. For non-domestic lending and borrowing where rates are quite different from domestic rates, the interbank rates may not be appropriate and a reference rate for each currency must be found which could be the interbank rates in the country that issues the currency. Service charges on lending abroad or on deposits from non-residents are exports of services and the charges on borrowing abroad and on deposits abroad are imports of services.

VI. TREATMENT OF IMPORTS

6.1. This chapter will deal with an in-depth treatment of imports in the I/O model and the use table in basic values in particular. Valuation is further discussed and the use of input-output for the analysis of imports is also briefly discussed. For a full discussion of impact analysis on imports, reference is made to chapter XII.

A. Compilation of imports

6.2. Imports are goods and services provided by non-residents to residents through sales, barter, gifts or grants. Imports take effect when transfer of ownership does. To account for imports, it is important that residents and non-residents and the time when transfer of ownership takes place be clearly identified. Readers are advised to read the SNA for a full discussion of the above issues. It suffices to note here that:

(a) Residents include all institutional units (individuals, households, corporations, quasi-corporations, unincorporated enterprises, government units, non-profit institutions serving households) having a long-term economic interest in the economy or residing in it for more than one year, students studying abroad, institutional units working or going abroad for less than one year, ships, aircraft, drilling rigs and platforms owned by residents but operating in international waters or airspace;

(b) Non-residents include all institutional units that stay or operate for less than a year or do not have a long-term economic interest in the economic territory of the economy. Non-residents include students from foreign countries, embassies, consulates, military establishments and other entities of a foreign Government that are considered as extraterritorial by the economy and international organizations.

6.3. Transportation needs special attention in the SNA as a carrier may operate outside the economic territory in which the corporation is resident, either in international waters, in airspace, or in one or more other economies. Below are some rules that the SNA applies to transportation:[47]

(a) A carrier that operates in international waters or airspace should be attributed to the economy of residence of the operator; the same rule applies if the activity takes place in more than one country during the course of, but for less than a year;

(b) A carrier who operates in other economies is a resident of the country in which the activity occurs, if accounted for separately by the operator and so recognized by the tax and licensing authorities there; otherwise the activity may be attributed to the country of residence of the operator;

(c) In the particular case of ships flying flags of convenience, the country of registry in most instances is different from the country of residence of the operator but the shipping activity is to be attributed to the country of residence of the operating unit; if the unit has branches for tax or other considerations, their activities are attributed to their country of residence;

[47] See *System of National Accounts 1993*, paras. 14.25-27.

(d) When a corporation is established by special legislation by two or more Governments acting jointly and is registered in each of the countries concerned, there are two possible treatments: the first one is to allocate all transactions to each of the countries in proportion to the amount of financial capital which they have contributed; the second one is to treat the corporation as resident of the country in which its headquarters are located and the premises of the corporation in the other countries as foreign branches (direct foreign investment enterprises) which are residents of the countries where they are located.

6.4. Goods that are imported and then re-exported or returned unprocessed are omitted from exports and deducted from imports.

6.5. Direct purchases abroad by residents are included in imports of goods and services. These purchases abroad by residents have fewer reasons to be identified by product when they are analysed by using input-output analysis, so, the SNA's treatment is quite satisfactory for this. Residents are assumed to be households only. If residents include business persons or government officials, their purchases abroad should be treated as intermediate consumption of enterprises. A modification in the use table must be introduced to handle this problem. These purchases may be treated as one value of non-competitive imports of either households, government, enterprises or non-profit organizations, which will be clarified later in the chapter.

6.6. Imports of goods, in addition to regular ones, include:

(a) Imports of goods for processing;
(b) Imports of goods which are exported for processing abroad;
(c) Imports of repairs to fixed assets;
(d) Imports of goods under financial leasing;
(e) Imports of non-monetary gold used as valuables and industrial production;
(f) Transfers in kind from the rest of the world such as household goods and gifts transferred by migrants, foreign countries, etc.;
(g) Imports of fuel and stores purchased abroad by ships and aircraft operated primarily in international waters by resident enterprises, fish and salvage purchased abroad by national fishing vessels;
(h) Direct purchases abroad by residents;
(i) (-) Transport and insurance services on imports rendered by residents and non-residents.

6.7. Imports of services, in addition to regular ones, include:

(a) Transfers in kind from the rest of the world;
(b) Imports of insurance services;
(c) Imports of financial intermediation services indirectly measured;
(d) Transport and insurance services on imports rendered by non-residents.[1]

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[1]One must be careful in analysing and accounting for these items. The reason is that if an importer pays upon delivery at a domestic port, costs of insurance and transport services on imports are included in the value of the goods and would be paid by the sellers. In that case, payments for insurance and transport services to non-residents are not registered as import of services while in the SNA, they should be treated as such. The payments by non-resident shippers to resident insurers or carriers are registered as export of services while they will be treated as domestic production in the SNA.

6.8. **Estimation**: Data for imports of merchandise (goods) come mainly from foreign trade statistics. Data for imports of services come mainly from the balance of payments. Merchandise trade statistics must be adjusted to exclude goods in transit and goods that are returned. They must also be adjusted to include transactions that are not covered by foreign trade statistics which are elaborated on in para. 6.6. Other sources of data are: foreign exchange records, customs, maritime transport statistics, government accounts, accounts of organizations involved in international business like post offices, telephone and telegraph, insurance companies and special surveys on expenditures by tourists.

B. Treatment of imports in the use table

1. Valuation of imports

6.9. Imports c.i.f. are treated as equivalent to basic values by the SNA. They are the values of imported products delivered at domestic ports before being subjected to import duties. Imports c.i.f. plus import duties are treated as equivalent to producers' values. In the SNA, imports are shown as part of the supply table. In input-output analysis, imports must be incorporated as part of the use table. To do this, the use table must be in basic prices and imports must be entered as negative values and become part of net final demand. In this chapter, imports are shown as part of the use table.

6.10. In the SNA, imports are all valued f.o.b., i.e. measured without the transnational costs of transport and insurance services on imports to bring goods from the border of one country to that of another country. In input-output tables, however, components of imports must be valued c.i.f. to make them equivalent to basic values that are used to measure domestic products, but in order to be compatible with the SNA the total value of imports must be measured f.o.b. through a c.i.f./f.o.b. adjustment.

2. Types of imports

6.11. Imports are usually classified into two types: competitive and non-competitive imports, the latter being also called complementary imports. Competitive imports include imported products that are also being produced by the domestic economy. Non-competitive imports include products that are either not producible or not yet produced in the country. For example, products that can only be grown in tropical climate are treated as non-competitive imports by countries with cold weather. This distinction is important for the modelling of imports in input-output tables that will be discussed later.

(a) Non-competitive imports

6.12. The first table (table 6.1.a) shows the import of goods that are used as inputs by industry A. The same example will be used to illustrate how non-competitive and competitive imports are treated in the use table in basic prices. Table 6.1.b shows the treatment of non-competitive imports as a separate row in the use table. It has no corresponding column since no equivalent products are produced domestically. One can create as many rows as there are non-competitive imported products instead of only one row in order to show more detail in the input-output table.

6.13. The example in table 6.1.a shows the change of value of the imported product from a foreign port to the gate of industry A. The total cost to the producers of product A is 32, which is the purchasers' price paid by industry A that uses the non-competitive imports. Non-competitive imports are valued c.i.f. at only 24 in the use table to make them equivalent to basic values. The total value of imported goods must, however, be valued f.o.b. in the SNA, so a column and a row of c.i.f./f.o.b. adjustment on imports must be introduced in the use table. While the principle of adjustment was discussed in chapter II, the example in table 6.1.b is intended to clarify all the detail of the treatment of imports.

6.14. The following will explain how the content of imports c.i.f. in part A of table 6.1. a is entered into the final demand quadrant in table 6.1.b. The payment of transoceanic margins has already been included in the c.i.f. value of imports. The part of transoceanic margins supplied by resident producers (.6 + .2) is treated as domestic services, the other part supplied by non-resident producers (1 + .2) is treated as imports of services in the column of imports of services (negative values). The transport and insurance margins are entered as part of the column of c.i.f./f.o.b. adjustment (1.6 and .4) so that the differences between total margins and imported margins become domestic margins. Domestic production of transport services serving imported goods is equal to 2.6, which includes .6 as transport services on imports rendered by resident carriers and 2 as internal transport margins to bring the goods to users (see table 6.1.b). The internal transport margins in the example show the complete picture of the treatment of imports, but compilers of the use table need not worry about the collection of data on internal transport margins in the industry quadrant because they would be filled up when compilers prepare intermediate inputs of industries.

6.15. In table 6.1.b, a positive value of imports value c.i.f. (24) is entered as intermediate inputs to industry A, and a negative value (-24) is entered in the column on imports of goods so that no output of the imported product is produced in the country. In the column on imports of goods, an adjustment equal to transoceanic margins (2) is added to make the total value of imports of goods equal to an f.o.b. value of -22. Duties (3) and sales tax (1) on imports (table 6.1.a) which are taxes on products are treated as part of the total cost of production of industry A (table 6.1 b).

(b) Competitive imports

6.16. Table 6.1.c shows the treatment of competitive imports of product B used as input by industry A. It uses the same example as table 6.1.a, the only difference being that the whole value of non-competitive imports is now considered as the import of only one product - product B. The imported product is treated in the same fashion as the domestic one. Product B in basic prices (24 i.e. imports c.i.f.) is entered as input to industry A, regardless of whether it is imported or not, then imports of B are entered as negatives (-24) in the column of imported goods so that no value equal to the value of import of product B is produced inside the economy. Transoceanic margins, duty and other internal margins are treated as in the case of non-competitive imports.

6.17. With the above method of valuation of imports, it is important to remember that transoceanic margins on imports including transport and insurance services provided by resident producers are part of final demand and must be estimated exogenously in I/O modelling by using the I/O coefficient matrix.

Table 6.1.a. An example of imports broken down by components

Imports of products by industry A			
	Cost element		Amount
A	Foreign port value (imports f.o.b.)		22.0
	Transoceanic margins		2.0
	Transport		1.6
	by resident carriers	.6	
	by non-resident carriers	1.0	
	Insurance		.4
	by resident carriers	.2	
	by non-resident carriers	.2	
	Imports c.i.f.		24.0
B	Duty		3.0
	Internal margins		5.0
	Transport	2.0	
	Trade with sales tax	3.0	
	Trade margins	2.0	
	Sales tax	1.0	
	Purchasers' value		32.0

Table 6.1.b. Treatment of non-competitive imports in the use matrix

Non-competitive imports in use matrix in basic prices						
	INDUSTRY	NET FINAL DEMAND				PRODUCT OUTPUT
PRODUCTS	A	Imports Goods	Imports Services	C.i.f./f.o.b. adjust-ment	Final consumption, gross capital formation, exports	
Trade	2.0					2.0
Transport	2.0		-1.0	1.6		2.6
Insurance			-.2	.4		.2
Non-competitive imports	24.0	-24.0				0.0
C.i.f./fob adjustment on imports		2.0		-2.0		0.0
Total uses at basic prices	28.0					
Taxes on products	4.0					
Total uses at purchasers' price	32.0	-22.0	-1.2	0.0		

Table 6.1.c. Treatment of competitive imports in the use table

Competitive import of product B by industry A in the use matrix in basic prices						
	INDUSTRY	NET FINAL DEMAND				PRODUCT OUTPUT
PRODUCTS	A	Imports		C.i.f./f.o.b. adjustment	Final consumption, gross capital formation, exports	
		Goods	Services			
Product B	24.0	-24.0				0.0
Trade	2.0					2.0
Transport	2.0		-1.0	1.6		2.6
Insurance			-.2	.4		.2
C.i.f./f.o.b. adjustment on imports		2.0		-2.0		0.0
Total uses at basic price	28.0					
Taxes on products	4.0					
Total uses at purchasers' price	32.0	-22.0	-1.2	0.0		

3. Alternative presentation of imports in the use table

6.18. This section will discuss alternative ways to present imports in the use table so as to provide information for economic analysis by using I/O models. With regard to non-competitive imports, there is no alternative to the treatment mentioned above, i.e. they must be included in the use matrix as either one row, each of its element representing all non-competitive imports used by an industry, or as a number of rows, each row representing a non-competitive imported product.

6.19. However, there are two different ways to show competitive imports in the use table, i.e. uses of domestic and imported goods and services shown together *or* separated.

6.20. The first way is to show all inputs consumed in the intermediate demand matrix and in final expenditures regardless of origins of supply. This method is shown in table 6.2. The sum total of consumption in each row is the supply of a product. The total product output produced by the economy is then obtained by subtracting imports from total supply. The method has the advantage of showing the technical requirements of every industry. In table 6.2, only a simple input-output structure with no secondary products is shown to obtain the balance between input and output; the table also assumes no c.i.f./f.o.b. adjustment on imports to simplify the presentation.

6.21. The other method (uses of domestic and imported goods and services separated) shows competitive goods and services in the same manner as the treatment of non-competitive imports, that is imported inputs are shown separately from domestic ones. This method is shown in table 6.4. For example, industry 1 uses 18 as the value of product 1, of which 8 is imported. Then, table 6.4 will show only the value of 10 of domestic product. The value of imported 8 is moved down to the row of (all) imports. Product 2 is treated similarly. The values of competitive imports are moved down to the rows of competitive imports. These rows are treated similarly to the value added in an I/O model.

Table 6.2. Input-output table with total input presented in the intermediate and final demand matrices

	Intermediate consumption		Net final demand		Product output
Products	1	2	Final demand	Imports	
1	18.0	36.0	80.0	-34.0	100.0
2	42.0	36.0	62.0	-38.0	102.0
Non-competitive imports	5.0			-5.0	0.0
Value added	35.0	30.0			
Industry output	100.0	102.0			

Table 6.3. Matrix of competitive imports

	Intermediate consumption		Final demand	Total competitive imports by products
Products	1	2		
1	8.0	16.0	10.0	34.0
2	12.0	20.0	6.0	38.0
Competitive imports by industry	20.0	36.0	16.0	

Table 6.4. Input-output table in which domestic and imported resources are separated

	Intermediate consumption of domestic products		Final demand	Product output
Products	1	2		
1	10.0	20.0	70.0	100.0
2	20.0	16.0	56.0	102.0
Non-competitive imports	5.0			
Import of product 1	8.0	16.0	10.0	
Import of product 2	12.0	20.0	6.0	
Value added	35.0	30.0		
Industry output	100.0	102.0		

6.22. The second method is used by many countries. It will provide information for the basic I/O model.

6.23. Imports as shown in matrix form in table 6.3 are usually not readily available. In fact, they are derived from special surveys and assumptions. For many products, especially when labels of origins are required, users are well aware if they are imported or domestically produced. Surveys will then serve the purpose of filling the import matrix of table 6.3. For other products such as petroleum or gas etc., the users may not be able to determine their origins. In such cases, we have to assume that the same import share for a particular product is applied to every user. For example, if a certain percentage of a product is imported by the country in question, that percentage of import can be assumed for every user of the product. Or if surveys on imports can only identify import shares for a group of users, the rest of the imports can be distributed proportionally to the rest of the users on the basis of their total uses. Exports are always from domestic production. So, before applying proportional distributions for the estimation of import shares per user, it is helpful to set aside exports. In order to use assumptions effectively based on the proportionality principle, product classification should be as detailed as possible. In some countries, the number of products exceeds 2,000.

C. Analysis of imports in an input-output model

6.24. How an input-output model is used for the analysis of imports is dependent on many factors such as the influence of changes in prices, exchange rates, incomes and so on but it also depends on how the input-output table is constructed. This section will emphasize the latter problem more than other economic factors. The analysis is, therefore, expected to be simple and provide answers mainly to simple questions of a comparatively static nature.

6.25. Given that the input-output table is organized as recommended in table 6.2, the relationships in production and final demand can be written in the following general formula:

(6.1) $X = AX + Y$

where

X = Vector of output
A = I/O coefficient matrix
Y = Vector of net final demand which is equal to final consumption expenditures, gross capital formation and exports less imports.

6.26. Matrix A represents total input coefficients including input from both domestic and foreign sources. The vector of final demand represents total final expenditures minus total imports including imports for both intermediate and final expenditures. The model in table 6.1 provides a neat way to show the relationships in production, consumption, gross capital formation, exports and imports in the economy, but it is not yet a model that can be used to calculate, for example, the impact of a change in final demand on imports. The reason is that in order to get the value of Y so as to find the value of X, it is necessary to know the total import of each product because net final demand Y is equal to final demand less imports. But imports are, in fact, the unknown entity that the model aims to estimate. Thus, equation 6.1 is just a balancing equation and as it stands it cannot be used to calculate impacts on outputs or imports of a change in final demand. It can be used for analysis given that one assumes a value for the vector of net exports, a component of net final demand.

6.27. Table 6.4 showing domestic input is the equation that can be directly used to calculate the impact on outputs and imports of a change in final demand. The relationships in table 6.4 can be written as follows:

(6.2) $X = A^dX + Y^d$

6.28. In equation 6.2, Y^d represents only final demand that is produced domestically. A^d, which is the matrix derived from the intermediate flow matrix in table 6.3, also represents input coefficients that are domestically produced. It is possible to show A^d as including rows of imported products with corresponding columns of zeros. The other alternative is to show it without these rows and corresponding columns. In the latter case, the rows of imported products are treated in the same manner as the rows of value added. After the vector of output is obtained, imports can be calculated by multiplying the matrix of import coefficients to the output vector. Equation 6.2 can be derived mathematically as follows:

From equation 6.1, we can write

$$X = (A^d + M^{id})X + (Y^d + Y^m - M)$$

where

Y^d is the vector of domestically-produced final-demand products
Y^m is the vector of imported final-demand products
M is the vector of imported products
M^{id} is the coefficient matrix of imported intermediate demand

thus,

$$M = M^{id} X + Y^m$$

$$X = A^d X + Y^d + (M^{id} X + Y^m - M)$$

then,

$$X = A^d X + Y^d$$

One can solve for X by using the formula:

$$(6.3) \quad X = (I - A^d)^{-1} Y^d$$

6.29. Equation 6.3 needs all the information that is or can be assumed to be, available. Economically, equations 6.2 and 6.3 show that as there is an increase in final demand, with part of this final demand lost to imports. So only Y^d, the part that is domestically produced will have an impact on domestic production. And then, as intermediate input is required to satisfy this increase, only input that is domestically produced will have an impact on other rounds of domestic production, which is represented by A^d, and the other part is leaked out of the system. In order to use equation 6.3 for analysis, it is necessary to first estimate Y^d, i.e. final consumption of domestic goods and services, demand of domestic capital goods and exports. In other words, it is necessary to estimate total final consumption expenditures, gross capital goods and also the imports of final consumption goods and services, and of capital goods. Only imports of intermediate goods and services are estimated by model 6.3.

6.30. It is also possible to use matrix A directly by introducing the import matrix into the system in a different way as follows:

$$(6.4) \quad A^d = R \otimes A$$

$$a^d_{ij} = r_{ij} \times a_{ij} \quad \text{for all i and j.}$$

6.31. The symbol $\otimes$ stands for product multiplication in which each element of A^d is the product of the corresponding elements in R and A, i.e. with the same row and column indexes. For example (using the input coefficient derived from table 6.2):

$$A = \begin{bmatrix} .18 & .35 & .0 \\ .42 & .35 & .0 \\ .05 & .00 & .0 \end{bmatrix}$$

$$R = \begin{bmatrix} .75 & .75 & .0 \\ .71 & .44 & .0 \\ .00 & .00 & .0 \end{bmatrix}$$

6.32. R_{ij} is the domestic ratio of the input-output coefficient a_{ij}, which is the ratio of input a_{ij} supplied by domestic producers. In other words, it is equal to 1 minus the import ratio of coefficient a_{ij}.

From the example above

$$a^d_{21} = r_{21} \times a_{21}$$

$$\text{or} \quad .2982 = .42 \times .71$$

6.33. This example of relationship 6.3 is based on the assumption that was discussed previously, i.e. the import of each product used as input by each industry is proportional to the total input used. The matrix of domestic ratios R assumes that for the first product, the same import proportion is applied to all users since there is no information other than the ratio of import over total supply. For the second product, the import ratio varies from one user to another; this information should obviously be based on surveys. In the third row and column corresponding to non-competitive imports zeros are entered as noted previously.

6.34. With this method, new assumptions on imports can be introduced easily into matrix R, while the input-output matrix A is assumed constant.

6.35. Matrix R allows different import ratios for each element of the A matrix. However, if the same import ratio is assumed for all users of a product, then matrix R becomes diagonal, i.e. only the element in the diagonal is positive, the elements off diagonal are all zeros. In this case, we will have:

$$A^d = \hat{R}A$$

that is

$$\hat{R} = \begin{bmatrix} r_1 & 0 & . & 0 \\ 0 & r_2 & . & 0 \\ . & . & . & . \\ 0 & 0 & . & r_n \end{bmatrix}$$

This is the most commonly used assumption on imports.

6.36. From the calculation above, one can also calculate the import of intermediate goods and services by type of product necessary to support a given increase in final demand.

6.37. Competitive imports are equal to:

$$(A - A^d)X + (Y - Y^d)$$

or

$$M^{id}X + Y^d$$

6.38. The main advantage of the analysis presented in this chapter is its simplicity and the ability to incorporate vast detailed data in the import matrix without resorting to sophisticated theories. When prices and technology are stable, the modelling of imports presented above is quite useful and, in fact, has been used by many input-output practitioners to calculate import requirements and domestic production. Of course, sophisticated economic theories have been introduced into the analyses using input-output model but this literature, which is vast, will be found elsewhere since the description of all analytical methods is beyond the objective of this book.

VII. COMPILATION OF FINAL DEMAND

A. Introduction

7.1. Final demand is part of the use of goods and services. In the use table, these values are shown along the rows. This chapter will look into the conceptual framework and data sources for preparing final demand as broadly discussed in chapter II. Expenditures on goods and services are either for intermediate consumption by industries or for final demand (or final uses). Intermediate consumption is the value of goods and services that are used as inputs in production processes, as discussed in chapter V. Final demand includes final consumption expenditures to satisfy individual needs or wants and the collective needs of members of the community, gross capital formation and exports.

7.2. The term *final demand* is not mentioned in the SNA but is used here for the convenience of discussing input-output economics. From the point of view of modelling, as presented in table 1.1 of chapter I and YC in equation 4.8 of chapter IV, *net final demand* - final demand less imports - is required. It is the vector summing:

(a) Final consumption expenditures to satisfy individual needs or wants and the collective needs of members of the community;

(b) Gross capital formation;

(c) Exports f.o.b.;

(d) Minus imports f.o.b.

Net final demand can be observed in table 4.4 of chapter IV as the sum of columns 5-10. Net final demand is equal to the GDP. In order to arrive at net final demand, components of final demand should all be in basic values because imports are all in basic values. Thus values of final demand have already gone through a process converting purchasers' prices into basic prices. The basic data that need to be collected first are final demand in purchasers' prices. The definition of final demand is shown below with more details in table 7.1.

7.3. Final consumption expenditures are broken down into:

(a) Final consumption expenditures of the household sector including the value of goods and services that are purchased, actually consumed and ultimately paid for by resident households;

(b) Final consumption expenditures by non-profit institutions serving households (NPISHs) which, for simplicity's sake, are assumed by the SNA to serve individual needs of resident households even though some may serve collective needs, for example some research carried out by NPISHs;

Table 7.1. Components of final demand at purchasers' prices

	FINAL CONSUMPTION EXPENDITURES				GROSS CAPITAL FORMATION			EXPORTS	FINAL DEMAND
	Households	Non-profit institutions serving households	General government		Gross fixed capital formation	Changes in inventories	Acquisition less disposal of valuables		
	Individual	Individual	Collective	Individual					(1)+.+(8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Product 1	100				32	6	2	28	168
Product 2	48	1	5	5				9	68
Product 3	2							0	2
Taxes less subsidies on products									0
C.i.f./f.o.b. adjustment									0
Direct purchases abroad by residents	3								3
Direct purchases at home by non-residents	-1							1	0
TOTAL	152	1	5	5	32	6	2	38	241

(c) Final consumption expenditures by general government which may include the national Government and state and local governments. These expenditures are divided into two parts: one part serving the collective needs of members of the community and the other part serving individual needs of resident households.

7.4. Gross capital formation consists of:

(a) Gross fixed capital formation;

(b) Changes in inventories of finished goods, goods for resale, materials and supplies and work-in-progress;

(c) Acquisition, less disposal, of valuables: valuables are assets that are not used primarily for production, do not deteriorate over time under normal conditions and are held as stores of values. Examples of valuables are precious stones and metals, jewelry, works of arts such as paintings, sculptures, antiques, etc. These items are not covered in the 1968 SNA.

Gross capital formation should also be identified by institutional sectors, i.e. by non-financial, financial, non-profit institutions serving households (NPISHs), households and general government sectors. It should also be classified by industries so as to facilitate the estimation of capital stocks by industries.

7.5. Final consumption expenditures and gross capital formation are all measured at purchasers' prices in table 7.1. To convert them into basic prices, one should consult chapter III on valuation. However, whether components of final demand are measured at purchasers' prices, producers' prices or basic prices, the total value of final consumption or gross capital consumption by institutional sectors is the same.

7.6. Exports are measured f.o.b. at either the detailed or aggregate level. Imports are measured c.i.f. at the detail level but the total value of imports is valued f.o.b..

B. Final consumption expenditures and actual final consumption

1. Government final consumption

7.7. The final consumption expenditures of the general government sector are divided into individual final consumption and collective final consumption expenditures while all NPISHs final consumption expenditures are treated as individual final consumption. So, what is collective final consumption and what is individual final consumption?

7.8. **Individual final consumption expenditures** of government include individual goods and services that "are essentially 'private', as distinct from 'public' goods. They have the following characteristics:

(a) It must be possible to observe and record the acquisition of the good or service by an individual household or member thereof and also the time at which it took place;

(b) The household must have agreed to the provision of the good or service and take whatever action is necessary to make it possible, for example by attending a school or clinic;

(c) The good or service must be such that its acquisition by one household or person, or possibly by a small, restricted group of persons, precludes its acquisition by other households or persons."[1]

7.9. Included in individual goods and services are expenditures by general government for the following:

(a) Health services including public health;

(b) Recreation, culture and religion;

(c) Education;

(d) Social security and welfare services;

(e) Housing, refuse collection and sewerage services.

The above items are classified in division 14 of the *Classification of Individual Consumption by Purpose* (COICOP) and cross-classified with divisions in the *Classification of the Functions of Governments* (COFOG).[2] Also included in individual goods and services are overhead expenses made by ministries in connection with the administration and functioning of these institutions (see para.9.86 of the SNA). The final consumption expenditures by general government for individual goods and services are also called *social transfers in kind* by general government in the SNA. The *social transfers in kind* provided to individuals may take three different forms whereby government:

(a) buys goods and services on the market and transfers them to individuals;
(b) partly or fully reimburses goods and services bought by individuals;
(c) fully operates and pays for the facilities that produce non-market goods and services (i.e. government output) and provides them at prices that are not economically significant to individuals.

The first two items are called by the SNA *social benefits in kind* (SNA, paras. 8.101 to 8.104) since recipients have little or no choice; they are not part of the output of government services because the government unit "does not engage in any further processing of such goods or services."[3] The third item is called *transfers of individual non-market goods and services* (SNA, paras. 8.105 to 8.106) and is a part of the output of government services.

7.10. The treatment of social transfers in kind means that a given quantity of goods consumed by

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[1]*System of National Accounts 1993*, para. 9.81.

[2]International organizations have been working together to produce international standards for identifying items in government expenditures that may be classified as individual consumption. A draft linking individual goods and services and COFOG items has been published by the United Nations, see *Draft Classification of Expenditure by Purpose* on 24 November 1998. Compilers should consult with the final one when it is ready in order to produce internationally compatible statistics.

[3]*Ibid.*, para. 9.79.

individuals or households will be split into two parts: the part funded by government is individual final consumption of government and the part eventually paid by households is final consumption of households. Thus it is also important to note that social benefit reimbursement by government is not treated as current transfers to households. Only government transfers in cash to households for which households have total freedom to spend are treated as current transfers. These current transfers are not part of a production account.

7.11. **Collective final consumption expenditures** include only services (there are no collective goods) with the following characteristics:

"(a) Collective services can be delivered simultaneously to every member of the community or of particular sections of the community;

(b) The use of such services is usually passive and does not require the explicit agreement or active participation of all the individuals concerned;

(c) The provision of a collective service to one individual does not reduce the amount available to others in the same community or section of the community. There is no rivalry in acquisition."[4]

7.12. Included in collective services are the provision of security and defence, public administration, public research and development, maintenance and improvement of law and order, general administration including the setting and enforcement of policies, standards and regulation of public health, education, etc. In other words, they should include all current expenditures that are not treated as current transfers or individual final consumption expenditures.

7.13. The above clarification is also shown in the following simple example:

[4]*Ibid.*, para. 9.83.

Table 7.2. An example of government revenues and expenditures

Government expenditures		**183**
Government capital expenditures		30
Purchases of capital goods	23	
Own-account construction	7	
Current expenditures for non-market activities		100
Collective	80	
Individual	20	
Social benefits in kind (reimbursements included)		10
Social benefits in cash		43
Others*		0
Government revenues		**183**
Sales to households		5
Taxes		150
Others*		0
Deficit financing		28

*"Others" denote property income, capital and current transfers and transactions in financial assets and/or liabilities. They normally take values other than zero assumed here for simplicity's sake.

From the example, output, final consumption and capital formation of the government sector are as follows:

Table 7.3. Output, final consumption and capital formation of government sector

Output produced by government activities			107
Output of government services	Equal to current expenditures for non-market activities	100	
Secondary output	Own-account construction	7	
Government final consumption			105
Individual final consumption of government	Or *social transfers in kind* equal to current expenditures for non-market activities for individuals (20), less sales (5), plus social benefits in kind (10)	25	
Collective final consumption of government	Equal to current expenditures for non-market activities for collective needs	80	
Government capital formation			30

7.14. The output of government services is equal to current expenditures for non-market activities. In this example, the output of non-market activities of general government is 100 which may contain both non-market output such as education, health, defense, etc., and market output produced by secondary activities such as sales of documents, museum reproductions, etc. Out of 100, 80 are collective non-market services which are treated as collective final consumption expenditures of general government, and 20 are individual non-market goods and services which are treated as individual final consumption expenditures of general government after deducting a sale of 5 paid by households. Sales of outputs produced by government activities to be used as the intermediate consumption of industries do exist, but are assumed to be zero in the example for the sake of simplicity. In addition to the above expenditures, government partly or fully finances through reimbursement final expenditures of the household sector for market goods and services, which are 10 in the example. These values, which are commonly called in economic literature *consumption subsidies,*[5] must be treated in the 1993 SNA as part of individual final consumption expenditures of general government.

7.15. By the SNA definition, the output of producers of government services, less the value of government sales of non-capital goods and services, plus social benefits in kind is equal to government final consumption expenditures. Government sales include such items as receipts from sales of postcards and reproductions by museums, firewood sold by the government forestry department, government publications, fees for medical treatments and school fees, etc. Information on government final consumption expenditures comes from reports on government budget and expenditures. Other government expenditures such as subsidies to industries to reduce operation costs or costs of capital good procurement,[6] etc. lie outside the framework for calculating government output and final consumption.

7.16. The balancing of the output of government services,[7] government final consumption is shown in table 7.4.

Table 7.4. Treatment of general government final consumption expenditures*

	Other activities	Activities of general government	General government's final consumption expenditures		Household final consumption
			Collective	Individual	
	x	x		10	
Market goods and services	0		80	20-5	5
General government services	x	x			
Value added	x	100	80	25	5

*x means that values are not specified in the example.

7.17. It may be worthwhile here to point out the following SNA treatments:

(a) Subsidies by general government to enterprises to reduce input costs, prices of imported or exported goods and services are treated as subsidies on products in the SNA sense of the word and included as part of the value added of the recipient sectors; they do not form part of the output of government services;

[5]In the SNA, only producers get subsidies from government, not consumers.

[6]Own-account capital formation, which is quite important, should be part of government output.

[7]Secondary output is not included here since it may be treated as output of a separate establishment. For the example given, it should be included in the construction industry.

(b) Subsidies by general government to enterprises to reduce prices of capital goods to enterprises are capital transfers and do not form part of the output of government services either;

(c) Subsidies effected by government trading activities: when government buys products and resells them at a loss as a matter of deliberate economic or social policy, the difference between the purchase and selling prices is treated as other subsidies on production to government trading organizations. The output of trading organizations are part of the general government sector (SNA, para. 7.78);

(d) *Subsidies to households* by government are channelled indirectly to households through subsidizing enterprises and treated as social benefits in kind. They should therefore be part of individual final consumption of government.[8]

2. Final consumption expenditures of NPISHs

7.18. Final consumption expenditures of NPISHs are equal to the gross output of producers of NPISHs services less sales plus social transfers in kind. If own-capital formation is part of the output, it has to be deducted from it to obtain final consumption. In short, all output of NPISHs, except for the part that is sold, is treated as individual final consumption of NPISHs. The treatment of NPISHs is very similar to that of general government. However, unlike the government sector, there is no collective final consumption of NPISHs. In most countries, statistics on NPISHs are very weak, sometimes almost nonexistent. Surveys need to be carried out to cover their activities. Many activities of NPISHs are quite similar to government activities such as health services, recreation, culture, education and welfare services. But the following activities should also be included: political parties, civic associations, religion, professional and labour organizations, activities of environmental protection organizations, and other activities such as trust funds and charitable organizations that fund research and scientific studies, etc.

3. Household final consumption expenditures

7.19. Household final consumption expenditures should include:

(a) All purchases of consumer non-durable and durable goods except dwellings which are treated as capital goods of unincorporated enterprises of the household sector producing housing services;

(b) Imputed purchases of consumer durables by financial leasing (i.e. households may pay in installment, but the value of the goods bought through financial leasing must be calculated and imputed as individual final consumption);

(c) Imputed gross rental for owner-occupied housing (see para. 5.73 in chapter V again for more detail);

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[8]This is based on a further interpretation of the SNA by the Inter-Secretarial Working Group on National Accounts, *SNA New and Notes,* issue 3, January 1996.

(d) Own-account final consumption of goods by owners of unincorporated enterprises;

(e) Bartered consumer goods and services (net);

(f) Domestic services provided by domestic servants;

(g) Goods and services in kind provided by enterprises as a form of compensation of employees (see also paras. 5.15 and 5.27 in chapter V);

(h) Imputed financial intermediary (banking, insurance, pension, etc.) service charges;

(i) Purchases minus sales of second-hand goods by households except dwellings (see chapter V, section C.5 on the treatment of second-hand goods for further detail);

(j) Purchases by residents abroad;

(k) (Minus) Purchases by non-residents at home.

Estimation and sources of final consumption expenditures

7.20. Final consumption expenditures should be estimated by the commodity flow approach (the method will be discussed in the next chapter) which utilizes various sources, the most common and important being information obtained in the preparation of industry outputs, agricultural and industrial censuses and annual surveys, annual reports of industrial associations or societies, reports of public utilities, reports from the tourist industry, trade and balance of payments statistics, household expenditures surveys, censuses on retail sales and services, central and local government budgets.

7.21. Data on household expenditures collected in surveys of households are useful for making benchmark and annual estimates of distribution of household consumption expenditures by broad categories (i.e. objects of expenditure). To break down these broad expenditures into a more detailed product classification, and to supplement the gap in the household expenditure surveys which are generally based on small samples, it is necessary to resort to a census of retail sales or annual retail sale statistics. However, household surveys would not give any estimate on imputed gross rental, or direct information on imputed service charges of banks, casualty and life insurance, though interest payments and premium payments may be given, and these SNA-defined expenditures must be independently estimated. The method has been discussed in section E.5 of chapter V.

7.22. Information from household surveys has to be cross-checked with information from retail sales and other sources. Retail sale statistics give a vast source of data on household consumption expenditures. Household consumption of goods and services can be sometimes identified by the nature of the goods and services. Care must be taken to exclude from retail sales purchases by government and enterprises and also second-hand goods. Only trade margins of second-hand goods involving households are treated as household expenditures -- see again chapter V. Other sources of information on household expenditures are from censuses of agriculture for estimating own-account production, and from reports of particular establishments such as public utilities (i.e. telephone companies, gas and electric companies, water and other sanitary services), schools and hospitals, restaurants and hotels, and financial firms such as banks, stockbrokers, etc.

7.23. Because no source of information gives the most accurate and complete data, one has to use the supply and use tables introduced in chapter II, also called the commodity flow technique - to evaluate the data. This technique is discussed in detail in the next chapter.

7.24. One final point that needs to be clarified is that, in the SNA, the concept of final consumption expenditures of enterprises does not exist so that expenditures by enterprises for the benefit of individuals who are not their employees must be imputed as current transfers to the household sector which will use the transferred income for its final consumption[9] even though the household sector does not have to pay for it. These transfers in kind (not the same as *social transfers in kind* which are made by general government or NPISHs) must be imputed to household final consumption expenditures in column 1 of table 7.1(para. 7.3 above). Whatever goods and services an enterprise buys for the main benefit of its employees, these expenditures would have to be treated as compensation of employees in terms of payments in kind even though they may be recorded by enterprises in their books as intermediate consumption. These expenditures would then be treated as a part of both value added and imputed final household consumption expenditures. Outlays on goods and services which, in addition to being of some benefit to employees, mainly benefit the employers for purposes of public relations or employees' morale, should be treated as intermediate consumption. Examples of these outlays are expenditures on sports tournaments, medical examinations, work-related training or educational programmes. Also important are the cases of proprietors of unincorporated enterprises who may infuse both expenditures for their business and their own household consumption. In the latter case an apportioning of expenditures between final and intermediate consumption is needed. On the other hand, if employees are required to provide certain tools, equipments or uniforms at their own expense, these expenditures should be treated as intermediate consumption by enterprises and then the compensation of employees must be accordingly adjusted downward.

4. Final consumption expenditures versus actual final consumption

7.25. The distinction between final consumption expenditures and actual final consumption is an extension of the distinction between collective and individual final consumption in the SNA. Final consumption expenditures of an institutional sector are the expenditures incurred freely by the sector. Actual final consumption of an institutional sector refers to either the taking possession of goods and services or the consuming of goods and services by the sector. Actual final consumption aims at capturing the consumption of goods and services that are provided in kind by other sectors. The distinction serves international comparisons of the actual levels of final consumption by households and provides two alternative concepts of consumption for analysis. Specifically, the actual final consumption of households includes:

(a) Household final consumption expenditures (column 1 of table 7.1);

(b) Final consumption expenditures of NPISHs (column 2 of table 7.1); and

(c) Individual final consumption expenditures of general government (column 4 of table 7.1): These expenditures make up social transfers in kind by the general government sector.

Items (b) and (c) above are also called *social transfers in kind* by the SNA. All of the final consumption of

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[9]These current transfers appear in the secondary distribution of income account of the SNA and do not appear in the input-output table.

NPISHs is treated as social transfers in kind by the SNA, so that the actual final consumption by the NPISHs is zero. The actual final consumption of the general government sector is equal to its collective final consumption expenditures.

C. Gross capital formation

7.26. Gross capital formation includes:

(a) Gross fixed capital formation;

(b) Changes in inventories;

(c) Acquisitions less disposal of valuables.

The following paragraphs will discuss in detail the components of gross capital formation.

1. Gross fixed capital formation

7.27. Gross fixed capital formation is measured by the total value of a producer's acquisition, less disposal, of fixed assets during the accounting period plus certain additions to the value of non-produced assets realized by productive activities of resident producers. Fixed assets are tangible or intangible assets which are outputs of production processes. They must have a life span of not less than one year, except for small tools of economically insignificant value. The threshold value under which an expense is considered insignificant is normally decided by convention or by the business accounting rules of a country. The 1995 *European System of National Accounts (ESA)* sets the threshold values for European Union members.

7.28. For institutional sectors, their gross fixed capital formation may include existing or second-hand goods, but for the total economy as a whole, gross fixed capital formation includes only new expenses on fixed capital formation and net second-hand capital goods imported from abroad. For second-hand capital goods that already exist in the economy, a purchase by one institutional sector, say unincorporated enterprises of the household sector, must be netted out by a sale of the same value by another institutional sector, say the non-financial sector. The increase to gross capital formation is the transfer cost only. The second example in the annex to chapter X of the SNA is repeated below to show how a transaction in second-hand capital assets is treated in input-output tables. In this example, say the first owner who is classified in the non-financial sector sold second-hand machinery to an unincorporated enterprise which is classified in the household sector. The transaction costs involved are shown in table 7.5. The seller received from the buyer 750, but the actual value he received after paying the transfer costs was only 670. The buyer had to pay more than the price he paid to the seller, i.e. 880. Thus 880 is considered gross capital formation of the buyer and 670 is considered the reduction in gross capital formation of the seller. In the process of transaction, an output of trade services of 110 was generated, and an additional value of 210 (880-670) including taxes was added to gross capital formation in the total economy. Table 7.6 shows all the transactions in an abbreviated form of the use table. Here, one may wonder why new capital formation was created for the seller when no real new asset had been created nor any improvement made. The solution to this problem in the SNA is to write the value of 80 incurred to the seller in the balance sheet as a holding loss. This solution, however, is not covered in the production account, i.e. the I/O framework.

Table 7.5. Transaction in second-hand capital goods

	Seller (non-financial)	Buyer (household)
Acquisition / disposal value (basic value)	750	750
Costs of transfer	80	130
Trade	80	30
Taxes		100
Value received/Value paid	670	880

Table 7.6. Treatment of transaction costs in second-hand capital goods

	Intermediate consumption			Gross capital formation	
	...	Trade	...	Non-financial sector	Household sector
...					
Machinery				-750	750
Trade				80	30
...					
Taxes on products					100
Value added					
Output/Total		110		-670	880

7.29. As shown in table 7.6, sales of domestic second-hand capital goods have to be entered as negative values to net out the purchase value of the same good. For the acquisition value to net out the disposal value of the same good, both of them must be measured at basic prices, i.e., excluding transfer costs. Net second-hand capital goods from abroad are netted out by net imports.

7.30. Dwellings including houseboats, mobile homes and caravans used as principal residences are treated as capital goods of owners of unincorporated enterprises producing housing services. Other consumer durable goods such as refrigerators, air-conditioners, etc. are treated as final consumption expenditures, not capital goods. Included in gross fixed capital formation are:

(a) Acquisitions, less disposal, by enterprises of new and existing tangible fixed assets (dwellings, other buildings and structures, machinery and equipment) and by households of dwellings including:

Purchases;
Barter transactions;
Own gross fixed capital formation;
Capital transfers in kind;

(b) Acquisitions, less disposal, of intangible fixed assets (mineral exploration, computer software, entertainment, literary or artistic originals) including:

Purchases;
Barter transactions;
Own gross fixed capital formation;
Capital transfers in kind;

(c) Transfer costs of existing tangible and intangible fixed assets: the transfer costs cover expenditures for agents' or lawyers' fees, dealers' margins or commissions, stamp duties and so on. The value of non-produced fixed assets (i.e. land, mineral deposits, invented patents) themselves should not be netted out as capital formation for the economy as a whole because these assets are not an output of the processes of production for the existing accounting period or, in the case of natural assets, they are not an output of any production process;

(d) Major improvements to tangible non-produced assets including land and costs associated with the transfers of ownership of non-produced assets;

(e) Expenses to transform existing capital goods into different kinds of capital goods such as major renovations and extensions:

(i) Expenses to transform natural assets such as draining, reclamation, clearing and levelling of land for purposes of agriculture and construction, clearing for planting of forests, etc.;

(ii) Changes in animal stocks which are not reared primarily for purposes of meat production; these consist of draught animals, animals used for purposes of sport or entertainment, cattle used to produce dairy products, or wool and breeding stocks;

(f) Acquisitions of produced fixed assets under financial leasing.

7.31. It is important to recognize that though (a) and (b) above are valued at purchasers' prices, the separation of these values into two components (basic values and transfer costs) would allow the value of items (a) and (b) to be measured at basic prices so that the buyer and seller of a capital good face the same price. This is important for the balancing of gross capital formation from the points of view of both the seller and buyer. Transfer costs which make the difference between the buyer's price and the seller's are included in (c).

7.32. Gross capital formation should exclude:

(a) Outlays by government on construction and durable equipments that can only be used for military purposes (they are treated by SNA as intermediate consumption by the producers of government services). However, other capital goods that can also be used for civilian purposes like military airports, roads, troop carrying transport equipment like buses, aircraft, ships, etc. are treated as capital goods);

(b) Outlays to acquire non-produced tangible assets such as land, mineral deposits or timber tracts, or non-produced intangible assets such as patented entities, leases, goodwill, etc. (but the transfer costs that arise when these goods change hands are included) ;

(c) Other changes in volume of tangible assets owing to new finds of subsoil assets and natural growth of other natural assets or to losses of tangible assets;

(d) Outlays on fixed capital formation by non-residents like embassies, consulates, and other extraterritorial bodies such as international organizations.

7.33. Gross fixed capital formation should be prepared separately by industries as well as for these sections:

(a) Financial sector;

(b) Non-financial sectors;

(c) Government sector;

(d) Household sector;

(e) Non-profit institutions serving households sector.

7.34. Estimation: Data on construction are available from construction surveys or can be estimated from building permits preferably on completed works. Data on plants, structures, equipment and other capital expenditures are from production surveys of industries. It is important that data on gross capital formation be classified by type and by industry. Own-capital formation such as housing construction by households is very important in developing countries. It may be covered in household income and expenditure surveys, or else a special survey should be conducted to capture this important output. Capital formation of government and non-profit institutions comes from government financial accounts supplemented by information from the government agencies involved in various projects and from financial accounts of non-profit organizations. One reasonable approach to estimate gross capital formation by product is first to set up a matrix of gross capital formation by industries cross-classified by institutional sectors (similar to table 2.5) and by general types of goods (dwellings, other buildings and structures, transport equipment, other machinery and equipment). The next step is to expand the general types of goods into more detailed products using the commodity flow method. The use of the commodity approach which will be presented in chapter VIII can also help identify capital goods from domestic production, imports and exports by the nature of the goods, though it does not always help identify owners.

2. Changes in inventories

7.35. Changes in inventories held by producers, general government and non-profit institutions serving households are the second main component of gross capital formation. They cover the following:

(a) Inventories (or stocks) of raw materials and stocks of semi-processed or finished products purchased by producers for use as input into their production process;

(b) Work-in-progress which refers to goods produced during the accounting period but in need of further processing to be sellable on the market;

(c) Livestock raised for slaughter (but breeding stock, draught animals, dairy cattle and animals raised for wool and hair clips should be treated as fixed assets);

(d) Inventories of finished products produced as output but unsold.

7.36. The classification of changes in inventories by type of goods is shown in table 7.7.

7.37. To evaluate changes in inventories according to the SNA principles, and the practical experience in calculating volume changes in inventories which exclude holding gains as required for table 7.7, see appendix A of chapter V.

7.38. Estimation: Data on the value of inventories come from production censuses and surveys and also special quarterly and annual surveys of inventories. Countries may also hold inventories of commodities such as petroleum, grains, etc., that they deem important. Information on these inventories should also be used. These data may have to be supplemented by data from tax returns, reports of marketing boards and balance sheets of enterprises. Changes in inventories by products may be estimated by, first, setting up a matrix of changes in inventories according to the classification in table 7.7 and by industry; the more detailed the latter the better since it allows the identification of products. From production surveys, it is possible to identify inventories of work-in-progress and finished products held by industries. The identification of wholesale and retail trade establishments by general types of products traded allows the broad identification of the types of products held in inventories. The next step is to expand the general types of goods into more detailed products using the commodity flow method.

Table 7.7. Classification of changes in inventories

1.	Changes in inventories, total
2.	Goods producing industries
3.	Materials and supplies
4.	Work-in-progress
5.	Livestock, except breeding stocks, dairy cattle, etc.
6.	Finished goods
7.	Wholesale and retail trade
8.	Other, except government inventories
9.	Government inventories

D. Exports

7.39. Exports of goods and services consist of sales, barter, gifts or grants of goods and services from residents to non-residents (see para. 6.2 in chapter VI for definition of residents and non-residents). Exports take effect when transfer of ownership from residents to non-residents does.

7.40. In the SNA, exports are all valued f.o.b. i.e. measured without the transnational costs of transport and insurance services to bring goods from the border of one country to that of another country.

7.41. Goods that are imported and then re-exported or returned unprocessed are omitted from exports and deducted from imports. Also included in exports are transport, communication and insurance services in respect of merchandise imports, which are provided by domestic carriers and domestic insurers as exports of services.

7.42. Direct purchases in the domestic market by non-residents are included in exports of goods and services. Unlike national accounts, direct purchases in the domestic market by non-residents in the use table have to be broken down by types of goods and services so that it is possible to know the value of every product consumed by non-residents and residents. This is what the 1995 ESA recommends. However, if exports cannot be broken down by product or if the details are not needed for economic analysis, as a purchase of a product by residents or non-residents would have the same effect on the total economy, the SNA's treatment would be acceptable. For countries with many non-residents (i.e. foreign armed forces, diplomatic and international extraterritorial bodies, etc.) and a large tourist sector, the breakdown is quite important.

7.43. Exports of goods, in addition to regular goods, include:

(a) Exports of goods for processing;

(b) Exports of goods imported for processing;

(c) Exports of repairs to fixed assets;

(d) Exports of goods under financial leasing;

(e) Exports of non-monetary gold used as valuables and in industrial production;

(f) Transfers in kind to the rest of the world;

(g) Exports of fuel and stores, fish and salvage sold to non-resident ships and aircraft operated primarily in international waters by resident enterprises;

(h) Direct purchases at home by non-residents.

7.44. Exports of services, in addition to regular services, include:

(a) Transfers in kind to the rest of the world;

(b) Exports of insurance services;

(c) Exports of financial intermediation services indirectly measured.

7.45. Estimation: Data for exports of merchandise (goods) come mainly from foreign trade statistics. Data for exports of services come mainly from balance of payments. Merchandise trade statistics must be adjusted to exclude goods in transit and goods that are returned. They must also be adjusted to include transactions that are not covered by foreign trade statistics which are elaborated above. Other sources of data are foreign exchange records, customs, government accounts, accounts of bodies involved in international business such as the post office, telephone and telegraph, insurance companies and special surveys on expenditures by tourists. Special surveys must be used to estimate and break down by kind of product direct purchases of non-residents at home.

VIII. COMMODITY FLOW METHOD AND TABLE BALANCING

A. Introduction

8.1. The commodity flow method is a term which is commonly known in national accounting and used by many developed countries to estimate gross domestic product (GDP). It has been a formal part of the SNA in the form of the use and supply tables of the input-output framework and is fully described in chapter II. This chapter further details the practical aspects of completing the use and supply matrices of the input-output framework by using various sources of information from censuses, surveys, company and industry reports, and expert knowledge on either the input structure of an industry or the market consumption of a product.

B. Table construction

8.2. In constructing the use and supply tables of the input-output framework, one normally utilizes information on the input uses as well as input structure of every industry in the tables that are provided by censuses, government, business reports. When censuses of most economic activities are available, a benchmark SUT may be compiled which may then serve as the basis for the compilation of annual tables for subsequent years. Even though censuses are available, supplementary information is always needed and, in most cases, special studies or surveys may be needed. For example, para. 5.9 in chapter V discussed the need for a special survey on the commodity breakdown of office supplies that are always reported in aggregate in business reports. In addition, other information on various uses of a product either from expert knowledge or from the very nature of the product, information on product market or sales published by producers' marketing associations and information on the inter-linking within groups of industries are always needed. This chapter will focus only on the general aspects of compilation and balancing since the preparation of output, intermediate consumption, components of final demand and value added have been discussed in detail in previous chapters. For the compilation of annual SUT on the basis the benchmark SUT, one should refer to chapter IX.

1. Industry input

8.3. An important part of the work of input-output compilation is to fill in each column of the use table with inputs used by the industry identified with the column. Surveying inputs used is the principal method in estimating intermediate consumption because it is based on the theory of production function with constant input coefficients. Because of this theory it is legitimate to use (i) input information on a few establishments in an industry to generalize for the whole industry, (ii) engineering information to estimate input flows for the establishments on which only their outputs are known, or (iii) information on different time vintages to estimate the input coefficients for a certain industry in the period when the input-output tables are prepared. The last technique sometimes is necessary when the implementation of production censuses is spread out over a number of years due to financial and logistical constraints. The information on inputs is at best approximate and therefore must be cross-checked systematically with information from other sources basically by balancing the use and supply of each product (e.g. commodity) at the most detailed level. An SUT is recommended by the SNA for the compilation of annual production accounts in an integrated and consistent manner.

Table 8.1. Commodity flow method

	Supply of goods and services				Total supply at purchasers' prices	Uses at purchasers' prices				Total uses
	Domestic output at basic prices	Imported products c.i.f.	Trade & transport margins	Taxes less subsidies on products		Intermediate consumption	Final consumption expenditures *	Gross capital formation**	Exports	
	(1)	(2)	(3)	(4)	(5)=(1)+.+(4)	(6)	(7)	(8)	(9)	(10)=(6)+.+(9)
Products (CPC)										
(1)										
(2)										
...										
(k)										

* Final consumption expenditures should be split into final consumption expenditures of households, NPISHs and Governments.

** Gross capital formation should be split into three columns: gross fixed capital formation, changes in inventories and acquisition less disposal of valuables.

2. Commodity uses

8.4. The elaboration of industry uses of products provides a major method to fill in the use table along each row. This method which is presented in more detail in the use and supply tables is summarized in table 8.1. The aim of the method is to trace across each row of the use matrix the consumption of every good and service by industries as intermediate consumption and by various institutional sectors as final demand. In order to do this, the total supply of a product must first be compiled, by adding to the domestic output of the product, both market, own final use and other non-market, the import of that product c.i.f., domestic trade and transport margins and taxes on products in order to obtain the total supply of the product at purchasers' prices (see column 5). This total supply is then used as the control total for the distribution of the product to various uses along the same row from column 6 to column 9. The total uses of the commodity must be equal to the total supply, e.g. column 10 must be equal to column 5.

8.5. The consumption of a product as intermediate inputs is determined by three factors: (i) input coefficients, (ii) outputs of the industries that consume the product as inputs, (iii) output of the product itself. Sources and methods for estimating components of final uses have been discussed in chapter VII. Given (i) and (ii), it is possible to estimate intermediate uses of a product; and given final uses of the product, it is possible to estimate its total uses. Total supply includes the product output and imports. The total use of a product in excess of its total supply indicates that either domestic production is higher or imports are. Whatever adjustment compilers want to introduce must be judged on the basis of the reliability of data sources or of our own knowledge of the industry.

8.6. Commodity flow analysis along the rows requires the output of any establishment to be broken down by detailed kind of goods and services, following a certain scheme of classification, for instance the United Nations Central Product Classification (CPC), version 1.0 which has 1,787 separate classes of products. The classification of products has to be much more detailed than the classification of establishments. At a minimum, it is normally necessary to identify the product output of 200 to 300 items. In many countries, for instance Norway and Denmark, the commodity flow method was applied to 2,000 commodities. Norway recently reduced the number of commodities from 1,750 to 1,000 when the 1993 SNA and the 1995 ESA were implemented.

8.7. The commodity flow approach gives a clear advantage in identifying many flows. For many products, by their nature, it is possible to identify whether they are current or capital goods, and even where they are used. For example, tractors can only be capital goods that are used in agricultural sectors. Even with current goods and services, one may be able to identify whether they are used for intermediate or final consumption, for instance haircut services should go to personal final consumption. The more detailed the way commodities are classified, the better it is possible to use expert knowledge to supplement surveys in allocating products to different uses. For instance, one may not be able to allocate coffee in general, but if it is broken down into coffee beans and roasted coffee, then, one may allocate a part of the coffee beans to exports (which are known most of the time), and the residual to industries which process coffee. The allocation is obviously much more difficult if coffee is aggregated with tea, coconuts, etc. to form a sector of cash crops. Similarly, machinery classified by type is easier to allocate (obviously to fixed capital formation) than if it is aggregated to fabricated metal products some of which can be used for intermediate consumption.

3. Sales ratio

8.8. Another source of information that might be used to fill in the use matrix is the distribution of goods and services to various sectors by sale ratios (i.e. sale of a product to a sector over the total output of that product). This method should only be used as a last resort and always in combination with a careful checking of the likelihood of consequent input coefficients. The reason is that (i) sales may not match uses as uses can be satisfied by a withdrawal from inventories, (ii) the sale ratio of a product to an industry may drastically change while the same product input coefficient of the industry remains unchanged. For example, a certain industry may lose its market to a foreign producer, say by one half and as a consequence its output is halved. Obviously the sale ratios of the output of this industry to other industries would be cut dramatically. But if there is no change in the production technology of the industry that consumes the product, the input coefficient of the industry should remain unchanged.

4. Flow and coefficient adjustment

8.9. When compilers decide to adjust a certain flow, obviously the decision will affect other flows that are closely associated with it either as suppliers of input or as market consumers. To make the adjustment more systematic, i.e. to take into account inter-industrial relationships, compilers should set up the most clearly separable blocks of sectors and assign them to separate groups of input-output statisticians responsible for balancing. A block should include industries that are closely related in terms of input requirements. For example, cement would be definitely required in construction, therefore cement supplies can be used to cross-check estimates of construction, particularly for the household sector in developing countries. The work can be divided into the following blocks of sectors:

(a) Agriculture, fishing, manufacture of food products and beverages, hotels and restaurants;

(b) Metal and machinery industries, construction, auto repair shops;

(c) Forestry and industries producing wood and wood products, quarrying and non-metallic mineral products, construction;

(d) Manufacture of textile and textile products, footwear;

(e) Chemical industries, including plastic products;

(f) Energy sectors;

(g) Service industries and producers of government services.

Within each block, there might be technical and behavioral changes that are more discernible by the same experts. It is always important to adjust flows while taking into account the resulting input coefficients.

8.10. Given input-output coefficients of previous periods, one should also inquire why there are changes in the coefficients, particularly big changes and whether they are justified. Reasons for coefficient changes are numerous, but the most important ones are:

(a) Changes in classification where a group of establishments has been recently added to the industry or a subgroup has been removed and aggregated in another industry;

(b) Changes in the composition of the industry in terms of subgroup outputs;

(c) Changes in relative input prices such as the drastic changes in the price of petroleum and consequently of energy as a whole in 1973 and 1979;

(d) Changes in technology: for example in Indonesia from 1980 to 1985, there were important changes in the poultry industry as a result of commercialization of the sector with large increases in input coefficients of feed, medicines, wages and salaries, while there was a reduction of operating surplus.

8.11. Finally, an important reason for large changes is error. By analysing changes, it is possible to understand them in each industry and reduce error to a minimum. Thus it is always important to list in parallel new coefficients and coefficients of past periods to help the analysis. To do this, it is important to use the same schemes of classification for both industry and product.

C. Construction of margins

8.12. The construction of the import matrix together with the construction of the trade margin matrix and that of transport margins are the weakest parts in terms of reliability in the construction of the use table. It is clear that for some products users may not know whether they are domestic or imported. It is even much more difficult to know the actual transport margins and trade margins of many products by specific users. These margins are estimated more or less as averages given total margins of specific products and margins of some individual flows in the use matrix. Margins are assigned to product flows on the basis of the proportionality principle, i.e. for a given product, a higher flow is assigned proportionally higher margins and vice versa. Detailed product classification should help in allocating margins.

1. Construction of import margins

8.13. Though imports and the construction of the import matrix are discussed in detail separately in chapter VI, it is important to emphasize again that the detailed classification of products greatly simplifies the task of distributing an imported product across each row in proportion to the use of the product by each industry and by final demand. With very detailed classification, it is possible more fully to use expert knowledge on the product, for example, to know where the imported product is not utilized as input, and, given actual figures of imports for a number of industries or final demand, compilers only have to distribute the residual proportionally to the sectors that are believed to use the imported product. The distribution of imports on the basis of the proportionality principle supplemented by expert knowledge will certainly lead to a more accurate compilation of the import matrix.

2. Construction of the trade margin matrix

8.14. Detailed product classification also helps in allocating trade margins. The derivation of trade margins which include both wholesaling and retailing margins either as one sector or as two separate sectors also follows the same principle as the distribution of imported products. The proportionality principle is used in conjunction with knowledge of wholesale and retail trade margins. There are some rules of thumb that need to be kept in mind, namely:

(a) Most retail margins will be allocated to households' final consumption expenditures, with the exception of the procurement of office supplies, gasoline and probably some other goods that are also obtained from retailers;

(b) Industry and government purchases are mostly from wholesalers;

(c) Exports do not involve retail trade, with the exception of some minor transactions.

8.15. For developing countries, it may be better as far as possible, to divide each product into six separate groups:

(a) Products which are produced and marketed by major corporations in an organized and modern fashion;

(b) Products which are produced by small manufacturers and craftsmen, and mainly used in local markets;

(c) Products which are produced by small producers like rice or wheat farmers but are procured and marketed in an organized manner through wholesalers and retailers;

(d) Products which are produced for own consumption;

(e) Products which are produced for own capital formation;

(f) Products which are imported.

Obviously, each type of product will require more or less in the way of trade margins. Cases (d) and (e) may require no trade margins, cases (a) and (c) may require higher trade margins than case (b). Finally, case (f) may require the highest trade margin in developing countries because of import monopolies.

3. Construction of the transport margin matrix

8.16. Transport margins which relate to the movement of goods should be clearly distinguished from transport services that are consumed directly as a means of personal movement. The construction of a transport margin matrix is similar to the construction of a trade matrix and normally they are prepared together. But it is important to note that in the 1993 SNA only transport costs which are billed separately to purchasers by suppliers or paid to third parties by wholesalers and retailers are treated as transport margins, not as part of trade margins (SNA, para. 6.112(c) or paras. 5.64 and 5.65 of chapter V) and will appear in the consumption of transport services by industries. In this case, these known values assigned to a known destination should be subtracted from the total output of transport services before the residual is distributed proportionally. Other known transport costs that are paid by purchasers of goods directly to transport establishments because these purchasers hire movers of the goods themselves can be obtained by surveys on input used. By SNA rule, own-account transport of goods by purchasers will not appear as output of transport services.

D. Final balancing of the tables

8.17. The main focus in SUT balancing is on balancing the use and supply tables together. The balancing may begin after all components shown in table 8.1 have been prepared. One should use all statistical and engineering information to fill in the intermediate demand matrix of the use table. One should use information from household expenditure surveys, surveys on retail sales capital formation, inventories, government expenditures and foreign trade to fill in the final demand part of the use matrix. Only small residuals should be mechanically distributed. Discrepancy between supply and use by commodity may be the result of under-reporting, over-allocation, mis-classification or improper valuation and timing of production, intermediate consumption, final uses, gross capital formation, exports and imports. All of these problems must be thoroughly investigated, which requires the re-examination of basic records and an intimate knowledge of the industries and commodities concerned.

8.18. One of the tools for distributing the residuals in existing flows and to keep industry output (column sum) and product output (row sum) fixed at predetermined values is the RAS method. The method will be discussed in chapter IX but here it is sufficient to say that the basic objective of the method is to distribute the differences between known product outputs and the sums of the rows of the present intermediate matrix proportionally along the rows and then to distribute the differences between known industry outputs and the sums of the columns proportionally along the columns. This process is carried out continuously until all discrepancies are reduced to an acceptable minimum. This method is equivalent to minimizing differences between the flows that have been obtained by using available information and the final calculated flows of the use table given row and column sums. It is also possible to fix certain flows to known figures while using RAS to distribute the discrepancies only in the rest of the flows. The latter method is called the modified RAS method. Thus, in balancing the use table, it is important to divide the flows into two parts: those that are based on sure information, and those that can be modified. If the use table is a benchmark where most of the information comes from censuses, then one must keep the flows that one is sure of constant and distribute the residual proportionally to the rest of the flows both horizontally and vertically. The RAS method is used mostly to balance the intermediate demand matrix, given known industry output, product output, value added and final demand. However, the RAS method can also be used for the entire use matrix, given additional information on total values for each category of final demand, like total personal consumption expenditures, total gross capital formation, total exports, total imports, etc.

8.19. Most of the methods used for balancing input-output tables are ad hoc, but they have to be based on statistical information, and expert knowledge. Only as a last resort, when discrepancies are reduced to the minimum possible, should an arbitrary method like the proportionality principle be used to allocate the residuals. If one does not want to distribute flows arbitrarily, one may create a row and a corresponding column to store discrepancies, though they may look odd in an input-output tables. However, the latter method may still be preferable to the allocation of discrepancies to changes in inventories as some countries have attempted.

8.20. In some countries, there are no clear-cut benchmark tables, and additional information is introduced every year to arrive at new annual tables. Some use the modified RAS method to update the old table into the new table by incorporating new information. Because of the nature of the method, it is possible to force the new table to be close to the old one when even the old one is not based on the fullest possible information. Thus, it is still preferable to compile a benchmark table using SUT on the basis of the fullest possible information provided by censuses to check accuracy of the tables derived by other methods. Annual SUT should also be compiled given the benchmark table and annual information because that is the most reliable and integrated method to check the consistency of the data and components of national accounts.

IX. UPDATING INPUT-OUTPUT TABLES: RAS METHODS

9.1. This chapter discusses two techniques--i.e. the simple RAS and modified RAS -- that are widely used to update input-output tables on the basis of the benchmark tables compiled with detailed census and survey data. Since the techniques are based on the stability over time of input-output coefficients, the chapter starts with that topic by reviewing studies that confirm this stability (see section A below). The widespread use of the techniques is explained because in most countries it takes two to five years after the end of the year before the input-output tables for that year can be prepared and published. If the tables are to be used in current analysis, it is important to check whether and to what extent the coefficients have changed since the year to which they relate. By incorporating the most up-to-date information, the two RAS techniques are used to carry out this check and update those coefficients that are clearly changed in view of the newly available information. The RAS techniques are used not only to update entire I/O tables, but, as will be shown below, to balance supply and use tables at the last stage, which was discussed in chapter VIII. The Lagrangian multiplier approach has also been tried but it does not seem to provide better results. This approach will be briefly discussed in paragraph 9.39 at the end of the chapter. It is important to emphasize from the beginning that no purely mechanical method would be able to replace updating SUT on the basis of comprehensive data. The best approach is always to use all available information to compile annual SUT and then use modified RAS at the last stage of balancing. In this context, the current Canadian method is worth mentioning.[1] It uses the following steps:

- Real value added by industries of the current period, to calculate real industry output;
- Real industry output and the intermediate coefficient matrix of the base year, to estimate intermediate consumption flows;
- Real industry output and the market share matrix, to estimate product output and the supply table;
- Use price indexes, to transform the real supply table into the supply table and industry output at current prices;
- Use price indexes, to transform the real intermediate consumption matrix into the matrix at current prices;
- Compile components of final uses at current prices from available statistics;
- Estimate trade and transport margins by base-year margins, and reflate them to current prices;
- Estimate taxes on products using the benchmark method and then confront them with control totals;
- Balance SUT with supplementary data and expert knowledge.

A. Stability of I/O coefficients

9.2. Changes in the input coefficients in current values may be caused by three major reasons:

(a) Changes in technology;
(b) Changes in relative prices;

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[1]Yusuf Siddiqi and Mehrzad Salem, "A Synthetic Approach to Projecting Input-Output Tables" in *Economic Systems Research,* Volume 7, No. 4, 1995.

(c) Imperfect data.

9.3. The most important changes, in technology, are beyond manipulation by statisticians. These resulted for instance from the sudden and drastic changes in relative prices, due to increases in the price of petroleum in 1973 and 1979. In current prices, the input coefficients showing the use of petroleum in various industries increased significantly immediately after petroleum prices increased, while the increases abated and even declined after a while when conservation (technical change) took effect. Another cause of changes in input-output coefficients is inflation also causing changes in relative prices; the effect of these changes can be eliminated by using input-output tables in constant prices (see chapter XI for a discussion on input-output tables in constant prices). The changes due to imperfect data might be reduced --but can never be entirely eliminated-- by the use of statistical classifications developed on the basis of the homogeneity principle. Using such classifications would avoid adding together products with different technical coefficients, so that changes in product-mix within a given classification are insignificant. If these conditions are met, changes in input-output coefficients at constant prices can be treated as caused by technical changes.

9.4. Many studies have shown that input coefficients are not stable over time but that changes take place fairly gradually. Vaccara[2] of the United States showed that during the period 1947-1958, the average annual rate of change in intermediate output requirements (ignoring signs) for a fixed bill of final demand was 2.3 per cent. Over the 1958-1961 period, the change averaged 1.7% per year. Tilanus[3] of the Netherlands showed that the median coefficients for all observed cells indicated a tendency for coefficients to change by about 2 per cent a year and he found that over half the coefficients of the time trends were statistically significant. The fact that changes over time are fairly gradual makes it possible to extend the useful life of any input-output table. The work of Sevaldson[4] in Norway showed that 60% of coefficients had either a moderate or clear (positive or negative) trend, and that trends which changed the coefficients as much as 1% a year were rare. He also noted a considerable dispersion about the mean value of each coefficient, but when the values were compared with a time trend the dispersion was reduced but still quite large. It was drastically reduced when tables were aggregated from 64 industries to 14.

9.5. However, because of a still large dispersion about a linear trend, the method of projecting coefficients by linear extrapolation does not provide good estimates of future input-output tables. Tilanus showed in the study mentioned above that such extrapolations generated worse results than simply using the most recent coefficients. When T.S. Barker[5] performed the same type of exercise, projecting the 1963 intermediate demand for Britain using the 1954 table as the benchmark, results showed that trend projection was worse than using the most recent table of 1960. In all cases, the tables updated by simple RAS method, which will be described later, performed better.

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[2]Beatrice N. Vaccara, "Changes over Time in Input-Output Coefficient for the United States" in *Readings in Input-Output Analysis,* edited by Ira Sohn, New York, Oxford University Press, 1986.

[3]C. B.Tilanus, *Input-output Experiments : The Netherlands 1948-1961,* Rotterdam University Press, 1966.

[4]P. Sevaldson, "The Stability of Input-Output Coefficients" in *Applications of Input-Output Analysis* edited by A.P. Carter and A. Brody, North Holland, 1969, also in *Readings in Input-Output Analysis,* edited by Ira Sohn, *op. cit.*

[5] T.S. Barker, "Some Experiments in Projecting Intermediate Demand" in *Estimating and Projecting Input-Output Coefficients*, edited by R.I.G. Allen and W.F. Gossling, England, Input-Output Publishing Company, 1975.

9.6. Another method of projecting future input-output tables is the "best practice" firm method proposed by William Miernyk[6]. Miernyk suggested the use of the coefficients of the best practice firms in each industry as the future technology. He argued that these technologies of "best practice" firms in the present should gradually become the norm of the future, five to six years ahead. Many objected to the arbitrariness in selecting the length of time needed for the present best technology to mature. However, this objection can be met by figuring out a predicted time schedule for a given technology to be adopted, industry by industry. Until now no study has been carried out to test the accuracy of this proposal.

B. The mathematics of the RAS method

9.7. As changes in the coefficients are shown to be gradual, it might be possible to use a current input-output table to project to the near future, with its calculated values adjusted for technological changes. However, the tables used should be the most up-to-date ones. This raises the question whether there are methods that are efficient in updating tables that are normally completed five years after the year they refer to.

9.8. The problem of updating, i.e. adjusting an intermediate consumption matrix to fit new column and row sum constraints was first regarded as a statistical problem and tackled by statisticians working as early as 1940[7]. New column sums refer to the differences between gross outputs and value added, and the new row sums refer to the differences between gross outputs and net final demand. The new values are normally provided by annual surveys. The method used was the so-called RAS method, a well-known technique to update input-output tables, which was adapted from the work of Deming and Stephen to input-output tables by Richard Stone in 1961[8] and remains the simplest and most widely used. Even though variations of this technique have been developed, practically no other methods seem to perform better.

9.9. The RAS approach assumes that there exists an input-output table estimated from full data for a past year and that row and column sums for the input-output table of the present year are available. The basis of the RAS method suggested by Stone consists in finding a set of multipliers to adjust the rows of the existing matrix and a set of multipliers to adjust the columns so that the cells in the adjusted matrix will sum up to the required row and column totals relating to the later current year. In mathematical terms, if A_0 is the coefficient matrix corresponding to the benchmark input-output matrix F_0 table and A_1 is the updated matrix of input-output coefficients corresponding to the estimated input-output matrix F_1, then

$$(9.1) \quad A_1 = \hat{r} A_0 \hat{s}$$

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[6]William L. Miernyk, *The Elements of Input-Output Analysis.* New York, Random House, 1965. See also "Long-Range Forecasting with a Regional Input-Output Model" of the same author in *Readings in Input-Output Analysis,* edited by Ira Sohn, op. cit.

[7]W. E. Deming and F.F. Stephen, "On a Least-Squares Adjustment of a Sampled Frequency Table When the Expected Marginal Totals are Known" in *Annals of Mathematical Statistics*, 11, 1940.

[8]Richard Stone, *Input-Output and National Accounts,* Paris, Organization for European Economic Cooperation, 1961. Also Richard Stone and A. Brown, *A Computable Model for Economic Growth,* Vol. 1, London, Chapman and Hall, 1962. The full mathematical development of RAS should be read in Michael Bacharach, *Bi-proportional Matrices and Input-Output Change*, Cambridge, U.K., Cambridge University Press, 1969. Various variations of the RAS technique as optimization methods can be found in R.I.G. Allen and W.F. Gossling, *Estimating and Projecting Input-Output Coefficients*, London, Input-Output Publishing Company, 1975.

where r and s are row and column multipliers and ^ stands for a diagonal matrix.

9.10. An elaboration of the above formula for two industries (1 and 2) illustrates the role of the multipliers r and s.

$$A_1 = \begin{bmatrix} r_1 & 0 \\ 0 & r_2 \end{bmatrix} x \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} x \begin{bmatrix} s_1 & 0 \\ 0 & s_2 \end{bmatrix}$$

$$A_1 = \begin{bmatrix} r_1 a_{11} s_1 & r_1 a_{12} s_2 \\ r_2 . a_{12} s_1 & r_2 a_{22} s_2 \end{bmatrix}$$

The example shows that the row multipliers r_1 or r_2 are merely scaling factors to adjust elements of each respective row equally so that the sum of the new row is equal to the known row total. In the above formula, elements of the first row are multiplied by r_1 and elements of the second row are multiplied by r_2. Similarly, a given column multiplier also acts as a scaling factor applied equally to every element of that column so that the sum of the new column is equal to the known column total. Thus, all elements of the first column are multiplied by s_1 and all elements of the second column are multiplied by s_2.

9.11. An economic interpretation of the RAS multipliers r and s is that input-output coefficients a_{ij} of the input-output coefficient matrix A_0 change over time due to two effects: (a) the effect of substitution, expressed by r, measuring the extent to which product i has been replaced by, or used as a substitute for, other products in industrial production; and (b) the effect of fabrication, expressed by s, measuring the extent to which industry j has come to absorb a greater or smaller ratio of intermediate to total inputs in its production. The method further assumes that each effect works uniformly, e.g., that product i is increasing or decreasing as an input into all industries at the same rate and that any change in the ratio of intermediate to total inputs into an industry has the same effect on all products used as inputs. The substitution multipliers which operate along the rows are denoted as vector r and the fabrication multipliers operating on the columns as vector s. Each cell in the benchmark matrix, A_0, will be subject to these two effects. The assumption of uniform effects on inputs across industries is, however, economically unrealistic.

9.12. In order to find r and s, one must introduce the input-output flow matrix to be estimated, together with the known row and column totals, which will be called u^* and v^*. Let F_1 be the input-output flow matrix of the current year which is unknown, X_1[9] the known output vector of the current year, and A_1 is the new

[9]If output by industry is not the same as product output because of the existence of secondary products, X stands for the industry output vector.

coefficient matrix to be estimated corresponding to F_1. If X_1 is converted into a diagonal matrix[10], indicated by the sign ^ over it , the following identity holds:

$$(9.2)\quad \begin{aligned} F_1 &= A_1\hat{X}_1 \\ &= (\hat{r}\ A_0\ \hat{s})\hat{X}_1 \end{aligned}$$

Define u* to be the row total[11] of intermediate inputs of matrix F_1. Then

$$\begin{aligned} u^* &= F_1 i \\ &= (\hat{r}\ A_0\ \hat{s})\hat{X}_1\ i \end{aligned}$$

$$(9.3)\quad \begin{aligned} &= (\hat{r}\ A_0\hat{X}_1)\ \hat{s}\ i \\ &= \hat{r}\ (A_0\hat{X}_1)\ s \end{aligned}$$

In the above definition, i is a column vector in which each element is equal to 1. Vector i is used to sum the flow matrix across the rows to obtain the row sums of the flow matrix F_1. In the second equation F_1 is replaced by the expressions in equations 9.1 and 9.2. Then, in the next equation the order of matrices $\hat{s}X_1$ is switched to $X_1\hat{s}$, which does not change the value of u^*, because the $\hat{s}$ and X_1 matrices are diagonal. And, finally in the last equation, $\hat{s}$ i is replaced by the column vector s. If the column totals of F1 are defined as

$$v^* = F_1'\,i$$
and
$$v'^* = i'F_1$$

then 9.3 can be rewritten as:

$$(9.4)\quad v'^* = r'\ (A_0\hat{X}_1)\ \hat{s}$$

where r' is a row vector.

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[10]A diagonal matrix is a matrix with non-negative values on the diagonal and zeros everywhere else:

$$\hat{X} = \begin{bmatrix} x_1 & 0 & . & 0 \\ 0 & x_2 & . & 0 \\ . & . & . & 0 \\ 0 & 0 & . & x_n \end{bmatrix}$$

[11]The subscripts 1, 2, ... in u and v (see table 9.1) refer to the year to which the input-output table is intended to be updated and do not refer to the elements of these matrices.

9.13. The two equations 9.3 and 9.4 consist of the two unknown r and s vectors and known information on the benchmark coefficient matrix A_0, the new row and column constraints u^* and v^* and the new output levels X_1. Thus, if these equations are solved simultaneously the values of the r and s vectors will be found and then the updated matrix A_1 can be derived on the basis of equation 9.1. The mathematical properties of the RAS method have been explored by Bacharach[12] who shows that the iterative method will converge and produce a unique solution, which does not depend on whether rows or columns are adjusted first. Further, experience has shown that the method is not too demanding on computing time.

C. The iterative solution of the simple RAS method

9.14. The estimation process of obtaining F_1 from F_0 or alternatively from A_1 from A_0, in effect amounts to nothing more than a proportional adjustment of the benchmark matrix elements successively along the rows and columns until convergence is reached between the row and column sums of the new matrix found through iteration, and the known row and column sums. Due to the nature of the RAS method, it is also called the "bi-proportional adjustment" method.

9.15. How the RAS method functions will now be illustrated and later its properties will be outlined and some refinements discussed. The simplified accounting matrix for the benchmark year 0 is given in table 9.1(a) and all known information for the current year 1, is presented in table 9.1(b). From (a) one can calculate the coefficient matrix A_0 as presented in (c). If initially it is assumed that there is no technical change, the matrix for year 1 would be found by applying these coefficients to the new output levels, resulting in $A_0 X_1$ shown in (d). The row and column sums of this matrix, u_1 and v_1, are then calculated and compared with the known row and column sums for year 1, u^* and v^*. Then in table 9.1(e) - (g) the elements of X_1 calculated in (d) are adjusted to fit the new constraints by solving for the r and s multipliers. This effectively removes the assumption of unchanged technical coefficients.

9.16. The first step in the iteration is to calculate the first set of row multipliers r_1 at (d) and then to multiply the values in each of the rows to the multiplier for that row so that the row totals meet the constraints as reflected in (e). The column totals of the matrix at (e) are then compared with v^*, the know column sums, and a set of column multipliers are described which bring the column sums of the matrix to equal v^* in (f). As a result of this step in the iteration, the row totals of this matrix are no longer equal to u^*. A second set of multipliers, r_2, must now be applied to the rows so that they sum again to u^*. The column sums will then require further adjustment and this process will continue until no further adjustment is necessary. The resulting matrix after many iterations is shown at (g), together with the r and s multipliers. The latter are the product of the multipliers used at each of the successive rounds of adjustment. Thus, the accumulated row multiplier for the first row, 0.884, is $r_1 \times r_2 \times r_3 \times \ldots \times r_n$, which in the case of the example presented is equal to $0.873 \times 1.010 \times 1.002 \times 1.001 = 0.884$.

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[12] M. O. L. Bacharach, *Bi-proportional Matrices and Input-Output Change,* Cambridge University Press, 1969.

Table 9.1. Illustration of the RAS method

(a) I/O data for year 0

		Product[13]				Final demand	Total output
		A	B	C	Total		
Product	A	50	100	0	150	50	200
	B	30	50	20	100	200	300
	C	20	50	30	100	100	200
	Total	100	200	50	350	350	700
	Value added	100	100	150	350		
	Total output	200	300	200	700		

(b) Available I/O data for year 1

		Product			Total u^*	Final demand	Total output
		A	B	C			
Product	A				160	40	200
	B				150	250	400
	C				120	180	300
	Total	100	250	80	430	470	900
	Value added	100	150	220	470		
	Total output	200	400	300	900		

[13] For simplicity, no distinction is made between products and industries in this example.

(c) Input-output coefficients for year 0 (A_0)

	A	B	C
A	0.250	0.333	0
B	0.150	0.167	0.100
C	0.100	0.167	0.150

(d) Year 0 coefficients applied to year 1 outputs (A_0X_1) and calculation of the first set of row multipliers (r_1)

	A	B	C	u_1	u^*	$r_1=u^*/u_1$
A	50	133.3	0	183.3	160	0.873
B	30	66.7	30	126.7	150	1.184
C	20	66.7	45	131.7	120	0.911
v_1	100	266.7	75			
v^*	100	250	80			

(e) Adjustment of matrix along rows based on the first set of row multipliers (r_1) and calculation of the first set of column multipliers (s_1)

	A	B	C	$u_1=u^*$
A	43.6	116.4	0	160
B	35.5	79.0	35.5	150
C	18.2	60.8	40.1	120
v_1	97.3	256.2	76.5	
v^*	100	250	80	
$s_1=v^*/v_1$	1.027	0.976	1.046	

(f) Adjustment of matrix down columns based on the first set of column multipliers (s_1), and calculation of the second set of row multipliers (r_2)

	A	B	C	u_2	u^*	$r_2=u^*/u_2$
A	44.8	113.6	0	158.4	160	1.010
B	36.5	77.1	37.1	150.7	150	0.996
C	18.7	59.3	42.9	120.9	120	0.992
$v_2=v^*$	100	250	80			

(g) Further adjustment of rows and columns, until both u $=u^*$ and v $=v^*$ in the final updated matrix

	A	B	C	$u=u^*/u$
A	45.3	114.7	0	0.884
B	36.2	76.6	37.2	1.177
C	18.5	58.7	42.8	0.902
$v=v^*$	100	250	80	
$s=v^*/v$	1.025	0.974	1.054	

(h) Short-cut method

	A	B	C	$u=u^*/u$
A	45.3	114.7	0	1.119
B	36.2	76.6	37.2	1.488
C	18.5	58.7	42.8	1.140
$v=v_*$	100	250	80	
$s=v^*/v$	0.811	1.025	1.201	

9.17. Each cell in the benchmark matrix (d) can be multiplied by its summary row and column multipliers to yield the value of cells in the final matrix at (g). Thus the input of A into B which is 133.3 in the benchmark matrix must be multiplied by its row multiplier (0.884) and its column multiplier (0.974) to give 114.7, which is the value in the updated matrix at (g).

9.18. It can be seen in this example that product B with a row multiplier of 1.177 is replacing products A and C as an input into intermediate demands. When reviewing the column multipliers it becomes apparent that product B is subject to a downward fabrication effect, i.e., it is using fewer product inputs and thus more primary inputs in its production process, perhaps because the production process has become more complicated. On the other hand products A and C are using more intermediate products as inputs and fewer primary inputs per unit of output, perhaps because their inputs are being purchased in a form which requires less processing before being transformed into the finished product. This would be the case if a firm in the motor industry began to purchase the engines for its vehicles from another supplier, whereas previously it had purchased the various parts and made the engine itself.

9.19. If a particular cell of the benchmark matrix was zero, the RAS method would not change this. It would remain zero, since the proportional scaling along both row and column will not affect a zero value. Also no negative entries will appear in any cells in the final matrix as the allocation by the RAS method is based on the base matrix that is non-negative.

9.20. An alternative short-cut to the method shown in tables 9.1(a)-(g) is to start with the benchmark flow matrix and simply adjust this matrix to the new controls. This omits stages (c) and (d). The resulting matrix in this case, shown in table 9.1(h), is identical to that obtained in (g) but the row and column multipliers are different. Indeed, the same meaning cannot be attached to the multipliers which are covering changes in output levels as well as the two effects operating on the coefficients. This so-called short-cut method is defined by the following mathematical presentations:

$$(9.5)\quad F_1 = \hat{r}\, F_0\, \hat{s}$$

that is

$$(9.6)\quad A_1\hat{X}_1 = \hat{r}\, A_0\hat{X}_1\, \hat{s}$$

$$(9.7)\quad A_1\hat{X}_1 = \hat{r}\, [A_0\hat{X}_0(\hat{X}_1)^{-1}]\, \hat{s}$$

9.21. Equation 9.7 is similar to the RAS equation 9.1, however, with output levels X_0 and X_1 additionally included. If one is interested in the values of r and s as measures of substitution and fabrication effects, this method is not suitable; they cannot be derived. If there is no interest in these effects and the RAS methods are seen only as mechanical techniques of adjustment, the use of this short-cut method is recommended.

D. The modified RAS method

9.22. A modified version of the RAS method incorporates some firmly based information about some of the cells in the matrix being estimated. This method is illustrated in table 9.2 below where it is assumed that information is available on the input of B into A and hence there is no need for this cell to be involved in the adjustment process. The value of this cell is subtracted from the required row and column constraints, u^* and v^*, and this cell is set at zero in the benchmark matrix. This forms the starting point for the RAS adjustment in (c). The RAS adjustment procedure is then carried out in the normal way as was explained above, and when a solution has been reached at (d) the zero for the input of B into A is replaced by the known value 40.

Table 9.2. Illustration of modified RAS

(a) I/O data for year 0

		Product A	Product B	Product C	Total	Final demand	Total output
Product	A	50	100	0	150	50	200
	B	30	50	20	100	200	300
	C	20	50	30	100	100	200
	Total	100	200	50	350	350	700
	Value added	100	100	150	350		
	Total output	200	300	200	700		

(b) Available I/O data for year 1

		Product A	Product B	Product C	Total u*	Final demand	Total output
Product	A				160	40	200
	B	40			150	250	400
	C				120	180	300
	Total	100	200	80	430	470	900
	Value added	100	150	220	470		
	Total output	200	400	300	900		

It is assumed that the input of B into A is 40, otherwise the table is the same as table 9.1(b).

(c) Year 0 coefficients applied to year 1 outputs

	A	B	C	u_1	u^*	$r_1 = u^*/u_1$
A	50	133.3	0	183.3	160	0.873
B		66.7	30	96.7	110	1.138
C	20	66.7	45	131.7	120	0.911
v_1	70	266.7	75			
v^*	60	250	80			

(d) Final updated matrix

The RAS adjustment continues as in table 9.1(d)-(g) and when a solution is obtained the exogenous cell value of 40 is entered in the result.

	A	B	C
A	42.7	114.3	0
B	40	73.7	36.3
C	17.3	59.0	43.7

E. Evaluation of the simple and modified RAS methods, based on a literature survey

9.23. It is important to know how accurate the RAS method of updating input-output tables can be and various tests have been carried out to compare tables thus updated with tables subsequently estimated for that year from full statistical data.

9.24. Paelinck and Waelbroeck[14] compared an input-output table for 1959 estimated by RAS from the 1953 table with the actual 1959 table, and Schneider[15] performed similar tests with United States tables over the period 1947-1958. These tests showed that a matrix estimated by RAS from a past year gave a somewhat better estimate of the later year than did the matrix of the past year, i.e., r A_0 s was closer to A_1 than A_0. The number of errors in individual cells greater than 1 per cent was reduced from 17 to 9 in the Belgian case and from 121 to 103 in the United States case, with a larger table. In a more recent study by R. G. Lynch[16] using the 1963 and 1968 United Kingdom input-output tables, the improvement of the

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[14]J. Paelinck. and J. Waelbroeck, "Etude Empirique sur l'évolution de Coefficients Input-Output" in *Economie Appliquée*, 1965.

[15]J. Schneider, *An Evaluation of Two Alternative Methods for Updating Input-Output Tables* (B.A. Thesis, Harvard, 1965).

[16]R.G. Lynch, "An Assessment of the RAS Method for Updating Input-Output Tables" in *Readings in Input-Output Analysis*, edited by Ira Sohn, New York, Oxford University Press, 1986.

updated tables versus the tables of the past years was also confirmed and it was shown that the root mean square error decreases with the level of aggregation. However, in all these studies, the improvement in terms of mean square error is small unless the level of aggregation is increased significantly, which reduces the usefulness of the input-output table for detailed studies of industries.

9.25. Another recent study by P. Gretton and P. Cotterell of Australia[17] showed that errors in the estimates of large coefficients tend to be smaller than in those of smaller coefficients and that coefficients aggregated from those estimated by RAS method using more desegregated tables have smaller errors than coefficients estimated directly from aggregated tables.

9.26. The simple RAS method will normally fail to produce an accurate estimate of A, since the assumption that the row and column effects work uniformly along rows and columns is not justified. This will be the case if product groups are not homogeneous but consist of, say, one product which is replacing a product in another row and one product which is not replacing another or is being replaced by some other product. The net effect as recorded by RAS may be, say, an upward substitution effect on the row. However, if the two products are used in different proportions by consuming industries the substitution effect will not be uniform. A similar problem arising from lack of homogeneity was observed in the Belgian tests where it was found that the cells relating to fuel inputs were badly estimated by the simple RAS method. This was because coal, for instance, is used as a raw material in energy-producing industries but as a source of power in all other industries but in the latter case coal was being replaced by other fuels at a much faster speed than in the former case. This markedly different substitution rate seriously affected the results of the RAS updating estimate.

9.27. The incorporation of exogenous data into the simple RAS method will tend to improve the accuracy with which other cells can be estimated in the same rows and columns as the known cells. This does not mean that theoretically the improvement is always achieved as shown in an example given by R.E. Miller and P.D. Blair. The example is a small table of 3 by 3 in which one coefficient is assumed known. The overall accuracy of updated coefficients using the modified RAS method actually declines when compared with the normal RAS method.[18] This observation is also confirmed by a test by Gretton and Cotterel of Australia mentioned above when the inclusion of the coefficients of one more industry made overall errors worse. In general, most tests on real data show an improvement in the use of the modified method over normal RAS. The improvement is more significant if more exogenous data are incorporated.

9.28. In the Belgian tests, six of the cells which the simple RAS method had estimated were treated as if they were known exogenously and the modified RAS method was used. The number of cells with errors of more than 0.5% was reduced from 20 in the simple RAS method to 8 in the modified method. This conclusion is also reported in Lynch's study mentioned above.

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[17]P. Gretton and P. Cotterell, *The RAS Method for Compiling Input-Output Tables*, Australian Bureau of Statistics, Canberra, 1979.

[18]Ronald E. Miller and Peter D. Blair, *Input-Output Analysis: Foundations and Extensions*. New York, Prentice-Hall, 1985, pp.292-293.

F. Conclusions for application of the RAS methods in country practices

9.29. From the above it may be concluded that when input-output coefficients only change gradually, the RAS method and in particular the modified RAS which uses additional information that is available, provides satisfactory results. Thus, in order to make optimum use of the limited statistical resources available in many countries, it is acceptable to compile benchmark input-output tables based on a comprehensive database every 5-10 years and to compile annual tables integrated with the national accounts using the modified RAS updating techniques described here. While the annual tables based on a modified RAS method require some data on inputs, these requirements are nothing compared to the statistical requirements of benchmark input-output tables. Some data on inputs may be available on an annual basis and should therefore be used. On the other hand, the annual updating exercise of the input-output table should not involve the additional collection of statistical information on a major scale.

9.30. It is difficult to generalize as to which cells, rows or columns are well recorded by normally available statistics. In many countries fuel industries are well documented and information on the cells relating to fuel inputs should be available. The same may be true of the major inputs (fertilizers and feed) into agriculture. In some cases, it may be worthwhile to investigate a particular cell or cells to be incorporated into an updating exercise. Alternatively, it may be possible to combine indices of price and volume movements with the benchmark year value of a cell and obtain a measure of the value in the current year. Where there is no domestic production of a particular product it may be possible to obtain an estimate of the input of that product from international trade statistics, e.g. the input of crude oil into the petroleum refining industry.

9.31. In this context it should be noted that exogenous data on certain cells may lead to a greater improvement in the accuracy of the updating methods than data on other cells. Tests on United Kingdom input-output tables have shown that substantially improved results can be obtained when relatively small amounts of additional information about preselected major coefficients were incorporated into the updating exercise[19]. It seems useful, therefore, to perform some tests of updating exercises to find the most important cells in particular national tables. When these have been identified, efforts can be made to find exogenous data on those coefficients which will improve the accuracy of the updating exercise.

9.32. In developing countries, the modified RAS method could be used to cut the cost of frequent full-fledged surveying. The key coefficients are often determined by large establishments over which the Government has significant control. In addition, the number of such establishments is small, which allows less costly supplementary surveys for the purpose of identifying changes in the key coefficients or key industries.[20] In general, when using the modified RAS, it is important to divide the flows into two parts: those that are based on sure information, and those that can be modified. If the use table is compiled for a benchmark year, where most of the information comes from censuses, then only the flows that are based

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[19]R.I.G. Allen, "The Effects on Intermediate Output Predictions of Incorporating Coefficients with Known Values into the RAS Updating Method" in *Aspects of Input-Output Analysis,* edited by I.G. Stewart, Edinburgh University Press.

[20]This point was discussed in Victor Bulmer-Thomas, "Application of Input-Output Analysis for Less Developed Countries (LDCs)" in *Readings in Input-Output Analysis*, edited by Ira Sohn, New York, Oxford University Press, 1986.

on census and similar data sources are kept constant with the residual proportionally distributed in the rest of the flows both horizontally and vertically.

9.33. In many countries it should be possible to extract from regularly available statistics some information on inputs or trends in input coefficients (if clear trends can be established) since the year of the previous full table. It should be possible to produce an input-output table by this method quite soon after the full national accounts are produced. Australia is the country that has adopted the modified RAS method to compile its annual input-output tables with significant annual supplementary basic data in order to speed up the availability of more current input-output tables. According to Australian reports more than 28% in 1974-1975, 18% in 1977-1978, and 20% in 1978-1979 of all intermediate inputs (in terms of value) were estimated from basic data.[21]

9.34. Such an updated table will obviously not be so accurate as a table estimated on full data (although even these will suffer inevitably from errors of measurement, particularly of smaller inputs), but should be sufficiently accurate to remove the need for a full table each year, particularly if some exogenous data on coefficient can be incorporated. This is certainly likely to be true if the input-output table is used in any analysis or model-building. If, on the other hand, the input-output table is used to check the consistency of data in a statistical framework, there may be some need for an updated table. For instance, if a very high multiplier is found for a particular product which does not fit in with knowledge of changes in industrial techniques, this would suggest either that final demand has been underestimated or total output overestimated, resulting in an overestimate of intermediate demand. Similarly, an unusual column multiplier might lead to suspect over-estimation of primary inputs or total output of the industry.

9.35. It follows from the above observation that the application of the RAS method, either simple or modified, will only produce an accurate estimate of the input-output table if the control totals are accurate. This requires accurate estimates of industry and product outputs, primary inputs (net input) and final demand. Any errors in this area of national accounting data are likely to be transmitted to the input-output table whose row and column totals are derived as residuals from these other vectors.

9.36. It should be noted that when the short-cut RAS method is used, no economic significance can be attached to the values of the row and column multipliers. This should not prevent the use of the modified RAS method. It may be preferable under those circumstances to regard the RAS method simply as a statistical tool which can be used to adjust two-way tables. The basic method can be applied to many tables other than input-output tables. In some of these applications some meaning may be attached to the values of the multipliers as in the simple input-output case but in other cases the values of particular multipliers may have no significance. In this context it should be mentioned that the use of the RAS method is not necessarily limited to balancing the intermediate demand matrix, but could also be used to balance the use matrix of a supply and use table, and in the case of the modified version of RAS, not only additional data on intermediate uses could be incorporated, but also additional information on total values for each category of final demand like total household final consumption expenditures, total gross capital formation, total exports, total imports, etc. might be used.

9.37. In some countries, there are no clear-cut benchmark tables; additional information is introduced every year as new data become available, to arrive at new annual tables. These practices are found in many

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[21] *Australian National Accounts: Input-Output Tables*, 1974-1975, 1977-1978, 1978-1979, Canberra.

countries and some use the modified RAS method to update the old table into the new one by incorporating new information. Because of the nature of the method, however, one should realize that the data in the new table have to be close to those in the previous table, even though the latter may be based to a large extent on less reliable data. Therefore those practices still require that from time to time a benchmark table be compiled on the basis of the fullest possible information provided by censuses to check the accuracy of the tables derived by other methods. In Norway, a country with a long tradition of compiling the full SUT annually, the full SUT benchmark framework is revised every five years, the annual SUT is an updated version of the benchmark on the basis of as comprehensive data as are available, either by current values or by indices, specially where only more aggregated data are available.[22]

9.38. Finally, it is important to realize that all the tests carried out until now were on individual cell accuracy (i.e. partitive accuracy) rather than on overall accuracy of the estimated input-output table in practical projection (i.e. holistic accuracy), for example tests on how estimated tables perform on predicting gross outputs given that final demand is known. The reason is that tests will be rendered trivial by the nature of the RAS method to equate the sum of estimated elements in the intermediate matrix and final demand (which is known) to total outputs. However, it is still possible to carry out tests on the performance of an updated coefficient matrix on the most recent set of final demand and gross outputs, e.g. to compare errors in gross output of time t+1 generated by using the coefficient matrix at time t updated from time t-1 with errors in gross output generated by using the more outdated real coefficient matrix based on surveyed data of time t-1.

G. Other alternative methods for updating coefficients

9.39. Bacharach[23] also demonstrated that the RAS method is similar to the minimization of an objective function of the form:

$$\textit{Minimize} \sum_{i,j} \tilde{X}_{ij} \ln(\tilde{X}_{ij} / X_{ij})$$
$$\textit{subject to row and column sum constraints}$$
$$\textit{where } \tilde{X} \textit{ is the estimated value of } X.$$

The Lagrangean multiplier approach is a further extension of the above formula:

$$\textit{Minimize} \sum_{i,j} \frac{(\tilde{x}_{ij} - x_{ij})^2}{\pi_{ij}}$$
$$\textit{where } \pi_{ij} \textit{ are weights.}$$

[22]Communication from Mr. Erling Flottum, Statistics Norway.

[23]M.O.L. Bacharach, op cit.

If one assumes that the larger elements are less subject to change than the smaller, then weights assigned are larger, for example by using X^2_{ij}. A weight of infinity means that the element X_{ij} is fixed. Similarly, some elements may be more likely to change, a weight can be X_{ij}. Elements may be negative unless they are constrained to be non-negative. W.I. Morrison and R.G. Thurman[24] experimented with this method and found that the RAS method produced better results that the Lagrangian multiplier approach with simple weights and without additional constraints. The RAS is also computationally much cheaper. Statistics Netherlands[25] has tested the Lagrangean multiplier approach and argued that it has some advantages over RAS. However, its advantages over the modified RAS are not clear.

[24]W.I.Morrison and R.G. Thurman, "A Lagrangian Multiplier Approach to the Solution of a Special Constrained Matrix Problem", *Journal of Regional Science*, Vol. 20, No.3, 1980.

[25]Harthon, R. and J. van Dalen, *"On the Adjustment of Tables with Lagrange Multipliers"*, National Accounts Occasional Paper, No. NA-024, Statistics Netherlands, 1987.

PART THREE

SOME APPLICATIONS OF INPUT-OUTPUT TABLES AND MODEL

X. CREATING AN INDUSTRY NOT IDENTIFIED FROM ISIC CLASSIFICATION: ANALYSIS OF THE INTERNATIONAL TOURIST INDUSTRY

A. Introduction

10.1. This chapter was written to demonstrate an application of input-output modelling in studying a specific industry. International tourism is selected because, firstly, it is an economic activity that attracts a lot of attention in many countries but at the same time is not separately classified in either national accounts or input-output tables and, secondly, it is not a very complex issue to deal with. The principles of impact analysis will be discussed in chapter XII and this chapter will focus mainly on how to create the international tourist industry in input-output tables and how to apply the principles discussed in chapter XII. It should be noted that the World Tourism Organization may come up with a different way of creating the tourist industry. Its plan is to aggregate establishments that produce mainly tourist services.

10.2. International tourism is not an industry that can be immediately identified in input-output tables or in national accounts which are constructed on the basis of the United Nations International Industrial Classification of All Economic Activities (ISIC). However, this industry can be formed by aggregating different economic activities which serve it directly. Procedures for forming the industry will be discussed in this chapter, together with methods to analyse some of the major roles of the industry in generating employment and taxes or in creating demand for capital and imports in the economy. These analyses are very simple but may be used as powerful tools to provide important information on the industry. The procedures used in analysing international tourism can also be applied to study other industries such as energy and information that do not appear explicitly in input-output tables and national accounts.

10.3. The chapter will first define the industry and then discuss technical issues relating to its analysis.

B. Definition and classification of the international tourist industry

1. Definition

10.4. The importance of international tourism as a contributor to GDP and as a source of employment is being increasingly recognized. It is estimated that in 1984 receipts from world international tourism totalled $100 billion, which is over 5 per cent of total world merchandise exports in the same year. International tourist receipts amounted to 8 per cent of GNP and 36 per cent of foreign exchange earnings in 1982 in Austria, 12.3 per cent of GNP in Cyprus, 20 percent of employment in Barbados, and 48 percent of employment in the Bahamas.[1]

10.5. The international tourist industry of a country may be defined as the sum of domestic activities that

[1] "World Tourism: an Economic Analysis" by S. I. Papadopoulos, Braford in *Revue de Tourisme,* No.1, 1987 and UNDP/TCDC News, Vol. 3, p. 9.

directly support the consumption of goods and services of foreign tourists in the country. Therefore, definition of the international tourist industry is dependent on the definition of international tourists, which in turn can be based on a narrower definition of non-residents. That is, tourists should include:

(a) Persons visiting the country for less than one year, specifically for purposes of recreation or holiday, medical care, religious observances, family affairs, participation in international sport and cultural events, conferences and other meetings, study tours and other student programmes, as well as persons in transit to another country;
(b) Foreign students remaining for more than one year;
(c) Crew members of foreign vessels and aircraft docked in the country or on lay-over;
(d) Foreign business travellers who are in a given country for less than one year;
(e) Employees of international bodies who are on a mission of less than one year;
(f) Nationals who are residents of other countries who come back for visits of less than one year.

10.6. In comparison to the boundary of activities of non-residents in a country, only activities of diplomats and extra-territorial bodies like members of the armed forces of other countries are excluded as not belonging to tourists' activities.

10.7. In general, it is quite difficult to measure directly the domestic activities that support the consumption of goods and services of foreign tourists in a country. When this happens, the activity may be measured in terms of the share of goods or services that are consumed by foreign tourists. Those expenditures (e.g. on meals, accommodations, purchases of gifts, international as well as local transportation), according to the SNA, should be treated as the country's exports.

2. Classification

10.8. ISIC recommends the classification of parts of the following activities into the international tourist industry:

Table 10.1. ISIC components of the international tourist industry

Class	Activities
5510	Hotels; camping sites and other provision of short-stay accommodation
5520	Restaurants, bars and canteens
6010	Transport via railways
6021	Other scheduled passenger land transport
6022	Other non-scheduled passenger land transport
6110	Sea and coastal water transport
6120	Inland water transport

6210	Scheduled air transport
6220	Non-scheduled air transport
6304	Activities of travel agencies and tour operators; tourist assistance activities n.e.c.
7111	Renting of land transport equipment
7112	Renting of water transport equipment
7113	Renting of air transport equipment
9219	Other entertainment activities n.e.c.
9231	Library and archives activities
9232	Museum activities and preservation of historical sites and buildings
9233	Botanical and zoological gardens and nature reserves activities
9241	Sporting activities
9249	Other recreational activities
..	Other direct purchases.

Table 10.2. Compilation worksheet for the international tourist industry

	ISIC	Purchasers' value	Trade, transport margins	Taxes on products	Imports	Basic values
	(1)	(2)	(3)	(4)	(5)	(6)
(1)	5510					
(2)	5520					
(3)	6010					
(4)	6021					
(5)	6022					
(6)	6110					
(7)	6120					
(8)	6210					
(9)	6220					
(10)	6304					
(11)	7111					
(12)	7112					
(13)	7113					
(14)	9219					
(15)	9231					
(16)	9232					
(17)	9233					
(18)	9241					
(19)	9249					
(20)	Trade and transport margins					*
(21)	Taxes on products					**
(22)	Other products purchased by tourists broken down by ISIC					
(23)	Total		*	**		

Steps to calculate the output of the international tourist industry:

(a) Break down tourist purchases into ISIC listed in column (1);
(b) Break down each detailed purchase at purchasers' price into the components listed in col. (3)-(6);
(c) Each component of the output of international tourism in col. (6) is equal to col. (2) minus (3) minus (4) minus (5);
(d) Move total trade and transport margins and taxes on products (i.e. sum of col. 3 and 4 to asterisked places in col. (6);
(e) The sum of col. (6) is the total output of international tourism and can be treated as the whole vector of col.(6) or one single value shown at row (23) of col. (6).

10.9. In fact, it is only possible to survey tourist expenditures by products, not by economic activity. In this case, using ISIC, one implicitly assumes that the products consumed by tourists are matched with the ISIC classification in table 10.1. The expenditures by tourists on the outputs of these activities should either be direct purchases by the tourists themselves or through their purchases of package tours from tourist agencies. When expenditures are made by buying package tours, they have to be broken down into ISIC components as listed in table 10.1. For example, an expenditure on air travel tickets should be split into the payment for air tickets (ISIC 6210 or 6220) and the payment of fees to travel agents (6304).

10.10. Other direct purchases of goods and services by tourists like souvenirs which are directed exclusively to tourists, and others such as hairdressing services, etc. listed as the last item in table 10.1 above are not shown with a corresponding ISIC class number because the kinds of goods and services detailed in ISIC bought by tourists may only be known by conducting a survey on their expenditures. These other direct expenditures are, unfortunately, not included by the United Nations in its recommended ISIC categories of the international tourist industry. However, to be complete these items should be included since without tourists these purchases would not be made. All these expenditures are at purchasers' prices and have to be broken down into basic values, trade and transport margins and taxes on products. In the case of tourism, except for the goods directly purchased by tourists, most of the items listed as parts of the activities of the international tourist industry are services and therefore do not have trade and transport margins. However, the margins are still shown in table 10.2 so as to make the table compatible with a more general approach.

10.11. After all expenditures by international tourists are classified by ISIC, the vector of expenditures is broken down into those supplied by resident producers versus non-resident producers. Only those goods and services that are domestically supplied will impact the domestic economy. For example, air transport may be provided by non-resident carriers but services of domestic travel agencies and airport services represented by airport user fees charged on carriers and tourists are part of exports and should impact the domestic economy. Similarly, the goods that are bought directly by tourists might be imported but the margins on these goods that are domestically supplied will impact the economy. The final vector of international tourist purchases of domestic products in detailed ISIC should be the vector of output of the international tourist industry shown in table 10.2. It is important to know that trade and transport margins on all goods and services consumed by tourists should also be part of the industry output. When included, the output is at purchasers' values.

10.12. By the definition given above, the output of the international tourist industry consists of either direct expenditures made by the tourists themselves or through tourist agencies that are supplied by resident producers. The output of the industry, therefore, is not the same as the total tourist expenditures in the country. In addition, the output of this industry is also the same as the final consumption by tourists of domestic products, which is then treated as exports. The treatment of the total output of this industry as exports is a special case since normally only part of the output of an industry is exported. This special characteristic has to be taken into account in modelling the industry in an I/O table. Before creating an international tourist industry in input-output table is discussed, a general scheme of creating a new industry by aggregating parts of other industries in an existing input-output table must be first. This general scheme will require techniques of disaggregation and aggregation of industries.

C. Modelling the international tourist industry in I/O table

10.13. The output of the international tourist industry in an input-output table as described in section B above is a vector contained in column 6 of table 10.2 rather than a single value, which consists of parts of the outputs of many industries. With regards to inputs, there should be an input structure corresponding to every detailed component output of the international tourist industry contained in column 6 of table 10.2. It is possible to proceed with the work of creating the international tourist industry by, at first, separating every output and its associated inputs which are part of the international tourist industry from other industries and then aggregating these newly separated rows and columns to form the new industry. Fortunately, the international tourist industry is much simpler in the sense that its output is all consumed by non-residents and therefore must be treated as exports which are part of final demand. None of its output would be used as intermediate inputs in other industries. Or in other words, no domestic activities would generate output of international tourism (remember we focus only on tourism by non-resident tourists). To create the international tourist industry, one important assumption has to be introduced, i.e. the input coefficients of the industry that are separated out are similar to the input coefficients of the industry that remain. This may not be applicable to other industries since final demand for the output of a particular industry normally generates only part of the total impact of that industry, with other parts generated by final demand of the outputs of other industries which, in turn, indirectly generates the output of that particular industry. To create an industry that is not independently identified by an ISIC classification will be discussed in part D below.

1. Creating the international tourist industry

10.14. To analyse the international tourist industry, it is necessary to assume that the input coefficients of the industry which are separated out are similar to those of the industry that remain. Thus for the international tourist industry, only the inputs corresponding to every output which is a component of the industry are separated out. Its total composite output is then treated as exports. An example in table 10.3 will be used to demonstrate how the international tourist industry is created. The results are shown in tables 10.4 and 10.5. In the example, it is assumed that 10% of the output of industry 1 and 10% of the output of industry 2 make up the output of the international tourist industry.

10.15. The following steps will be used:

- (a) The components of output that belong to the international tourist industry are separated;
- (b) Associated inputs of the output components are separated;
- (c) An aggregation of inputs of the components of the tourist industry is used to form the inputs of the tourist industry;
- (d) The final demand of the remaining industries from which outputs and inputs are extracted to form the tourist industry is equal to its remaining outputs less intermediate consumption.

10.16. Table 10.3 shows the original table. Table 10.4 shows the separation of industry 1 and industry 2, each into two parts. From industry 1, 10 is the output of the tourist industry and from industry 2, 20 is also the output of the tourist industry. Final demand of industry 1 that remains is equal to its output (90) less the intermediate consumption of its output -- [90 - (9+1+13.5+1.5+30)=35]. The final demand of the part of industry 2 that remains is calculated in a similar manner. Disaggregation of inputs is simply done by extracting 10% from the inputs of the corresponding industries. Columns and rows 2 and 4 of table 10.4 show the inputs and outputs of the tourist industry that are extracted. Industries 2 and 4 in table 10.4 are then aggregated in table 10.5 into one industry (the third row and column). In both tables, the outputs of the international tourist industry are entirely consumed as final demand.

Table 10.3. Matrix without explicit components of international tourist industry aggregated

	Matrix f			Final demand	Total output
Industries	1	2	3		
1	10	15	30	45	100
2	20	9	7.5	163.5	200
3	30	50	22.5	47.5	150
Value added	40	126	90		
Output	100	200	150		

Table 10.4. Matrix with components of international tourist industry disaggregated

		Matrix f					Final demand	Total output
	Old industries	1		2		3		
	New disaggregated industries	1	2	3	4	5		
Row 1 in table 11.3 is split	1	9	1	13.5	1.5	30	35	90
	2						10	10
Row 2 in table 11.3 is split	3	18	2	8.1	0.9	7.5	143.5	180
	4						20	20
	5	27	3	45	5	22.5	47.5	150
	Value added	36	4	113.4	12.6	90		
	Output	90	10	180	20	150		

Table 10.5. Matrix with components of international tourist industry aggregated

	Matrix f				Final demand	Total output
New industries	1	2	3	4		
Industries of table 11.4 to be aggregated	1	3	2+4	5		
1	9	13.5	2.5	39	35	90
2	18	8.1	2.9	7.5	143.5	180
3					30	30
4	27	45	8	22.5	47.5	150
Value added	36	113.4	16.6	90		
Output	90	180	30	150		

10.17. The form in table 10.4 or table 10.5 can be used to analyse the international tourist industry. If the industry is treated as made up of two separate industries, its final demand would consist of two non-zero components (0 10 0 20 0). If it is treated as one industry, then its final demand would consist of only one non-zero component (0 30 0 0).

10.18. The second method may be preferred if the original input-output table is not very detailed to the extent of having each industry corresponding to a 4-digit ISIC, and if analysts want to see the international tourist industry separately identified. Table 10.5 shows the inputs used in the new industry as well as the value added generated.

2. Distortion created by aggregation

10.19. The aggregation of the components of the international tourist industry is mainly for the purpose of presentation rather than for analysis because of the distortion it creates. One can see the distortion if one applies impact analysis using equation 12.2 in chapter XII with the final demand vector of international tourism shown below:

$$Y = \begin{bmatrix} 0 \\ 0 \\ 0 \\ x \end{bmatrix}$$

in which x is both the output and final demand of the international tourist industry. Given that the components of x change relatively in the next period, the impacts would be distorted when the same output and input structures of the base-year period are used. In this case, the formulation shown in table 10.4 is preferred.

3. Impact analysis of the tourist industry

10.20. The analysis of the tourist industry should follow the procedure described in chapter XII.

D. A general aggregation and disaggregation scheme for the creation of a new industry not identified by ISIC

10.21. Many industries that are normally referred to in common language are not identified in ISIC, I/O tables or national accounts. For instance, the energy industry includes many diverse activities such as burning of organic substances (e.g. thatches, wood, etc.), mining and extraction of coal, crude oil, natural gas, uranium and thorium ores, the production of coke, petroleum products and nuclear fuel, the production and distribution of electricity, gas, steam and hot water. Another example is the pollution abatement industry which consists of all abatement activities connected with every industry identified by ISIC. Other industries, such as the port industry which is composed of the operation of ports and other services serving them such as transport, financial and administrative services, etc., are made up of segments of many activities. One important "industry" that one may want to look at as a whole in order to analyse its interrelationships with other industries is the food and agriculture industry. According to the recommendation of FAO, the economic accounts for food and agriculture consist of the following activities:[2]

(a) Crop and animal husbandry (ISIC division 01);
(b) Forestry, logging and related activities (ISIC division 02);
(c) Fishing (ISIC division 05);
(e) Food manufacturing production (ISIC division 15);[3]
(f) Environmental protection activities (desertification control, water resource protection, marine pollution control, erosion control, flood prevention or control and natural reserves;
(g) Research and development relating to crops, livestock, forestry, fisheries and food production (part of ISIC class 7310);
(h) Veterinary activities (ISIC class 8520);
(i) Technical and vocational and higher education relating to agriculture (part of ISIC classes 8022 and 8030);
(j) Agro-industries other than food products (part of ISIC divisions 16, 17, 19, 20);
(k) Production of inputs for the agricultural sector (ISIC class 2412 - manufacture of fertilizers and pesticides);
(l) Production of machinery and equipment for the agricultural sector (ISIC class 2921 - manufacture of agricultural and forestry machinery, ISIC class 2925 - manufacture of machinery for food, forestry and tobacco processing, and part of ISIC class 3511 - building of fishing boats and fish processing factory vessels);
(m) Development of infrastructure for rural areas (part of ISIC division 45).

Many economic activities cited above are only a part of an ISIC class and therefore must be separated before they can be re-aggregated into one industry. As a consequence, the formation of such industries requires the application of the procedures described in this part on disaggregation and aggregation.

10.22. In creating a new industry in an I/O table from existing information, parts of the new industry have to be separated from the existing I/O table before they can be aggregated to form the new industry. The separation technique will now be discussed before the aggregation technique.

1. Disaggregation scheme[4]

11.23. The general scheme is based on two assumptions:

(a) The input coefficients of the industry as separated out are similar to the input coefficients of the industry that remain;

(b) The consumption by other industries of the output of the industry that is separated out is proportional to the consumption pattern of the output of the original industry by other industries.

10.24. Assume that there exist two matrices: matrix f is the original flow matrix and matrix a is the coefficient

[2]FAO, *A System of Economic Accounts for Food and Agriculture*, Rome, 1996.

[3]Food production is defined by FAO as including food manufacturing production and primary food production included as part of ISIC divisions 01, 05.

[4] See Alan M. Wolsky, "Disaggregating Input-Output Models" in *Review of Economic Statistics,* May 1984.

matrix derived from the f matrix. Matrix f includes the row(s) of value added, matrix a includes only the intermediate coefficients. Corresponding to these matrices are the vectors of industry output x and of final demand y. Then, let's assume that the n^{th} industry is split into the remaining industry and the part that is separated out. The output of industry n is x_n, the remaining industry has the output $x_n = w_1 x_n$ and the output of the part that is separated out is $x_{n+1} = w_2 x_n$ where $w_1 + w_2 = 1.0$. w_1 is the share of output that remains to be the output of industry n and w_2 is the share of output of the newly separated part of the industry.

10.25. The newly disaggregated flow matrix F is obtained by:

- first, multiplying the n^{th} column by w_1 to obtain the column of the remaining industry and then multiplying the same n^{th} column by w_2 to obtain the column of the newly separated part;

- second, multiplying the n^{th} row by w_1 to obtain the row of the remaining industry and then multiplying the same n^{th} row by w_2 to obtain the row of the newly separated part.

10.26. The new final demand matrix Y can be easily obtained by multiplying y_n alternatively with w_1 and w_2 Below f is the original flow matrix, F is the newly disaggregated flow matrix, and Y is the newly disaggregated final demand matrix.

Table 10.6. The new disaggregated flow and final demand matrices

	Ind. 1	Ind. 2			Industry n Remain	Industry n split			Ind. m		
	f_{11}	f_{12}	.	.	$f_{1n}\,w_1$	$f_{1n}\,w_2$	.	.	f_{1m}		y_1
	f_{21}	f_{22}	.	.	$f_{2n}\,w_1$	$f_{2n}\,w_2$	.	.	f_{2m}		y_2
	.	.	.	.			.	.	.		.
	.	.	.	.			.	.	.		.
	$w_1\,f_{n1}$	$w_1\,f_{n2}$	.	.	$w_1\,f_{nn}\,w_1$	$w_1\,f_{nn}\,w_2$	.	.	$w_1\,f_{nm}$		$w_1\,y_n$
F =	$w_2\,f_{n1}$	$w_2\,f_{n2}$	.	.	$w_2\,f_{nn}\,w_1$	$w_2\,f_{nn}\,w_2$	.	.	$w_2\,f_{nm}$	Y =	$w_2\,y_n$
	.	.	.	.			.	.	.		.
	.	.	.	.			.	.	.		.
	$f_{m,1}$	$f_{m,2}$	.	.	$f_{m,n}\,w_1$	$f_{m,n}\,w_2$	.	.	$f_{m,m}$		y_m

10.27. In a more concise mathematical term, F can be written as:

$$F = SfS'$$

where S is a disaggregation matrix and S' is the transpose of S. The disaggregation matrix S, which is similar to an aggregation matrix that will be discussed later, is formed in terms of a (m+1)xm matrix in which the two rows of the new matrix F corresponding to the new n^{th} and $(n+1)^{th}$ rows of matrix F have respectively the values w_1 and w_2 on its n^{th} column, the column which needs to be split. Other rows of S are assigned values as follows: the first row has 1 at the first column and zero elsewhere, the second row has 1 at the second column and zero elsewhere, etc.. The S matrix corresponding to F is shown in table 10.7.

Table 10.7. The disaggregation matrix

$$
S = \begin{array}{c|cccccccc|}
 & \text{Ind. 1} & \text{Ind. 2} & & & \text{Industry n} & & & \text{Ind. m} \\
\hline
 & 1 & 0 & . & . & 0 & . & . & 0 \\
 & 0 & 1 & . & . & 0 & . & . & 0 \\
 & . & . & . & . & . & . & . & . \\
 & . & . & . & . & . & . & . & . \\
\text{The 2 new} & 0 & 0 & . & . & w_1 & . & . & 0 \\
\text{split up rows} & 0 & 0 & . & . & w_2 & . & . & 0 \\
 & . & . & . & . & . & . & . & . \\
 & . & . & . & . & . & . & . & . \\
 & 0 & 0 & . & . & 0 & . & . & 1 \\
\hline
\end{array}
$$

10.28. The newly diseggregated output is as follows:

$$X = (x_1,\ x_2,\ \ldots,\ w_1 x_n,\ \ w_2 x_n,\ \ \ldots,\ x_m)$$

10.29. If the newly disaggregated coefficient matrix that is derived from the original matrix f is called A, then A can be derived either by dividing each column of matrix F in table 10.6 by its corresponding industry output or directly by using the following form:

Table 10.8. The new disaggregated coefficient matrix

$$
A = \left[\begin{array}{cccccccccc}
a_{11} & a_{12} & . & . & a_{1n} & a_{1n} & . & . & a_{1m} \\
a_{21} & a_{22} & . & . & a_{2n} & a_{2n} & . & . & a_{2m} \\
. & . & . & . & . & . & . & . & . \\
. & . & . & . & . & . & . & . & . \\
w_1 a_{n1} & w_1 a_{n2} & . & . & w_1 a_{nn} & w_1 a_{nn} & . & . & w_1 a_{nm} \\
w_2 a_{n1} & w_2 a_{n2} & . & . & w_2 a_{nn} & w_2 a_{nn} & . & . & w_2 a_{nm} \\
. & . & . & . & . & . & . & . & . \\
. & . & . & . & . & . & . & . & . \\
a_{m,1} & a_{m,2} & . & . & a_{m,n} & a_{m,n} & . & . & a_{m,m}
\end{array}\right]
$$

10.30. The following example of a matrix f will be used to show how disaggregation is carried out:

$$(10.1)\quad f = \begin{bmatrix} 10 & 15 & 30 & 45 \\ 20 & 9 & 7.5 & 163.5 \\ 30 & 50 & 22.5 & 47.5 \\ 40 & 126 & 90 & 0 \end{bmatrix}$$

The last row of matrix f is the row of value added. The original vector of industry output and the original vector of final demand are as follows

x = (100, 200, 150)
y = (45, 163.5, 47.5)

The coefficient matrix a has the following value:

$$(10.2)\quad a = \begin{bmatrix} 0.10 & 0.075 & 0.200 \\ 0.20 & 0.045 & 0.050 \\ 0.30 & 0.250 & 0.150 \end{bmatrix}$$

10.31. Now we separate:

- Industry 1 in matrices f and a into industries 1 and 2 in the new matrix F and A and
- Industry 2 in matrices f and a into industries 3 and 4 in the new matrices F and A, assuming that output shares are the same for the two cases with $w_1 = 0.9$ and $w_2 = 0.1$.

10.32. The disaggregation matrix S for the case mentioned above can be written as follows:

$$(10.3)\quad S = \begin{bmatrix} 0.9 & 0 & 0 & 0 \\ 0.1 & 0 & 0 & 0 \\ 0 & 0.9 & 0 & 0 \\ 0 & 0.1 & 0 & 0 \\ 0 & 0 & 0.1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

10.33. In the S matrix with the order of 6 x 4, which is the matrix to disaggregate the rows of matrix f, we see that the first two rows aim at splitting the first row of matrix f, the next two rows aim at splitting the second row of matrix f, with the respective weights of 0.9 and 0.1. The last two rows of matrix S correspond to the rows of the third industry and value added in matrix f and the last two columns correspond respectively to the third industry and final demand in matrix f. The matrix S' with the order of 3 x 5, matrix S,' which is the matrix to disaggregate the columns, should have one column and one row less than the transpose of matrix S since there is no column corresponding to the row of value added in matrix f. In this example, S' is the transpose of S but with the last row and the last column eliminated .

$$(10.4)\quad S' = \begin{bmatrix} 0.9 & 0.1 & 0 & 0 & 0 \\ 0 & 0 & 0.9 & 0.1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

10.34. The final F and A are shown below:

$$(10.5)\quad F = \begin{bmatrix} 8.1 & 0.9 & 12.15 & 1.35 & 27 \\ 0.9 & 0.1 & 1.35 & 0.15 & 3 \\ 16.2 & 1.8 & 7.29 & 0.81 & 6.75 \\ 1.8 & 0.2 & 0.81 & 0.09 & 0.75 \\ 27 & 3 & 45 & 5 & 22.5 \\ 36 & 4 & 113.4 & 12.6 & 90 \end{bmatrix}$$

The final F matrix also includes value added in the last row.

$$(10.6)\quad A = \begin{bmatrix} .09 & .09 & .0675 & .0675 & .180 \\ .01 & .01 & .0075 & .0075 & .020 \\ .18 & .18 & .0405 & .0405 & .045 \\ .02 & .02 & .0045 & .0045 & .005 \\ .30 & .30 & .2500 & .2500 & .150 \end{bmatrix}$$

Equivalent X and Y are as follows:

X = (90, 10, 180, 20, 150)
Y = (40.5, 4.5, 147.15, 16.35, 47.5)

10.35. In matrix A, the input structures of industries 1 and 2 must be the same. Similarly, those of industries 3 and 4 must also be the same. Assumption (b) can be checked by dividing row 3 by row 4 in the final matrix F.

2. Aggregation scheme

10.36. Suppose that industries 2 and 4 in the new matrices F and A are parts of the international tourist industry. The creation of the new industry would require the aggregation of the above industries in matrices F and A.

10.37. Call F and A the matrices to be aggregated and a and f the resulting aggregated matrices. In matrices F and A, industry 2 must be aggregated to industry 4 to form industry 3 in matrix a, with $w_2 = 0.207$ (=

4.5/(4.5+17.25) and $w_4 = 0.793$ (=17.25/(4.5+17.25)) which are output shares of the industries that are subject to aggregation. The aggregation scheme of the flow and coefficient matrices are discussed separately below.

Aggregation scheme of the flow matrix

10.38. Aggregating the flow matrix is quite simple: one needs to add the rows to be aggregated together and then the columns to be aggregated together or vice versa. Mathematically, the aggregation can be written neatly by using an aggregation matrix. Call G the aggregation matrix. Say F is a 6 x 5 matrix, the same as the matrix in equation 10.5, and assume that industries 2 and 4 are aggregated together and put into the new industry in the third position of the new matrix f, then the aggregation matrix G can be written as follows:

$$(10.7)\quad G = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

10.39. In matrix G, on the third row where the resulting new row is put, 1 is entered in the second and fourth positions. This means that rows 2 and 4 of the original matrix F are aggregated and then put into the third row of the new matrix f. Since rows 1, 3, 5 and 6 are not aggregated, 1 is entered in the first, third, fifth and six elements respectively of the first, second, fourth and sixth row of G. Row 2 is to be aggregated to row 4 and therefore does not have a corresponding row in the aggregation matrix. The transpose of G, G', is for aggregating the corresponding columns in a similar manner. The new matrix f can then be written as follows: f = GFG'[5].

10.40. The resulting flow and coefficient matrices, after aggregation, are shown in tables 10.9 and 10.10

[5]If we need to aggregated only rows together we can apply the formula f = GF. If we need to aggregate only columns together we can use the formula f = FG. Aggregation of rows or columns is useful in some economic analysis. For instance, if one wants to know the use of electricity in manufacturing industries, one has to aggregate all columns of manufacturing industries together.

Table 10.9. The new aggregated flow and final demand matrices

	Ind. 1	Ind. 3	Aggregated industry	Ind. 5		
	F_{11}	F_{13}	$F_{12} + F_{14}$	F_{15}		Y_1
	F_{31}	F_{33}	$F_{32} + F_{34}$	F_{35}		Y_3
f =	$F_{21} + F_{41}$	$F_{23} + F_{43}$	$(F_{22} + F_{24}) + (F_{42} + F_{44})$	$F_{25} + F_{35}$	y =	$Y_2 + Y_4$
	F_{51}	F_{53}	$F_{52} + F_{54}$	F_{55}		Y_5

Table 10.10. The newly aggregated coefficient matrix

	Ind. 1	Ind. 3	Aggregated industry	Ind. 5
	A_{11}	A_{13}	$w_1 A_{12} + w_2 A_{14}$	F_{15}
	A_{31}	A_{33}	$w_1 A_{32} + w_2 A_{34}$	F_{35}
a =	$A_{21} + A_{41}$	$A_{23} + A_{43}$	$w_1 (F_{22} + F_{24}) + w_2 (F_{42} + F_{44})$	$F_{25} + F_{35}$
	A_{51}	A_{53}	$w_1 F_{52} + w_2 F_{54}$	F_{55}

where the new vector of industry outputs is as follows:

$$x = (X_1,\ X_3,\ X_2 + X_4,\ X_5)$$

10.41. In general, when industries n and n+1 are aggregated, the following formula can be used to calculate the new coefficients:

$$a_{ij} = A_{ij} \text{ for } i, j \neq n$$

$$a_{nj} = A_{nj} + A_{n+1,j} \text{ for } j \neq n$$

$$a_{in} = w_1 A_{in} + w_2 A_{i,n+1} \text{ for } i \neq n$$

$$a_{nn} = w_1(A_{nn} + A_{n+1,n}) + w_2 (A_{n,n+1}, +A_{n+1,n+1})$$

10.42. Looking at column 3 of table 10.10 or the formulas above, one can see that the newly aggregated industry has a new output which is equal to $X_2 + X_4$, with the shares of output equal respectively to w_2 and $w4_2$. The new coefficients are, as a result, the weighted average of the coefficients in columns 2 and 4 of the original matrix A.

10.43. Applying the formulas in table 10.9 to the example matrix of 10.5 (para. 10.34), one can derive the new matrix f with the third industry as the newly aggregated industry which is composed of industries 2 and 4 of the original matrix F in 10.1 (para. 10.30) as follows:

$$(10.8)\quad f = \begin{bmatrix} 8.1 & 12.15 & 2.25 & 27 \\ 16.2 & 7.29 & 2.61 & 6.75 \\ 2.7 & 2.16 & 0.54 & 3.75 \\ 27 & 45 & 8 & 22.5 \\ 36 & 113.4 & 16.6 & 90 \end{bmatrix}$$

10.44. The last row of matrix f is the row of value added. The new matrix a corresponding to the f matrix above is:

$$(10.9)\quad a = \begin{bmatrix} 0.09 & 0.0675 & 0.180 & 0.075 \\ 0.18 & 0.0405 & 0.045 & 0.087 \\ 0.30 & 0.2500 & 0.150 & 0.267 \\ 0.03 & 0.0120 & 0.025 & 0.018 \end{bmatrix}$$

10.45. From matrix f in 10.8, one can observe in column 3 the inputs used for the production of the newly aggregated industry and in row 3 the uses of the output of the new industry by other industries; 16.6 is the contribution to value added or GDP by the new industry. The latter figure can easily be obtained without going through the procedures of disaggregation and aggregation shown above, but the former figures can only be obtained by using input-output analysis.

XI. INPUT-OUTPUT TABLES AND PRODUCTION ACCOUNTS IN CONSTANT PRICES

A. Introduction

11.1. This chapter should be read as a continuation of chapter II. It discusses first the double deflation method and the procedures for applying the method for the benchmark years when full information is available and then on the basis of the relationships in the benchmark year and of incomplete annual information, it discusses the application of the method to estimate annual quantity and price indices in an integrated manner.

B. Double deflation method for benchmark years

1. Definition

11.2. Before discussing the double deflation method, it is necessary to review the definition of GDP:

GDP = value added at basic prices + taxes minus subsidies on products

Value added at basic prices is defined in turn as:

Value added at basic prices = industry output at basic prices - intermediate consumption at purchasers' prices

11.3. The double deflation method is aimed at deriving real GDP implicitly by deflating current industry output, intermediate consumption and taxes minus subsidies on products. Though the double deflation method may be applied as a short cut for each industry, it can only be consistently and systematically applied within the context of the full SNA supply and use framework (SUT). By using the full SUT framework, it is possible to derive implicit price indices for all aggregates in it such as: GDP, exports, imports, household final expenditure, government final expenditure, gross capital formation (which may be disaggregated by industries and/or by institutional sectors).

2. Procedures

11.4. The double deflation method when applied in the most comprehensive manner requires:

Table 11.1. The use table at basic prices

		Industries Intermediate consumption			Exports f.o.b.	Household final expenditure	Government final expenditure	Gross capital formation	Total product uses	Deflator
		Goods	Market services	Other non-market services						
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Domestic products	Goods	UB11	UB12	UB13	EB1	HCB1		KB1	UB1=(1+.+7)	Basic price indices
	Market services	UB21	UB22	UB23	EB2	HCB2		KB2	UB2=(1+.+7)	
	Other non-market services					HCB3	GC		UB3=(1+.+7)	
Imported products	Goods	M11	M12	M13		MHC1		MK1	M1=(1+.+7)	Import price indices
	Market services	M21	M22	M33		MHC2		MK2	M2=(1+.+7)	
	Other non-market services									
Trade and transport margins	Goods	TM11	TM12	TM13	TME1	TMHC1		TMK1	TM1=(1+.+7)	Base year trade margin
Taxes on products	Goods	TX11	TX12	TX13	TXE1	TXHC1		TXK1	TX1=(1+.+7)	Base year tax rates
	Market services	TX21	TX22	TX23	TXE2	TXHC2		TXK2	TX2=(1+.+7)	
	Other non-market services					TXHC3			TX3=(1+.+7)	
Gross value added at basic prices		V1	V2	V3						
Compensation of employees		W1	W2	W3						
Other taxes less subsidies on production		OTC1	OTC2	OT3						
Consumption of fixed capital		CC1	CC2	CC3						
Operating surplus/Mixed incomes		OS1	OS2							
Total industry output at basic prices		I1	I2	I3						
Other column total					E	HC	GC	K	U	
Price indices based on cost				P3						

- The supply and use tables of the benchmark or base year;
- The current supply and use tables at current prices;
- Basic price indices for all commodities;
- Import price indices;
- Changes in wage rates.

11.5. The procedures for applying the double deflation method can best be demonstrated using table 2.1 of chapter II and table 11.1[1], both compiled with detailed transactions measured at basic prices. (There is an alternative way of applying the double deflation method that does not require the conversion of the full system to basic prices. It is discussed in para. 11.45.) There are two reasons for converting the system into basic prices, namely:

- Price indices are more consistent when the price survey is carried out for basic prices, which are not affected by changes in trade margins and in tax rates. Basic prices in many countries are more popularly named "producers' prices" or "wholesale prices" which are the first prices offered in the process of transactions, excluding taxes on products;

- Provided there are differential changes in trade margins, import prices or taxes rates, the separation of intermediate consumption at purchasers' prices into domestic components at basic prices, imported components c.i.f., trade margins and taxes minus subsidies on products would allow the uses of different price indices with different components and thus the value added at constant prices would be more accurately derived.

(a) Preparation of the use table in basic prices

11.6. Table 11.1, the use table at basic prices is derived by splitting every transaction flow of commodities at purchasers' prices, for example U11 in table 2.2 of chapter II into four separate components: the domestic component at basic prices (i.e. UB11), the imported component c.i.f. (i.e. M11), the component of trade margins[2] (i.e. TM11) and the component of taxes on products (i.e. TX11). For example:

$$U11 = UB11 + M11 + TM11 + TX11$$

Thus along each row of table 11.1, the total uses at basic prices of every domestic product (i.e. UB1) must equal the total domestic production of the product (i.e. X1 = X11+X12+X13, see table 2.1).

Application of proportionality for trade margins

11.7. Normally the ratios of wholesale trade margin, retail trade margin and taxes on products for each commodity use are not available. The common procedure used in deriving these ratios is to assume that they are the same for each kind of use of the commodity whether it is domestic or imported goods and/or services. Thus, the ratio of trade margins for goods 1 is equal to TM1/SP1; the ratio of taxes on product 1 is equal to TX1/SP1 with all information available in the supply table 2.1 of chapter II. With the above assumption, it is

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[1]The presentation here benefits from Bent Thage's *Commodity Flow Systems and Construction of Input-Output Tables in Denmark*, Danmarks Statistik, 1986.

[2]Trade margins may be broken down separately into wholesale and retail trade margins but for simplicity of presentation, they are shown aggregated in this chapter.

possible to derive for example:

TM11/U11 = TM12/U12 = TM13/U13 = TMHC1/HC1 = TMK1/K1 = TM1/SP1 and
TX11/U11 = TX12/U12 = TX13/U13 = TXHC1/HC1 = TXK1/K1 = TX1/SP1

11.8. The census or survey of distributive trades and services provides the wholesale and retail trade ratios. The ratios when available and applied for a detailed list of commodities would enhance the accuracy of the method. Thus, it should be applied at the most detailed level of commodities available. In some countries such as Denmark and Norway the method is applied at the level of over 1,000 commodities. Obviously, when the use and supply tables are aggregated to a smaller number of commodity groups, the ratios of trade margins will vary by user due to the variation of detailed commodities used in each grouping. The application of the proportionality assumption at a more aggregated level will lose a lot of information available.

Splitting uses into domestic and import shares

11.9. The splitting of uses into domestic and imported goods is important for the purpose of deflation since prices of domestic goods and imports may change differently, and thus would affect the real value of value added differently, particularly at the industry level. The splitting of uses which are already known into domestic and imported goods requires estimating imports for each element of uses in the use table. Since the total import of each commodity is known, splitting is simply the problem of allocating this total to its users. The allocation of an imported commodity may be based on available surveyed information, expert knowledge and the proportionality assumption:

- Surveyed information of import shares (ratios). Census of manufacturing industries, if asked, may provide import shares of products used as inputs by every industry. This information must be analysed together with information provided by expert knowledge. The share of a product being imported into a particular industry should not be assumed to be the same across industries. This means that the share of a product which is imported and used by a different industry or by final demand is different.

- Expert knowledge. The use of surveyed information is not enough to fill up the import matrix in table 11.1, expert knowledge is also needed. The use of information from import statistics at the very detailed classification level will help identify whether an imported commodity is complementary and fully imported. For example, natural rubber which is not produced in Europe or the United States must be fully imported. It is also possible to know by expert knowledge whether the imported commodity is used for final or intermediate consumption or for capital formation. For example, imported machinery certainly will be allocated to gross capital formation and imported motorcycles could be allocated to final household expenditures. Also at the detailed level it is possible to guess in what industries the imported products are used.

- Proportionality assumption. After having fully utilized the available information as discussed above, the residual of the import of a commodity can be proportionally allocated. One may allocate the residual to all appropriate users (namely to the elements of the row in the use table corresponding to that commodity) if the residual is large and if one is uncertain about the consumption of the import by the users that have not received any allocation. One may also decide that some flows need no additional allocation if one is sure about their consumption of the imported commodity. The criterion for allocation is the share of use of a particular user within the group to be distributed. For example, in table 2.2 of chapter II, if the imports of goods are all distributed proportionally to all users, then U11/U1, U12/U1, ..., HC1/U1 and K1/U1 will be used as shares respectively for the goods industry, the market services industry,..., household final expenditures and gross capital formation. Even without surveyed information and expert knowledge, the proportionality assumption is more useful if it is applied at the detailed level of commodity classification instead of at the more aggregate level. Applying the proportionality assumption at the detailed level will provide a different import ratio for each element in the use table when commodities in the use table are aggregated.

(b) Deflation by types of products

11.10. The deflation procedure that is applied to the SUT framework varies by type of products. For the purpose of demonstration, products are classified into three groups: goods, market services and other non-market services.

11.11. Goods and market services are normally treated similarly since information on their unit price is normally obtainable, except of course for some market services for which it is not easy or even possible to determine their quantities and thus their unit prices. Prices of other non-market services are not available because other non-market services are by definition not for sale. In table 11.1, it is easily recognized that only goods have trade margins and that other non-market services are assumed to be not subject to product taxes.

11.12. The basic deflation procedure is as follows:

First, deflate goods and market services in the supply table at basic prices (table 2.1 of chapter II) in order to derive industry output at constant prices and implicit industry output price indices;

Second, calculate the price indices for other non-market services based on production cost using the use table at basic prices (table 11.1);

Third, deflate intermediate consumption and final uses in the use table using basic price indices, import price indices and the price indices for non-market services calculated in step two;

Fourth, deflate gross value added at basic prices residually by taking the difference between industry output in constant prices and intermediate consumption in constant prices;

Fifth, deflate taxes on products by multiplying total product supply at basic prices (table 2.1 of chapter II) with the base year tax rates, applying different rates to imports and domestic goods;

Sixth, obtain GDP at constant market prices as the sum of real gross value added at basic prices and real taxes on products. (GDP at constant prices can also be obtained by summing components of final demand in constant prices.)

Below is further discussion of how goods, market services, other non-market services and taxes on products, value added at basic prices and other components of value added are deflated in the above procedure.

Deflation of goods

11.13. Domestically produced goods should first be deflated by basic price indices in the supply table across every row from column 1-3. The result of the deflation is the implicit price indices of industry outputs at constant prices and the implicit indices of industry outputs.

11.14. The application of basic price indices is also carried out for all the uses of products in use table 11.1. Here, obviously it is assumed that price affects all users similarly in terms of production costs and the differential effects on users come from changes in trade margins and taxes on products.

Deflation of goods sold at different prices to different users

11.15. For some products such as energy products which include electricity, gas, gasolines which are produced and/or supplied by the public sector but sold at different prices to different users even when there are no trade margins involved, the application of the same price index in the use table for all users is not logical. Different price indices to different users should be applied, but then it would not be possible to get the same implicit price index for the supply table and the use table. This is the well-known shift-share problem in price deflation. The problem created is that output quantity produced may decline while output uses at constant prices may increase and vice versa. The example in table 11.2 will make this problem clearer. Say electricity rates for the household sector are different from those set for to other sectors while their respective shares of quantity used changed.

11.16. In the example in table 11.2, prices set for households increased 10% from the base year to the current year while prices set for other sectors remained unchanged. Because of the price increase, households consumed less and with electricity cheaper and an increasing scale of production other sectors consumed more. One can see in the indices that there is no change in quantity index but there is a reduction in volume index. In fact, with a shift in shares it is quite possible to have an increase in quantity index and a reduction in volume index and vice versa. The above example reflects the situation in many countries where different users of energy are charged different prices.

Table 11.2. Shift share problem in price and quantity indices

	Household	Other sectors	Total
Base year			
Quantity	20	10	30
Unit price	6	5	
Value	120	50	170
Current year			
Quantity	15	15	30
Unit price	6.6	5	
Value	99.00	75.00	174.00
Value at constant prices, quantity and volume indices			
Value	90	75	165
Quantity index base year = 100	75.00	150.00	100.00
Volume index base year = 100	75.00	150.00	97.06

11.17. In this situation, the price index applied in the supply table is the one reflecting the cost of production and the price indices applied to the use table are users' price indices. In some countries, the implicit price indices derived from the use table are applied to the supply table to "harmonize" the two tables, but in this case volume indices in the use or supply tables would not reflect real quantity indices.

Deflation of imported commodities

11.18. Imported commodities used for intermediate and final consumption shown in table 11.1 are deflated, commodity by commodity, by import price indices.

Deflation of market services

11.19 Market services are produced for sale, therefore it seems natural that there exist quantities of services sold and their unit prices. In practice, it is not easy to define quantities of services and to collect statistics on their unit prices. There are normally three alternative methods that statisticians use in dealing with the problem. The first alternative is to use some proxies for unit price indices. For example, many service outputs are simply deflated by general consumer price index or by special price indices among consumer price indices that seem appropriate to the service outputs to be deflated. The second alternative is to construct price indices for the services on the basis of their costs of production. The approach is similar to that used to deflate other non-market services that will be discussed later. When price indices are constructed from the costs of production, the operating surplus is ignored, which means that it will be deflated by the constructed price index itself when output is so deflated. The third alternative is to derive quantity indices first and extrapolate base year values by these quantity indices. For example, the number of patients may be used as proxy for the quantitative index of hospital output. By the last method, price indices are derived implicitly given output at current and base year prices. It is not possible to describe in detail, product by product, how volume of a service is approximated or how current values are deflated in this chapter, therefore only some general common practices are described below.

Deflation of trade margins

11.20. Trade margins, which normally are separated into wholesale and retail trade margins, are the output of the trade industries. There should be quantity and price indices developed. But this is almost impossible. Changes in the ratios of trade margins over purchases are assumed to measure changes in price indices of trade margins even though changes in the ratios may also include changes in technology. In order to derive trade margins in constant prices, the ratios of trade margins of the base year are applied to the uses of goods at basic prices shown in table 11.1. It is important to note that the ratios used here are the ratios at basic prices which are calculated from table 11.1 of the base year, i.e they are equal to TM1/UB1 (UB1 is the total commodity uses of goods at basic prices) . These ratios are different from the those that are used to calculate trade margins at current prices, TM1/SP1 shown in the supply table 2.1 of chapter II.

Deflation of other market services

11.21. Other market services may be deflated by one of the methods described in paragraph 11.19. The practice among countries can be as diverse as one could imagine since no international standards have been developed in this area.

11.22. For financial intermediary services, some countries deflate imputed charges by obtaining details on various kinds of loans and deposits and their respective interest rates and deflate interest received and paid by changing their respective interest rates. Volume of explicit interest charges is normally extrapolated from the base year by a volume index of transactions. Other countries compute volume index by the sum of credits and debits of financial institutions deflated by the price indices of their final uses.

11.23. For passenger transport, price indices of transport fees are normally used to deflate outputs at current prices. For goods transport, volume indices based on ton-kilometres are normally used to extrapolate real outputs from the base year and implicit price indices are obtained as a result.

11.24. Hotel and lodging room rates can be used to deflate the output of hotel and lodging services by type of hotel and lodging.

11.25. The output of restaurants and the like may be deflated by input price indices or consumer price indices.

11.26. For life and casualty insurance, it is not easy to deflate their outputs by deflating the components that are used to calculate them. They are either deflated by general consumer price index or special indices according to kind of benefits.

11.27. Business services such as accounting, legal services, data-processing, engineering and architectural services, advertising services, machinery and equipment rental and leasing services, etc. are commonly deflated by input prices and wage rates. Volume indices are created in some countries to measure real outputs of legal services. Volume indices are based on the number of court cases and proceedings, property transfers and mortgage advances. Some legal services may be deflated by hourly rate index for lawyers.

11.28. Rents are deflated by rent indices. Owner-occupied housing services may be deflated either by rent index or by costs depending on how outputs of the services are estimated.

11.29. Deflators of education services and health services that serve specific individuals may be derived implicitly by first extrapolating real outputs from the base year by volume indices respectively by the number of students or patients. General education and general health services that serve the community at large may be deflated by general consumer price index. But generally, most countries calculate volume indices using employment based on persons engaged or hours worked in these areas.

Deflation of other non-market services

11.30. Non-market services are deflated by price indices that are constructed from production costs with operating surplus assumed to be zero. The cost structures of the use table in basic prices should be used for this purpose. As can be seen from column 3 of table 11.1, the price index for this column is the weighted price index of all the elements in the column including components of gross value added at basic prices.

11.31. In constructing a price index, compensation of employees can be deflated by changes in wage rates, other taxes on production can be similarly deflated as taxes on product and consumption of fixed capital is obtained automatically when the perpetual inventory method is applied. If the perpetual inventory method is not used, the same ratios used in the base year should be used to calculate consumption of fixed capital in real terms.

Deflation of taxes on products

11.32. Tax deflators can be approximated by multiplying the change in tax rate and the price change of the product taxed if taxes on products like VAT are levied as percentages of the value. A better way to achieve the same thing is to equalize the volume index of the tax and of the product taxed. The method is shown in table 11.3 below.

Table 11.3. Calculation of tax at constant prices

	t	t+1	Index (previous year = 100)
Quantity	100	200	200
Price	3	4.5	150
Value	300	900	
Tax rate	3%	3.6%	120
Tax collected	9	32.4	
Tax deflator = Change in tax rate x change in price			180
Tax collected in constant price = 32.4/1.8			18
or = volume index of product x tax collected at base year = 2 x 9			18

11.33. This approach however is elaborate and very time consuming. A short-cut method can be used instead, i.e. taxes on products in real terms are calculated by applying the average tax rates TX/SB of the base year (shown in the supply table 2.1 of chapter II) to both flows of domestic and imported goods and services at basic prices (shown in the use table 11.1). Taxes on products should be separated into: import duties which are applied only to imports, and other taxes on products which are applied to both domestic products and imports. In the revised SNA, taxes on products either imposed directly on producers before sales or on sales are collected and reorganized by commodities as shown in table 2.1 of chapter II. Subsidies are similarly treated.

Deflation of other components of value added

11.34. Compensation of employees can be deflated by wage rates. Consumption of fixed capital as said above can be deflated in the process of calculating gross and net capital stocks by the perpetual inventory method. Operating surplus similar to value added can only be deflated residually, that is:

- Value added at constant price = industry output at constant price minus intermediate consumption at constant prices;

- Operating surplus at constant price = value added at constant prices minus other components of value added at constant prices.

(c) Choice of index number formulas

11.35. The two commonly used types of indices are the Laspeyres and the Paasche indices. They are fixed weighted. The Laspeyres indices are based on the weights of the base year while the Paasche indices are based on the weights of the current year. The formulas are shown below:

Volume indices

Laspeyres volume index

$$\frac{\sum p_0 q_0 \frac{q_t}{q_0}}{\sum p_0 q_0} = \frac{\sum p_0 q_t}{\sum p_0 q_0}$$

$$Fisher\ volume\ index = \sqrt{Laspeyres * Paasche}$$

Paasche volume index

$$\frac{\sum p_t q_t}{\sum p_t q_t \frac{q_0}{q_t}} = \frac{\sum p_t q_t}{\sum p_t q_0}$$

Price indices

Laspeyres price index

$$\frac{\sum p_0 q_0 \frac{p_t}{p_0}}{\sum p_0 q_0} = \frac{\sum p_1 q_0}{\sum p_0 q_0}$$

Paasche price index

$$\frac{\sum p_t q_t}{\sum p_t q_t \frac{p_0}{p_t}} = \frac{\sum p_t q_t}{\sum p_0 q_t}$$

$$Fisher\ price\ index = \sqrt{Laspeyres * Paasche}$$

11.36. "In general, a Laspeyres index tends to register a larger increase over time than a Paasche index."[3] "The Laspeyres index provides an upper bound to the theoretic index [and] the Paasche index can be shown to provide a lower bound to the theoretic index"[4] (see columns 2 and 5 in table 11.4). This means that, over

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[3] *System of National Accounts 1993.*, para. 16.20.

[4] *Ibid.*, para. 16.22.

time, a Laspeyres tends to produce a higher rate of growth in the GDP. The Fisher index is preferable since it has been proved that "if the utility function can be represented by a homogeneous quadratic function (which is homothetic) Fisher's Ideal Index is equal to the underlying theoretic index.[5]

Table 11.4. Volume growth rate (t/t-1) of GDP of the Netherlands[6]

Growth rates	Laspeyres (weights of 1986)	Laspeyres (chain index)	Fisher (chain index)	Paasche (chain index)	Paasche (weights of 1986)
1987	1.4	1.4	1.4	1.4	1.4
1988	3.4	2.6	2.6	2.6	2.7
1989	4.8	4.7	4.6	4.4	4.6
1990	4.2	4.1	4.0	3.9	3.5
1991	2.3	2.3	2.2	2.2	2.0
1992	2.0	2.0	2.0	2.0	2.0
1993	1.3	0.8	0.8	0.8	0.7

11.37. However, the Fisher index has some drawbacks:

- "[It is] demanding in its data requirements as both Laspeyres and the Paasches indices have to be calculated, thereby not only increasing costs but also possibly leading to delays in calculation and publication;
- "[It] is not so easy to understand as Laspeyres or Paasche indices which can be interpreted simply as measuring the change in the value of a specified basket of goods and services;
- "The particular preference function for which Fisher provides the exact measure of the underlying theoretic index is only a special case;
- "The Fisher index is not additively consistent."[7]

11.38. The weighted Laspeyres volume index is based on the prices of a fixed base period and thus tends to become progressively less relevant to the economic situations of the later periods to the point that it becomes unacceptable, i.e. the rate of growth is overestimated. It may be necessary to update the base period and then to link the old series to the series of the new base period. When weights are changed every year, the index is called chained index. Time series results connecting year t to year 0 can be obtained by multiplying separately estimated year-to-year volume indices:

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[5]*Ibid.*, para. 16.23.

[6]Sake de Boer, Jan van Dalen and Piet Verbiest, "*The Use of Chain Indexes in the Netherlands*", Department of National Accounts, Statistics Netherlands, 1997.

[7]System of National Accounts, para. 16.25.

$$L_q = \frac{\sum p_0 q_1}{\sum p_0 q_0} x \frac{\sum p_1 q_2}{\sum p_1 q_1} x \ldots x \frac{\sum p_{n-1} q_n}{\sum p_{n-1} q_{n-1}}$$

Hence the name "chain indices." The overestimation of growth rates is averted. The chain volume Laspeyres index can serve as an alternative to the Fisher index. The SNA says, "The chain Laspeyres index should provide a very close approximation to the chain Fisher in situations in which it is too difficult or time consuming to calculate the Fisher."[8] A chain index suffers from the lack of additive consistency, i.e. the deflated total is not the sum of the deflated components or the sum of the share is not equal to unity.

11.39. The Paasche price index is recommended for use together with the Laspeyres volume index to satisfy the factor reversal test under which the product of the volume index and the price index must be equal to the ratio of values in current prices.

3. Some important remarks

11.40. The comprehensive double deflation method described above requires full information on industry and commodity outputs, intermediate consumption by industries, imports, exports, taxes on products and price indices by detailed commodities. Uses of commodities have to be broken down into values at basic prices, trade margins and taxes on products with values at basic prices broken down further into domestic and imported components. If the list of commodities is 500, then all fields of statistics from censuses of production to foreign trade, surveys of consumer expenditures, government expenditures, and gross capital formation must be broken down into 500 commodities. The number of activities or industries, however, need not be that detailed. Many countries classify activities in no more than 100 industries. Normally, the number of commodities is much higher than the number of industries. The information required normally is available only for benchmark years and therefore the method cannot be easily applied annually. In countries where it is it normally takes three years past the year with changes in real terms. Thus there is a need for a quicker method, to provide provisional annual estimates. This will be discussed in part C below. Final annual estimates will be prepared when more complete information is available.

11.41. A study of the Austrian table showed that[9]:

(i) A highly aggregated table would significantly affect bias in constant price values. Deflating 54 products instead of 1,000 domestically produced products and 3,500 imported products would let estimates of value added at constant prices deviate from the reference solutions (based on detailed information) by over 10% in 15 cases out of 54 and over 20% in 8 cases;

(ii) A separate deflation of domestically produced and imported products would somewhat reduce the overestimation or underestimation of value added at constant prices made by deflation without separation of domestically produced and imported products.

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[8] *Ibid.*, para. 16.67.

[9] Josef Richter, "The Role of Import-Matrices in Compiling Constant Price Input-Output Tables" in *Problems of Compilation of Input-Output Tables,* edited by Afred Franz and Norbert Rainer, Orac, Vienna, 1986.

This confirms the advantages of deflating at the detailed commodity level and of separation of domestically produced products from imported products.

11.42. In addition, the method shows that the implicit price index for household final expenditures may not be the same as the consumer price indices (CPI) that are compiled independently. The differences are due to three factors:

- Basic price indices, not the CPI, are used to calculate the implicit price index for household final expenditures;

- Some components of expenditures are covered by the SNA household final expenditures but not by the CPI, namely owner-occupied housing, production for own final consumption, financial intermediary service charges;

- Normal statistical errors.

But the CPI provides information to check the implicit price indices of household final consumption expenditures at purchasers' prices at both the aggregate and detailed commodity level. For the commodity level, implicit indices that combine price indices of goods and services, trade and transport margins, and product taxes consumed must be used.

11.43. The SNA implicit price index should reflect more accurately cost increases in the household sector. The information provided by the SNA and CPI is useful for policy analysis.

11.44. Similarly to the CPI, there might also be deviations of price indices calculated within the SNA framework from those used elsewhere. For instance, price indices for imports and exports in the SNA are also more comprehensive since they cover both goods and services, including both expenditures by residents abroad and expenditures of non-residents at home. Checking and adjusting implicit price indices for exports f.o.b., and prices against unit price based on data of external trade statistics should also be done.

4. Alternative procedures

11.45. Some countries apply the double deflation method with a different procedure. The deflation process is applied directly to intermediate consumption and final demand in purchasers' prices in table 2.2 of chapter II, without separating imports from domestically produced products and without separating trade and transport margins as well as taxes from basic values. Appropriate indices of purchasers' prices are then used for deflation, which may include indices of import prices, export prices, consumer prices, prices of investment goods, etc. This method is simpler since it does not require assumptions for separation. However, it may generate biased estimates especially when imports are not separated from domestically produced goods as noted in paragraph 11.40. The alternative procedures may be applied to calculate industry value added and GDP at constant prices, but to calculate the I/O table at constant prices, it is necessary that assumptions be used to create margins and to separate imports from domestically produced products. Nevertheless, more research is still needed to study appropriate procedures to apply the double deflation method.

C. Double deflation method for annual national accounts

11.46. For annual derivation of GDP, gross value added by industries and components of final demand in constant prices, the above elaborate procedure cannot be applied because, normally, the following information is not available:

- Intermediate consumption by kind of commodities (at best the information available is total intermediate consumption over output for the corporate sector collected by annual surveys in many countries);

- Household final expenditures (at best only information on retail trade is available by survey which can be used to estimate household final consumption).

11.47. The information that is normally available in current prices includes:

- Gross output by industries;
- Imports by commodities;
- Exports by commodities;
- Gross capital formation by institutional sectors;
- Government final consumption expenditures.

It is necessary to estimate the supply and use tables in current prices on the basis of the above information and the supply and use tables of the benchmark year before one can proceed with the deflation process as discussed above. The benchmark year can also be the preceding year, when annual SUT tables are established on a firm basis.

1. Estimation of main aggregates in current prices

11.48. The value added coefficients of the base year are needed to estimate current value added by industries. In addition, gross value added at current prices from the corporate sector, the general government sector and non-profit sectors may be estimated independently by taking the sum of compensation of employees, taxes on production, consumption of fixed capital and profits plus dividends and interests paid out minus dividends and interests received, which is operating surplus. The latter estimates may be used to adjust the estimates previously obtained by using the base year value-added coefficients for the corporate sector. With all the total aggregates available, the next step is to break down final demand aggregates into commodity components. Here, it is necessary to use both available information and the coefficients available in the base year. The RAS method which tries to estimate the components of an aggregate given the value of the aggregate, the shares of the components in the base year and possibly values of some components can also be used here. The RAS method was fully described in chapter IX.

2. Estimation of the supply table in current prices

11.49. The estimation of the supply table in current prices is in fact that of the total value of each commodity in current prices produced in the year. The application of the product-mix assumption to industry outputs will produce these estimates. This means that for the goods industry for instance the ratios X11/I1 are multiplied to goods industry output to estimate every commodity produced by the goods industry.

3. Estimation of the intermediate consumption in current prices

11.50. The estimation of the matrix of intermediate consumption at current prices for table 11.1 is implemented by the RAS method given value added by industries and final demand and commodity outputs obtained from the supply table in current prices in step 2.

4. Estimation of the use table in constant prices

11.51. The estimation of the use table in constant prices proceeds as described in section B.

5. Deflation process

11.52. With the supply and use table available in current prices, one is able to proceed with the deflation process as described in section B.

6. Special problem in the annual method

11.53. The comprehensive benchmark method and the annual method focus on estimating value added by industries and components of final demand in current prices before deriving these values in constant prices. Normally, annual surveys on various areas of statistics which national accountants have to rely on to get good estimates come late, always after the end of the year. But there is always a need to have estimates *by* the end of the year. To respond to this need, national accountants have to use monthly and quarterly statistics and rely on the relationships of the last quarter to the previous three of the previous year to blow up the values of the three quarters to the full year.

11.54. In many cases, they have to rely on quantity indices of production for some industries. The procedure of estimating gross outputs is then applied in the reverse direction as previously discussed. In such cases, some quantity index has to be used to estimate an industry output in constant prices first. The output in current prices is obtained later. For agricultural production, quantities of products are always estimated first, then multiplied by current prices to get outputs in current prices. In other cases when industry output is a composite of many commodities, quantity indices are applied to previous year values and then inflated by constructed price indices for the industry. The constructed price indices of the industry outputs are the weighted price indices of the commodities produced by the industries. Product-mix shares of the base year have to be used as weights.

11.55. In any case, the appropriate method is to obtain values in current prices so that they can be balanced in the SUT framework with other values which are readily available in current prices.

7. Concluding remarks

11.56. Estimation of annual quantity and price indices should be as detailed as possible. However, the process is normally time-consuming, particularly with regard to the availability of many annual basic statistics long after the end of the year. It is therefore advisable to proceed by using the use table at a more aggregated level for preliminary estimates, possibly at a 30-commodity level or less. Revised estimates will be based on the detailed supply and use tables in current prices updated from the benchmark year.

11.57. Though the method provides real value added by detailed industries and all components of final demand by detailed commodities, it may also produce a negative value added at the detailed level, especially when the base year is too far away from the current year during which significant technical changes occurred.

XII. IMPACT ANALYSIS

12.1. Normally, policy makers want to see how a particular industry will evolve in the future so that they can plan accordingly. They also want to see the importance of that industry in the economy in terms of how much employment, income and taxes it generates and also what capital and imports it needs to grow. Thus, impact analyses are usually focused in both directions: the impact of other activities on the industry under study or the impact of that industry on other industries. This chapter will present various ways of modelling impact analysis using input-output tables, including multipliers, backward and forward linkages as well as the use of the Social Accounting Matrix (SAM).

A. Full-fledged impact analysis

1. Basic impact equation

12.2. An input-output model in its simplest form is a full articulation of inter-activity analysis; the development of any single industry is interrelated to the development of all other industries. Thus, the right approach to study an industry in both directions is first to predict the path of growth (or if prediction is not possible, to look at different probable paths of growth) of the full vector of final demand, i.e. the growth of final demand of every product in the economy and then use the following basic impact equation to calculate total impacts on gross outputs:

$$(12.1) \quad \Delta X = (I-A^{d})^{-1} \Delta Y^{d}$$

or

$$(12.2) \quad \Delta X = C^{d} \Delta Y^{d}$$

where $C^{d} = (I-A^{d})^{-1}$

12.3. It is important to further clarify the concepts used in equation 12.1 which have been discussed in chapter X. The basic input-output relations are as follows:

$$(12.3) \quad X = (I-A)^{-1} Y$$

where

$Y = S + E - M$

- Y: The column vector of final demand
- S: The column vector of final expenditures (i.e. final consumption expenditures of households, NPISHs and general government, gross capital formation)
- E: The column vector of exports
- M: The column vector of total imports.

As AX, the intermediate inputs, can be split into two components: one supplied domestically (A^dX) and the other supplied from abroad (M^{id}), equation 12.3 can be rewritten as

$$(12.4) \quad X = (A^d X + M^{id}) + Y$$

or

$$(12.5) \quad X = A^d X + (S + E - M + M^{id})$$

When the following are given

$$Y = S + E - M$$

$$Y^d = S + E - (M - M^{id})$$

equation 12.1 is obtained. This equation can be applied to the level of Y^d or a change in Y^d. (M-M^{id}) is imports for final expenditures. ΔY^d is change in final demand. A^d stands for the domestic input coefficients. Its calculation is explained in chapter VI. Y^d stands for final demand of domestic goods and services.

2. Preparation of the initial impact vector

12.4. ΔY^d is the initial impact vector that is used to calculate total impacts on other industries in the economy. It stands for a change in final demand of domestic goods and services. Final demand of domestic goods and services is understood to be final consumption expenditures plus exports and minus imports for final expenditures, i.e.:

Final expenditures (S)

.Household final consumption expenditures
.Final consumption expenditures of NPISHs
.Government final consumption expenditures
.Gross capital formation

(+) Exports (E)

(-) Imports for final expenditures ($M - M^{id}$)

A full ΔY^d has to be prepared because change in the output of a given industry is caused by change in final demand not only for its product but also for the outputs of all other industries.

12.5. The result obtained by equation 12.2 can then be used to compute total impacts on the total economy.

3. Calculation of total impacts

12.6. The total impacts on various economic indicators such as value added, employment, capital stocks and imports are further results of the calculation of total impacts on outputs.

Total impact on outputs

12.7. ΔX is the total impact on outputs caused by the change in final demand of domestic goods and services. It is calculated by equation 12.1.

Total impacts on value added

(12.6) $\Delta V = v\,\Delta X$

Total impacts on employment

(12.7) $\Delta L = l\,\Delta X$

Total impacts on capital formation

(12.8) $\Delta K = k\,\Delta X$

where:

ΔV is the change in value added generated by the change in Y as defined in para. 12.3, v is the row vector of value added and coefficients (i.e. value added per unit of output of each industry);

ΔL is the change in employment generated by the change in Y, l is the row vector of employment coefficients (i.e. employment -- hours worked -- per unit of output of each industry);

ΔK is the change in fixed capital stocks required to satisfy the new level of final demand and k is the row vector of total stock of produced and even non-produced assets (such as land) per unit of output of each industry if all assets are summed together.

Vectors v, l and k may be replaced by matrices if value added, labour and capital can be split into types. For example value added includes compensation of employees, operating surplus, consumption of fixed capital and taxes on products and production (indirect taxes); labour can be divided into managers, skilled technicians and the unskilled. For studying capital formation, some adjustment to the SNA concept may be needed. In the SNA, capital stock is linked to the economic activity or industry that owns the capital. For this reason, investment in roads, ports, airports and irrigation networks constructed and owned by the Government may be linked to the activities producing government services instead of to the economic activities that benefit directly from them such as the transport or agricultural industry. Analysts may need to reclassify capital stocks to the appropriate industries which benefit.

12.8. Table 12.3 gives an example of an increase in final expenditures in the economy of Thailand which is listed in column 1. On the assumption of domestic content listed in column 2, final expenditure of domestic goods and services (ΔY^d) is calculated and listed in column 3. Column 4 shows the increase in outputs calculated by equation 12.2. Column 5 shows the increase in intermediate inputs supplied by imports (ΔM^{id}) calculated by $(A - A^d)\Delta X$. ΔM which is imports for final expenditures is the difference between column 1 and column 3. Total impacts on imports or the sum of ΔM^{id} and ΔM^{f} are shown in column 6. Column 7 shows the percentage of imports over outputs, industry by industry. The input-output coefficient matrix and the domestic coefficient matrix shown in tables 12.1 and 12.2 provide information used in the calculation. In table 12.4, total impacts on value added and its components are shown. No data on capital stocks by industry are available so that increases in capital stocks can only be calculated in a manner similar to that of value added. Total impacts on employment can also be similarly calculated.

Table 12.1. Table of input-output coefficients in Thailand, 1985

	1	2	3	4	5	6
1.. Agr. and mining	.0984	.2233	.0276	.0000	.0001	.0213
2. Manufacturing	.1676	.3295	.4342	.0536	.4302	.1781
3. Construction	.0015	.0013	.0006	.0018	.0009	.0083
4. Trade	.0260	.0450	.0545	.0054	.0213	.0339
5. Transport	.0132	.0238	.1118	.0240	.0483	.0181
6. Others	.0227	.0210	.0344	.1104	.0395	.0398
Compensation	.1150	.0943	.1195	.2144	.1759	.3688
Operating surplus	.4939	.1747	.1717	.5299	.1921	.2071
Consumption of fixed capital	.0387	.0309	.0252	.0464	.0703	.0957
Taxes on production	.0230	.0562	.0206	.0141	.0214	.0289
Input multipliers	1.646	2.263	2.402	1.363	2.173	1.608

Table 12.2. Table of domestic coefficients in Thailand, 1985

	1	2	3	4	5	6
1. Agr. and mining	.0980	.1691	.0265	.0000	.0001	.0207
2. Manufacturing	.1250	.2243	.3238	.0487	.2805	.1610
3. Construction	.0015	.0013	.0006	.0018	.0009	.0083
4. Trade	.0260	.0450	.0545	.0054	.0213	.0339
5. Transport	.0132	.0238	.1118	.0240	.0242	.0181
6. Others	.0153	.0204	.0338	.1087	.0333	.0363
Compensation of employees	.1150	.0943	.1195	.2144	.1759	.3688
Operating surplus	.4939	.1747	.1717	.5299	.1921	.2071
Consumption of fixed capital	.0387	.0309	.0252	.0464	.0703	.0957
Taxes on production	.0230	.0562	.0206	.0141	.0214	.0289
Domestic output multipliers	1.443	1.770	1.912	1.294	1.613	1.457

Table 12.3. Initial impacts and total impacts

	1	2	3	4	5	6	7
	ΔY	Domestic ratio	ΔY^d	ΔX	$\Delta M^{id}=(A-A^d)\Delta X$	$\Delta M=\Delta M^{id}+\Delta M^y$	$\Delta M/\Delta X$
1.Agr. and mining	3,350	95.9%	3,197	13,920	2,797	2,935	21.1%
2.Manufacturing	29,485	82.3%	24,278	51,109	8,501	13,708	26.8%
3.Construction	6,743	100.0%	6,743	7,020	0	0	0.0%
4.Trade	6,361	100.0%	6,361	10,300	0	0	0.0%
5.Transport	6,227	96.7%	6,021	9,230	222	428	4.6%
6.Other	15,388	95.5%	14,739	18,995	281	929	4.9%
Total	67,554		61,336	110,574	11,796	17,994	16.3%

Table 12.4. Increases in value added due to an initial increase in final expenditures shown in table 12.3.

	1	2	3	4	5	6	Total
Compensation	1,600	4,822	839	2,208	1,624	7,005	18,098
Operating surplus	6,876	8,928	1,205	5,458	1,773	3,934	28,174
Consumption of fixed capital	538	1,577	177	478	648	1,817	5,235
Taxes on production	320	2,871	145	145	198	550	4,229
Total value added	9,334	18,198	2,366	8,289	4,243	13,306	55,736

4. Endogenization of household income effects

12.9. The total impacts shown in sections 1, 2 and 3 require that every component of final demand, including household final consumption expenditure be estimated exogenously. Personal consumption expenditure and its corresponding counterpart, value added, can be endogenized in the basic equation 12.1. Table 12.5 will show how the household sector can be endogenized in a simple manner, using value added as a proxy for household incomes. A more elaborate treatment of the household sector is the focus of the social accounting matrix (SAM) technique that will be introduced in section C.

12.10. In table 12.5, the normal intermediate matrix has been extended into three rows and three columns, that is, it includes an additional row for value added and an additional column of household or personal final consumption expenditures (PCE). Value added becomes the source of revenue to finance final expenditures of the household sector. Since not only is household disposable income normally smaller than value added but also its total expenditures are normally smaller than its disposable income, the PCE coefficients must be derived by dividing values in the PCE column by 220 (total value added). This derivation implicitly assumes that (i) household income is a fixed percentage of the part of value added that is subject to distribution and redistribution to the household sector (wages, dividends, net property income, net transfers), (ii) a fixed percentage of household income is saved, (iii) the income left for consumption is spent on various goods and services in fixed shares.

Table 12.5. Endogenization of the household sector

		Intermediate consumption		PCE	Other final demand (FD)	Total
		1	2	3		
Product	(1)	10	20	35.1	34.9	100
Product	(2)	20	30	58.5	91.5	200
Value added	(3)	70	150	0	0	220
Total		100	200	93.6		

12.11. Table 12.5 shows that the intermediate demand matrix includes three rows and three columns, ΔY^d used in the basic equation 12.1 is the column "other final demand (FD)" with the last element equal to zero. Thus, the extended A matrix is equal to

$$A = \begin{bmatrix} .100 & .100 & .159 \\ .200 & .150 & .266 \\ .700 & .750 & .000 \end{bmatrix}$$

12.12. The endogenization of the household sector produces both advantages and disadvantages. On the advantage side, it is not necessary to estimate directly household income and consumption for a given impact study. They are the results of the calculation. On the disadvantage side, in addition to the assumption of constant technical coefficients, it is necessary to make additional assumptions: the assumption of constant consumption behaviour, constant income distribution shares and constant saving behaviour which are not normally true even in the short term at a detailed level of input-output analysis.

12.13. When the household sector is endogenized, the initial impact vector ΔY^d would not include estimates of household final consumption expenditures. These values will be automatically generated through the use of value added that is subject to distribution and redistribution to the household sector. The economy is now driven mainly by government final consumption expenditures, exports, changes in inventories, and gross capital formation.

12.14. The above example shows the endogenization of only the household sector in a very simple way. In order to endogenize additional sectors, for example the government sector, it is necessary to separate value added into household incomes and government incomes. This will be discussed in section C.

5. Conclusion

12.15. To summarize the discussion of section A, it is important to re-emphasize that a study of any industry in the economy must be implemented comprehensively, i.e. together with every other industry because of the inter-industrial linkages.

12.16. In some studies, some economists enter the output of the industry under study into the vector of final demand Y and calculate total impacts. The results obtained by using equation 12.2 are obviously much greater than the total contribution of the industry. For example, if the flow matrix in table 1.2, the coefficient matrix in table 1.3 and the inverse in table 1.6 of chapter I are used, and the vector of final demand as (100 0 0) is entered, total impacts on outputs will be (107.7 35.1 14.1). This is nonsensical because the total output of sector 1 in the economy is only 100 while the estimated output is 107.7. This type of analysis is similar to the use of output multipliers that will be discussed in section B.

12.17. In order to clarify further the point made above, assume that a new level of output of a certain product, for instance X_2, would be obtained in the future and that one would want to see the impact of this output on the economy. Let us call the vector of other products X_1; then the basic I/O equation can be written as follows:

$$X = AX + Y$$

or

$$(12.9)\quad \begin{bmatrix} X_1 \\ \overline{X_2} \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix} \begin{bmatrix} X_1 \\ \overline{X_2} \end{bmatrix} + \begin{bmatrix} \overline{Y_1} \\ Y_2 \end{bmatrix}$$

Equation 12.9 shows that Y_1 and X_2 are known. Thus unknown variables are X_1 and Y_2.

$$(12.10)\quad X_1 = A_{11}X_1 + [A_{12}\overline{X_2} + \overline{Y_1}]$$

$$(12.11)\quad Y_2 = \overline{X_2} - [A_{21}X_1 + A_{22}\overline{X_2}]$$

In equation 12.10, X_1 is computed given X_2 and Y_1. In equation 12.11, given that X_1 and X_2 are known, Y_2 is calculated as a residual. This means that if X_2 is oversupplied, the excess must be exported or kept in inventory. These two equations can also be used to calculate the impacts of changes in X_2 and Y_1 on X_1 and Y_2.

12.18. Thus it is not possible to isolate the total impact of a particular industry on the whole economy when calculating its total impacts. Impact analysis of an economic problem would make sense only if it can be formulated consistently as changes in the vector of final demand, i.e. changes in final consumption, exports, fixed capital formation (i.e. investment on capital goods) and inventories.

12.19. The impact analysis described above requires an articulation of the initial impact vector which is described in equation 12.5. It looks as though the full initial impact vector of the entire economy always has to be formulated. It is not so, however. For instance, the total impact of a project on the economy can be consistently formulated since change in final demand is only a vector of changes in capital formation (i.e. investments). Similarly, effects of changes in exports on the economy can also be calculated.

12.20. In addition, for any type of impact analysis, it is important to differentiate short-term from long-term effects. Increase in fixed capital investment is mostly short-term, the effects will disappear when production of goods and services for the investment project stops. The long-term effects would be replacement investment, maintenance and operation expenses to sustain the new production activities created by the project. How would that be introduced in the model described in equation 12.2? The answer is that an increase in replacement investment can be formulated as an increase in capital formation and an increase in maintenance and operation expenses can be formulated in terms of an increase in final demand that directly and indirectly requires the incremental level of maintenance and operation expenses.

B. Other types of impact analysis

12.21. Other types of impact analysis are also used in input-output economics. These techniques are more ad hoc as compared to the method described in section A. The more prominent ones are multipliers and backward and forward linkages.

1. Multipliers

12.22. Multipliers measure the total effects on either output, employment or value added, given an increase in one unit of output of a particular industry. The multiplier of an industry can be calculated by equation 12.2 to obtain ΔX and then sum it up by using the final demand vector Y^d in which only the value of final demand of that industry product is set to 1 with the rest set to zero. But this produces the same result as calculating the sum of the column corresponding to that industry of the domestic Leontief inverse C^d. This sum is called the output multiplier. Column sums of the Leontief inverse C summarize total inputs required and thus are called input multipliers. Input multipliers and output multipliers for each industry for the Thai economy in 1985 are shown at the bottom of tables 12.1 and 12.2. One can see that output multipliers should be smaller than input multipliers because imported inputs would not have any effects on the economy. Multipliers are mathematically defined as follows:

$$(12.12)\quad \textit{Input multiplier of industry } j = \sum_{i}^{n} C_{ij}$$

$$(12.13)\quad \textit{Output multiplier of industry } j = \sum_{i}^{n} C_{ij}^{d}$$

12.23. Multipliers in table 12.2 show that in Thailand in 1985, one unit of output of construction (industry 3) created more total outputs than any other sectors and that the output multiplier of agriculture and mining (industry 1) is smaller than the output multiplier of "other" industry (industry 6) though potentially it may have more impact (look at table 12.1 to see that the input multiplier of agriculture and mining is larger than that of other industry) because of imports of inputs.

12.24 Other types of multipliers such as income and employment can also be calculated as follows:

Income multipliers

$$(12.14)\quad \textit{Income multiplier of industry } J = \sum_{i}^{n} v_{i}.C_{ij}^{d}$$

Employment multipliers

$$(12.15)\quad \textit{Employment multiplier of industry } J = \sum_{i}^{n} l_i . C_{ij}^{d}$$

12.25. These multipliers calculated using the domestic Leontief inverse C^d are interpreted in the same way as output multipliers. They show total increases in either income or employment given an increase in one unit of output of each industry.

12.26. In an ad hoc sense, multipliers can be used as useful indicators to assess variation in effects for a particular activity in microanalysis such as at the regional level. However, if multipliers are used as criteria for development for the whole economy, there is a tendency to conclude (depending on the objective of the society for either highest total output, highest total income or highest total employment) that the industry with the highest multiplier, and that industry alone, will be selected for development. This conclusion tends to lead to the misuse of multipliers. This type of analysis is similar to the calculation of total economic impacts of an industry by using its output as final demand as analysed in section A. Any meaningful long-term analysis will have to start with the formulation of the vector of final demand.

12.27. Finally, in relation to the use of income multipliers, it is noteworthy that all value-added multipliers are the same, i.e. all equal to 1 if imports for intermediate goods and services are not eliminated from the I/O coefficients. This is so because equation 12.14 is the same as the price equation discussed in chapter I (see equation 1.16, para. 1.30). The "value-added" multipliers can be interpreted as follows: for a one-dollar increase in value of final demand of any domestic product, the value added will increase by the value of 1 in order to provide enough income for the final demand. In other words, a final demand of one dollar of any domestic product, must be matched by a one-dollar increase in income. Given that only part of value added is paid out as labour income with part of this labour income used for final consumption, and given again that imports of goods and services are not eliminated from the I/O coefficients, one may calculate income multipliers by endogenizing the household sector as in paragraphs 12.9-12.13.[1] Again, all industries will have the same income multiplier which is greater than 1 by a scalar. For example, the income multipliers of every industry in matrix A in equation 12.14 are equal to each other and to 1.7405, which are elements of the third row in the Leontief inverse. This means that for an increase in final consumption of one dollar, income must increase by 1.7405 since only a part of income is spent on final consumer goods and services. Readers may want to make up some examples of the A matrix and then proceed to calculate income multipliers in order to check the above conclusion. Thus, the discussion here tries to convey the main idea that without introducing imports of intermediate inputs into equation 12.14, income multipliers would not be meaningful for industry analysis.

2. Backward and forward linkages

12.28. The terms "backward and forward linkages" of an industry are meant to measure the inter-industrial linkages of a particular industry to other industries as suppliers of inputs (backward linkage) and as a provider of input to other industries. These concepts are developed in the context of studying

[1]Readers can see the proof of this in Thijs ten Raa, *Linear Analysis of Competitive Economies*, Hemel Hempstead, Harvester Wheatsheaf, 1995.

development strategy. Many authors[2] have proposed definitions as well as methods to measure these linkages.

12.29. The direct backward linkage of an industry is measured by the sum of the column corresponding to that industry in the coefficient matrix A. The total backward linkage is measured by the sum of the industry column in the Leontief inverse.

12.30. The direct forward linkage is measured by the sum of the industry row in the coefficient matrix A. The total forward linkage is measured by the sum of the industry row in the Leontief inverse.

12.31. The linkages also differ in whether A, A^d, C, C^d are used. The meaning of each concept derived by using different types of data should be apparent to readers of part A of this chapter. Of course, all these quantified concepts suffer from the same weakness of the multipliers since total backward linkages are nothing but output multipliers.

C. The System of National Accounts (SNA) and Social Accounting Matrix (SAM) as an extension of I/O model

12.32. In part B, the endogenization of the household sector does not explicitly show household incomes. The extension of the input-output framework in the SNA would allow us to show how incomes of the household, government and other sectors are formed.

12.33. As noted in chapter II, household incomes are not the same as compensation of employees. Household incomes can be obtained only after the process of distribution and redistribution of incomes. For example, the household sector receives, in addition to compensation of employees, dividends, interest on its deposits and transfers from other sectors like social security benefits but it also has to pay out income taxes, interest on loans, social security contributions, fines and penalties and other types of transfers. The net receipts form the disposable income. Disposable incomes of other sectors are formed in a similar way. All these distributions and redistributions can be modelled by extending the input-output framework to incorporate this type of distribution and redistribution. The usefulness of this extension has already been discussed in part B. Table 12.6 will show an example of how the process of distribution and redistribution of incomes is modelled.

12.34. It is possible to observe from table 12.6 that the full input-output matrix is spelled out, including every component of value added from column 1 to column 2 and from row 1 to row 5.

12.35. Columns 3-5 show the appropriation of value added shown in rows 3-5 by institutional sectors. Column 3 shows how compensation of employees (130) generated in the production process in row 3 is appropriated by the household sector. Column 4 shows taxes on products and production being all appropriated by the Government. Column 5 shows how consumption of fixed capital and operating surplus are appropriated by the household sector as mixed incomes and by other financial and non-financial sectors

[2] See P.N. Rasmussen, *Studies in Sectoral Relations*, Amsterdam, North Holland, 1956; Albert O. Hirshman, *The Strategy of Economic Development*, New Haven, Yale University Press, 1958; Hollis B. Chenery and T. Watanabe, "International Comparisons of the Structure of Production" in *Econometrica,* Vol. 5, No. 2, October 1958; Pan A. Yotopoulos and J. B. Nugent, "A Balanced-Growth Version of the Linkage Hypothesis: A Test" in *Quarterly Journal of Economics*, Vol. 90, No. 2, May 1973; Leroy P. Jones, "The Measurement of Hirshmanian Linkages", *ibid.*

(i.e. other sectors) before being distributed and redistributed.

12.36. Rows 6-8 show the receipts appropriated by various institutions before being distributed and redistributed.

12.37. Columns 6-8 show the net distribution and redistribution of receipts appropriated in rows 6-8. Column 6 shows how the receipts received by the household sector (140) are paid to the Government as direct taxes and contribution to social security (60), and to "other sectors" as interest payments, current transfers, etc. (10), with the residual (70) as disposable income. Column 7 shows the government receipts paid out to the household sector (30) as social security benefits, etc. and to "other sectors" (5) as subsidies, grants. Column 8 shows the net distribution of "other sectors" to the household sector (17) as interest, dividends, etc., to the government sector (3) as business income taxes, and to "others" (30) as interest, dividends, or retained earnings.

Table 12.6. Endogenization of the household sector

	1	2	3	4	5	6	7	8	9 PCE	10 Other FD	11 Total
1. Industry 1	10	20							35.1	34.9	100
2. Industry 2	20	30							58.5	91.5	200
3. Compensation of employees	40	90								0	130
4. Taxes on products and production	10	20							0	0	30
5. Other value added	20	40								0	60
6. Household			130		10					0	140
7. Government				30		60		3		0	93
8. Others					50					0	50
9. Household incomes						70	30	17		0	117
10.Government incomes							58				
11.Others' incomes						10	5	30			
Total	100	200	130	30	60	140	93	50	93.6		

Note: PCE = personal final consumption expenditure
FD = final demand.

12.38. Row 9 shows net incomes received or retained by the household sector. The total disposable income is equal to 117. Corresponding to this row is column 9 showing the consumption expenditures of the household sector, which are equal to 93.6 only. This amount is smaller than the total disposable income, part of which is saved.

12.39 The endogenization of the household sector will turn the matrix between columns 1-9 and rows 1-9 into the intermediate flow matrix F. The corresponding output vector that is needed to convert the intermediate matrix F into the coefficient matrix A is X = (100 200 130 30 60 140 93 50 117), the other final demand matrix is Y = (34.9 91.5 0 0 0 0 0 0 0) and the extended A matrix is

$$A = \begin{bmatrix} .10 & .10 & .000 & .00 & .000 & .000 & .000 & .000 & .300 \\ .20 & .15 & .000 & .00 & .000 & .000 & .000 & .000 & .500 \\ .40 & .45 & .000 & .00 & .000 & .000 & .000 & .000 & .000 \\ .10 & .10 & .000 & .00 & .000 & .000 & .000 & .000 & .000 \\ .20 & .20 & .000 & .00 & .000 & .000 & .000 & .000 & .000 \\ .00 & .00 & 1.000 & .00 & .167 & .000 & .000 & .000 & .000 \\ .00 & .00 & .000 & 1.00 & .000 & .428 & .000 & .060 & .000 \\ .00 & .00 & .000 & .00 & .833 & .000 & .000 & .000 & .000 \\ .00 & .00 & .000 & .00 & .000 & .500 & .322 & .340 & .000 \end{bmatrix}$$

It is possible to apply equation 12.2 to find X given Y but of course A^d is needed.

12.40. In table 12.6, the government sector is not internalized, because if it was, it would be necessary to add an additional corresponding column of final consumption expenditures for this sector.

12.41. The attempt to trace the formation of institutional incomes presented above is part of the SNA framework which is actually further extended to trace also the distribution of savings and the uses of these funds to finance investments in both financial and non-financial instruments, which form the capital and finance accounts. The Social Accounting Matrix (SAM) is the extension of the SNA system where the household sector is split into more sectors (high, low incomes, etc.). SAM may be extended further than the example given in table 12.6 to include all capital accounts and financial accounts. Readers are advised to read chapter XX of the SNA for a full discussion of SAM.

12.42. One may be tempted to think about the possibility of endogenizing every component of final demand, but this would in fact lead us to the problem of optimal growth that is beyond the scope of this study. However, it is already possible to perceive the limitation of this approach since it assumes that everything is determined in a "fixed" manner, including economic behaviours. The linking of business incomes to capital formation is more questionable than the linking of household disposable incomes to household final consumption expenditures in a "fixed" manner because investment as discovered by Keynes is quite volatile. Many general equilibrium models have relaxed this "fixed" relationship by the introduction of prices and other effects. Other coefficients such as input-output coefficients and import coefficients that are assumed fixed can also be relaxed. This is particularly true for import coefficients that were discussed in chapter VI.

XIII. AN ANALYTICAL APPROACH TO THE CALCULATION OF THE "GREEN GDP"[1]

13.1. The input-output model is one widely used tool in analysing pollution problems. This chapter is aimed at showing how I/O modelling may be utilized. In fact, there are many alternative ways in modelling pollution, depending on the objectives of the model and data availability. The model presented in this chapter aims at showing how I/O can be used to answer a "what if" question on the impact of pollution abatement on GDP. The chapter does not in any way imply a recommendation since there currently are many models, from the very simple to the highly sophisticated, that have been experimented with.[2] The framework in this chapter extends the simple I/O model to quantify explicitly pollution abatement activities, the information on which at this time is lacking in almost every country. If these activities are not explicitly shown, the model would be similar to many models commonly applied. In this chapter an "analytical concept" of Green GDP is introduced. It is defined by deducting from GDP the cost of abatement activities projected in a "what if" scenario, to avoid or eliminate degradation, as well the indirect feedback of these abatement activities including the pollution generated by abatement activities themselves and also the additional value added created by the latter. It differs from the "accounting concept" of Green GDP which is defined in the *SNA Handbook on Integrated Environmental and Economic Accounting* (SEEA) (Sales No. E.93.XVII, 1993) and in other environmental accounts systems, and which is calculated as the difference between GDP and the maintenance cost value of degradation. For the above reasons, the analytical concept of GDP should be looked at as no more than an exercise in using the I/O model.

13.2. The accounting concept of Green GDP is calculated for present accounting periods, the analytical concept of Green GDP is computed for "what if" scenarios describing the future. Also, the analytical concept cannot be standardized in the same manner as the accounting concept in SEEA. The value of the analytical concept of Green GDP would depend on the changes that are modelled to take place in the future as a result of shifts in resource uses to abatement activities; and those shifts are different, depending on the modelling scenarios that are used.

13.3. The analytical concept of Green GDP is developed in this chapter not to replace but rather to supplement the accounting concept of Green GDP. The differences between the two might be a measure of the extent to which the economy would have to change in order to adapt to the shift in economic activities needed to abate pollution in the future. Such adaptation might be considerable where pollution caused by industries is severe and the resources available for abatement activities are limited. On the other hand, if pollution is limited and many abatement activities have already taken place, the analytical and accounting concepts of Green GDP might converge.

13.4. When in the remaining part of the chapter the term Green GDP is used, it refers to the *analytical concept of Green GDP.* No further references will be made to the accounting concept as defined in the SEEA.

13.5. The analytical concept used in the chapter is mainly based on I/O relations and restrictions included

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[1]This chapter is a slight revision of the paper written by Viet Vu and Jan Van Tongeren for the second meeting of the London Group on National Resources and Environment Accounting, Washington, D.C., 15-17 March 1995.

[2]Readers can see references to some of the work done in this field at the end of the chapter.

in the national accounts. With help of the I/O focus, the implications of the approach are illustrated. The I/O approach should be considered as a first step in a more extended modelling exercise which will ultimately also include income and financial restrictions on abatement activities that are reflected in the institutional sector accounts of the SNA. The present chapter should therefore be considered as a report on work in progress.

13.6. The chapter is divided into four sections: The first section describes an input-output framework that is adapted to the calculation of the Green GDP. The second section presents a simple I/O model in which the Green GDP only allows for pollution generated by production activities, and all pollution is assumed to be abated. The third section extends the I/O model to deal with pollution generated by household consumption, and furthermore allows for partial abatement of pollutants generated by production and household consumption beyond a socially tolerated level of pollution. Section four is exploratory, in the sense that it goes beyond the scope of the I/O model and supply and use table (SUT) of the SNA and enters into elements that form part of the Integrated Economic Accounts (IEA) of the SNA. These deal with payments for pollution abatement through taxes and subsidies, and with saving and other elements financing investments in pollution abatement equipment.

A. Adaptation of the I/O framework to the Green GDP

13.7. Below is presented an adapted version of an I/O model in which the Green GDP is defined as the GDP that takes account of pollution abatement activities needed to reduce pollution generated within the current accounting period below a socially accepted level. This definition excludes the effects on GDP of abating pollution accumulated during previous periods. The model also assumes that there exists technology that can abate all pollutants generated by production and consumption activities in the economy.

13.8. Two types of activities are distinguished in the model: all economic activities except pollution abatement activities, and pollution abatement activities. The first group is referred to as *economic activities* and the second group is called *abatement activities*. Inputs and outputs of economic activities are measured in monetary terms. The output of the abatement activities is the services that result in elimination of the pollutants generated by production and consumption.

13.9. The two I/O models below are based on n economic activities (excluding pollution abatement activities), m pollutants and m pollution abatement activities. These define the following vectors and matrices:

- A_1 : the n x n direct input coefficient matrix of economic activities, presenting the inputs of products from economic activities (monetary units) per unit (monetary unit) of output of economic activities
- X_1 : the n x 1 vector of outputs of economic activities measured in monetary terms
- Y_1 : the n x 1 vector of final uses of products from economic activities, measured in monetary terms
- X_g : the m x 1 vector of outputs of pollution abatement activities (=pollutants abated) measured in physical units
- g_1 : the m x n direct pollution coefficient matrix of economic activities, presenting the amount of pollutants (physical units) generated per unit of output (monetary units) produced by economic activities
- g_2 : the m x m direct pollution coefficient matrix of abatement activities, presenting the amount of pollutants (physical units) generated per unit (physical unit) of pollutant abated (i.e. per unit of output of pollution abatement activities)
- g_3 : the m x n direct pollution coefficient matrix of final uses, presenting the amount of pollutants (physical units) generated per unit of product (monetary units) consumed by households

and/or otherwise used in final demand

H : the n x m direct input coefficient matrix of pollution abatement activities, presenting the inputs of products from economic activities (monetary units) per unit (physical unit) of pollutant abated (i.e. per unit of output of pollution abatement activities)

Y_g : the 1 x m vector of pollutants unabated.

13.10. In defining above the vectors of pollution generated in economic activities, and the vectors and matrices of pollution abatement activities, both the pollutants generated as well as the pollution abatement services are expressed in physical terms, i.e grams, litres, etc. This type of mixed monetary-physical valuation, which has become standard in environmental input-output analysis (see ref. 2-7), has been applied to the two I/O models in sections B and CI. In section D, which deals with value added and incomes in monetary terms, the physical units are replaced by the maintenance cost valuation of the SEEA.

13.11. Using the terminology defined above, two identities are defined that are closely related to each other:

$$X_1 = AX_1 + HX_g + Y_1 \tag{13.1}$$

$$X_g = g_1X_1 + g_2X_g + g_3Y_1 - Y_g \tag{13.2}$$

13.12. Equation 13.1 is based on the conventional I/O system, showing the use of the outputs of economic activities. AX_1 is the input used in the production of outputs of economic activities. HX_g is the input used in pollution abatement activities: X_g is the pollutants abated, or --said differently-- the outputs of abatement activities, measured in physical units; H being the direct input coefficient matrix of pollution abatement activities, converts X_g to products of economic activities that are needed to abate pollutants generated. Y_1 is the product of economic activities that are used in final consumption, assuming there are no other final uses.

13.13. Equation 13.2 shows the total amount of pollutants abated X_g. It is equal to the pollutants generated by the output of economic activities X_1 (i.e. g_1X_1), the pollutants generated by the output of pollution abatement activities (i.e. the pollution generated by the abatement of pollutants) X_g (i.e. g_2X_g), the pollutants generated by final consumption (i.e. g_3Y_1), minus the pollutants that are not abated Y_g with the latter determined by the socially accepted level of pollution, which in many countries is set normatively by government environmental protection agencies.

13.14. The two identities are presented below in a matrix format, that is similar to a conventional I/O model and may be handled in the same way:

$$\begin{bmatrix} X_1 \\ X_g \end{bmatrix} = \begin{bmatrix} A & H \\ g_1 & g_2 \end{bmatrix} \begin{bmatrix} X_1 \\ X_g \end{bmatrix} + \begin{bmatrix} Y_1 \\ g_3Y_1 - Y_g \end{bmatrix} \tag{13.3}$$

13.15. Without pollution abatement, the model would be reduced to:

$$X = AX + Y \tag{13.4}$$

in which X and Y are not necessarily the same as X_1, Y_1 in identity 13.3. The extent to which they deviate depends on two factors that reinforce each other. The first one is the quantitative importance of the pollution coefficient matrices g_1, g_2, g_3 which determines the pollution to be abated and thus the output of the pollution abatement industries. The second factor is the input coefficient matrix H of pollution abatement activities, which determines the amount of output that is diverted for use as inputs of the abatement industries, and is thus no longer available for final use. The environmental accounts features are thus integrated with the conventional input-output coefficient matrix A, without any modifications or adjustments of its coefficients.

B. Green GDP based on a simple I/O model

13.16. This section uses a very simple, but somewhat unrealistic, version of the I/O model presented in section A, in order to explain the method adopted in this chapter to calculate the Green GDP. In this example it is assumed that final use of goods and services does not generate pollution and that all pollutants generated by industries are fully abated.

13.17. Thus, as $g_3 = 0$ and $Y_g = 0$, equations 13.1 and 13.2 are reduced as follows:

$$(13.5) \qquad X_1 = AX_1 + HX_g + Y_1$$

$$(13.6) \qquad X_g = g_1X_1 + g_2X_g$$

13.18. By rewriting equation 13.6 and expressing X_g in terms of X_1 and then substituting this value X_g into equation 13.5, the following expressions can be derived:

$$(13.7) \qquad X_g = (I - g_2)^{-1}g_1X_1$$

$$(13.8) \qquad X_1 = AX_1 + H(I - g_2)^{-1}g_1X_1 + Y_1$$

13.19. Further rewriting 13.8 gives:

(13.9)	$X_1 =$	[A +	$H(I-g_2)^{-1}g_1]\ X_1$	$+\ Y_1$
		Direct inputs used in economic activities	Direct inputs used in abatement activities	Final use

In 13.9 Y_1 is the Green GDP. Without pollution abatement, a larger part of output is available for final use, i.e.,

$$(13.10) \quad Y_* = H(I-g_2)^{-1}g_1X_1 + Y_1$$

Thus, Green GDP Y_1 is smaller than the conventional GDP Y_*, as some final use of Green GDP is diverted as direct input in abatement activities.

13.20. A numerical example may further illustrate the above. In it, the first two rows and columns represent economic activities, the third ones refer to the pollution abatement activity, and there is only one pollutant. The direct input coefficient matrix is assumed to be as follows:

$$(13.11) \quad \left|\begin{array}{cc|c} .15 & .25 & .002 \\ .20 & .05 & .004 \\ \hline 1 & 3 & .020 \end{array}\right|$$

13.21. In matrix 13.11, A_1 is the 2 x 2 matrix in the top left quarter, g_1 is the 1 x 2 vector on the bottom left, H is the 2 x 1 vector in the top right, and g_2 is represented by the bottom right cell. H in the top right describes the abatement technology that is currently available; thus, in order to eliminate 1 unit of pollutant, .002 of monetary value of product 1 and .004 of monetary value of product 2 are needed; this also generates .2 unit of pollutant.

13.22. The point of departure for using coefficient matrix 13.11 is an output vector, i.e.,

$$(13.12) \quad X_1 = \begin{bmatrix} 1{,}000 \\ 2{,}000 \end{bmatrix}$$

The flow relations derived from this are shown in 13.13 below, using equation 13.9 to calculate the Green GDP and equation 13.7 to calculate pollution abated X_g. The first two rows show the outputs of economic products, intermediate consumption and final uses in monetary terms. The last row of the flow matrix shows the pollutant in physical units generated by each industry, and fully abated.

$$(13.13) \quad \underset{\text{Outputs}}{\left|\begin{array}{c} 1{,}000 \\ 2{,}000 \\ \hline 7{,}142.8 \end{array}\right|} = \underset{\text{Intermediate consumption}}{\left|\begin{array}{cc|c} 150 & 500 & 14.3 \\ 200 & 100 & 28.6 \\ \hline 1{,}000 & 6{,}000 & 142.8 \end{array}\right|} + \underset{\text{Final use}}{\left|\begin{array}{c} 335.7 \\ 1{,}671.4 \\ \hline 0 \end{array}\right|}$$

13.23. Thus, the Green GDP is equal to the total value of final use, which is (335.7+1,671.4) = 2,007.1. The GDP without pollution abatement is equal to the Green GDP plus the values of inputs used in pollution abatement shown in the first two elements of the third column in the middle part of the equation, i.e. 2,007.1 + (14.3 + 28.6) = 2,050. Full abatement of pollution will thus reduce GDP by 2.1% in this example. The last row shows total output and output of pollution in each industry abated.

C. Green GDP based on a more realistic I/O model

13.24. In a more realistic I/O model, two of the assumptions of the simple model have been eliminated, and all elements in equations 13.1 and 13.2 are utilized. Thus the realistic model includes pollution caused by final uses (g_3Y_1 in equation 13.3) and in it not all pollution is abated, but rather a socially acceptable level of pollution (Y_g in equation 13.3) has been introduced.

By rewriting 13.1, Y_1 is expressed in terms of X_1, i.e.

$$(13.14) \quad Y_1 = (I\text{-}A)X_1 - HX_g$$

By substituting the above expression for Y_1 in 13.2, X_g can be expressed in terms of X_1. Thus:

(13.15) $X_g = [I - (g_2 - g_3H)]^{-1} [g_1 + g_3(I-A)]X_1 - [I - (g_2 - g_3H)]^{-1} Y_g$

By substituting $R = I - (g_2 - g_3H)$, 13.15 is simplified to:

(13.16) $X_g = R^{-1} [g_1 + g_3(I-A)]X_1 - R^{-1} Y_g$

13.25. Replacing X_g in equation 13.1 by that in equation 13.16, it is possible to write equation 13.1 in terms of X_1 and exogenous variables Y_g and Y_1 as follows:

(13.17)	$X_1 =$	$\{A +$	$HR^{-1}[g_1 + g_3(I-A)]\}$	X_1	$- HR^{-1} Y_g$	$+ Y_1$
		Direct inputs used to produce output of economic activities	Direct inputs used in pollution abatement activities (full abatement of pollution)		Minus: Direct inputs of pollution that is not abated (socially accepted pollution)	Final use

13.26. The relationship presented in 13.17 above is similar to 13.9 in the case of the simple I/O model. In this case, polluted GDP (Y_*) is equal to polluted GDP (Y_1), plus direct inputs used in pollution abatement activities if all pollution were abated, minus direct inputs of pollution that is not abated, i.e.,

(13.18) $Y_* = Y_1 + \{HR^{-1}[g_1 + g_3(I-A)]\} X_1 - HR^{-1}Y_g$

13.27. The use of equation 13.18 in the calculation of the Green GDP is similar to what was described in section B (equation 13.10).

13.28. Below is presented a numerical example similar to that in section B, which includes the following additional values:

(13.19) $g_3 = (2 \quad 1.5)$

(13.20) $Y_g = 1{,}000$

13.29. Assuming again the same output vector as in the example of section B (equation 13.12), while using the identity of equation 13.17, the flow matrix of outputs, intermediate consumption, final use and pollutants to be abated, can be calculated as follows:

$$(13.21)\qquad \underset{\text{Outputs}}{\left[\begin{array}{c}1{,}000\\ 2{,}000\\ \hline 9{,}343.4\end{array}\right]} = \underset{\text{Intermediate consumption}}{\left[\begin{array}{cc|c}150 & 500 & 20.7\ -2.0\\ 200 & 100 & 41.4\ -4.0\\ \hline 1{,}000 & 6{,}000 & 186.9\end{array}\right]} + \underset{\text{Final use}}{\left[\begin{array}{c}331.3\\ 1{,}662.6\\ \hline 3{,}156.5 - 1{,}000\end{array}\right]}$$

13.30. The last element in the last column, 3,156.5, represents the total pollutants generated by final uses in the case of full abatement, minus 1,000, which is the amount of pollutants tolerated in the economy. The Green GDP (Y_1) in the example is equal to (331.3 + 1,662.4) = 1,993.7, and the GDP without pollution abatement (Y_*) is equal to the sum of the elements in the vector below:

$$(13.22)\qquad Y_* = \begin{bmatrix}331.3\\ 1{,}662.6\end{bmatrix} + \begin{bmatrix}20.7 & -\ 2\\ 41.4 & -\ 4\end{bmatrix} = \begin{bmatrix}350\\ 1{,}700\end{bmatrix}$$

D. Adaptation of the I/O model to study the economic impact of pollution abatement policies

13.31. The I/O models presented above reflect the scope of the discussion of Green GDP until now. In this discussion only production and final use considerations play a role, while effects on income, redistribution of income and the (financial) ability of industries to pay for pollution abatement are not dealt with. These effects and the restrictions they pose are, of course, important in the further development of an analytical concept of Green GDP as presented in this chapter. However, they can only be dealt with effectively if the data in the institutional sectors of the SNA are included in the discussion and until now no clear conceptual framework for doing this has been elaborated. In view of the importance of this aspect, however, some preliminary thoughts have been elaborated below on how to adapt the I/O model to study other economic impacts of pollution abatement policies. Further work on this continues in the Statistics Division.

13.32. The discussion below is in two parts. The first one discusses the incorporation into the model of output of abatement activities in monetary terms, partial abatement, environmental taxes and subsidies, and payments for abatement of pollution generated by final uses. The second part deals mainly with savings of institutional sectors and forms of financing investments in pollution abatement equipment.

13.33. The discussion below does not enter into two other important limitations of the I/O model. One is that neither prices of outputs nor intermediate consumption of industries are affected, even though the pollution abatement activities affect the resources available for final use. Also, the I/O models do not enter into any optimization of final use and Green GDP, which could only be achieved by applying linear programming techniques in which input and pollution coefficient matrices of equation 13.3 would play a role, and which would also take into account the capital stock needs of each industry.

1. Allocation of pollution abatement services to industries and final uses

13.34. The I/O models for the derivation of Green GDP discussed above only describe the pollutants generated by industries and final uses, and do not identify the industries and final-use sectors paying for the abatement services. Furthermore, Y_g shows the pollutants that are tolerated but does not specify in which industries or final use categories. Thus no information is available on the effects of abatement expenses on the operating surplus of industries and how final uses are actually affected.

13.35. To identify the effects of abatement expenses by industries and final uses, equation 13.2 of the I/O model is transformed into a pollution abatement equation, presented as 13.2' in the table below. It assumes that a specified percentage (δ) of pollution by type is tolerated for each unit of output. In addition, the output of abatement activities (X_g) must now be measured in monetary terms.

(13.2') $=$ X_g	$\delta_1 g_1 X_1 + \delta_2 g_2 X_g$	$\delta_3 g_3 Y_1$
	Abatement costs assumed to be paid by industries	Abatement costs assumed to be paid by final uses (principally final consumption by households)

13.36. In the table, δ_i is a m x m diagonal matrix in which all off-diagonal elements are zeros and diagonal elements are equal to the percentages of pollutants abated. Using the percentage of pollutant tolerated in each industry[3] to distribute Y_g to intermediate inputs of each industry, the latter is reduced to zero. If X_g is measured in monetary terms, equation 13.3 which incorporates 13.2' becomes a conventional I/O model. The direct input coefficient matrix of the I/O model measures both inputs to the production of economic activities and inputs of pollution abatement activities.

13.37. The abatement cost assumed to be distributed to industries and final uses on the basis of a model incorporating equation 13.2' is presented in table 13.1 below. In addition to the separate line for distributed abatement cost, the table includes for each industry --i.e. economic and abatement activities-- and final use sector, the output, inputs, value added and fixed capital requirements. The abatement cost corresponds to the cost of pollution abated in each industry and in final uses, taking into account that pollution is only abated to a specified degree. In the allocation, it is assumed that each industry and final use must pay for the pollution it generates. The allocation is based on a maintenance cost valuation of abated pollution. Thus, pollutants in physical units have been converted to costs of abatement, assuming linear I/O relationships and direct costs of abating each unit of pollutant by type.

[3]The assumption made in equation 13.2' is not entirely realistic. Pollution abatement is normally required when the total level of a pollutant exceeds a specified tolerated level for a particular firm and not when a level of pollutant generated by each unit of output exceeds a specified level of tolerance. However, this micro and more realistic scenario cannot be well incorporated into an I/O model as the latter relies on a macro view of an industry in which establishments involved in similar activities are aggregated into industries.

Table 13.1. Pollution abatement input-output structure (based on monetary valuations abatement)

	Economic activities 1	...	Economic activities n	Abatement activities 1	...	Abatement activities m	Final uses
Output							
Inputs							
Abatement cost							
Value added							
Fixed capital requirements							

13.38. The model of 13.2' would require further refinement to the extent that payments for abatement services are often not paid for by the industries causing the pollution. Thus in practice the following scenarios may be encountered:

(a) Private firms, independent of industries produce abatement services and then collect fees from industries and final users who generate pollution;

(b) Industries produce abatement services as ancillary activities within the same establishment;

(c) The Government produces abatement services (e.g. garbage collection) and then either collects pollution taxes on products (i.e. indirect taxes) from industries and direct pollution taxes from final users that generate pollution, or provides implicit subsidies by not charging any fee.

13.39. To accommodate the three scenarios (a) - (c) mentioned above, the model needs to be modified. For cases (a) and (b), in table 13.1, the value added and consequent operating surplus of an industry are reduced by the abatement cost paid for by each industry. In case (b) abatement is carried out as an ancillary activity of the establishments themselves. To deal with this case, ancillary activities mentioned in (b) are treated in the model as separate establishments.

13.40. If in case (c) the Government carries out the abatement and charges for it through environmental product taxes (for instance fees for garbage collection paid for by industries), the operating surplus is similarly reduced by the abatement cost. On the other hand, if the Government pays for the cost of abatement, but does not charge a fee, the value added of the industries concerned must be modified to include a subsidy equal to the abatement costs so that their operating surplus will remain unchanged.

13.41. The costs to abate pollution generated by final users are part of final uses if paid for by final users, otherwise a subsidy equal to abatement costs has to be entered into the column of final uses.

13.42. It is not possible to discuss all possible modifications but suffice it to say that table 13.1 has to be analysed and modified to reflect government policies on the payment of abatement costs.

2. Financing investments in abatement equipment by sectors

13.43. Institutional sectors are the entities that make investment decisions and therefore an impact study of pollution abatement must pursue the additional capital costs that institutional sectors have to pay in order to abate pollution. Because of the abatement costs incurred by each sector, operating surplus and therefore savings needed to pay for fixed capital requirements of abatement equipment are affected. To determine these effects on the financing capacity of each sector, a "Green Value Added" after deduction of abatement costs, and fixed capital requirements by industries shown in table 13.1 must be allocated to the institutional sectors that own the establishments.

13.44. To achieve this reallocation, the cross-classification matrix between industries and sectors (CCIS) --a new analytical feature in the 1993 SNA-- might be used, as in table 13.2 below. In the CCIS matrix, common elements between the SUT (supply and use table) and IEA (integrated economic accounts), such as value added and capital formation, are cross-classified by industries and sectors.

13.45. To use the CCIS to reallocate industry data on output, inputs and value added to sectors, the CCIS matrix of value added for the base year may be used and assumed to be a share coefficient matrix that remains constant over time. Thus, in table 13.2 the shares of each sector are entered instead of levels. The sum of each column then adds up to 1.0. Some further work needs to be done to determine which sectors are carrying out each of the abatement activities and to estimate their shares.

Table 13.2. Cross-classification of value added by industries and sectors (CCIS)

	Economic activities 1	....	Economic activities n	Abatement activities 1	....	Abatement activities m
Non-financial sector						
Financial sector						
Government sector						
Household sector						

13.46. If the CCIS share matrix of value added is S_{vd} and V_{ind} is the diagonal matrix where the off-diagonal elements are zero and the diagonal elements represent value added classified by industries, then value added classified by institutional sectors (V_{int}) is:

$$V_{int} = S_{vd} V_{ind} \qquad (13.23)$$

13.47. The CCIS share matrix used to distribute abatement costs may not use the value added shares matrix but rather the shares of operating surplus. Fixed capital requirements might be linked to output by capital/output ratios. The allocation to institutional sectors of abatement costs and capital requirements is otherwise similar to equation 13.23.

13.48. The capital requirement when classified by institutional sectors would show investment capital needed to abate pollution by each institutional sector. These increased capital requirements are to be confronted for each institutional sector with the lower value added, operating surplus and net saving, due to the effects of pollution abatement.

13.49. The effects are illustrated in tables 13.3 and 13.4 below. Table 13.3 classifies the data by industries and final uses and table 13.4 is a reclassification of the data by institutional sectors. In table 13.3 it is assumed that an abatement cost of 10 is caused by economic activities of non-financial corporations and that the Government carries out the abatement activity and assumes the cost. Thus an environmental subsidy (-10) is imputed to economic activities, which eliminates the effect of the imputed abatement cost on operating surplus.

13.50. In table 13.4, the effects on the income and capital accounts of the non-financial sector and the government sector are shown. To convert the data of table 13.3 to a sector classification in table 13.4, the CCIS matrix is used. In this simple example it is easy to trace how the transactions of table 13.3 are reconstituted in table 13.4. For the non-financial sector, all other things being equal, the operating surplus will remain as before the introduction of pollution abatement and thus the net savings will remain 15 and the net lending will too. As the government sector carries out the abatement activity, its net borrowing is equal to -40 and the net savings due to its abatement policy is -10.

13.51. The above analysis could be made more interesting if the non-financial sector were broken down into many more sub-sectors with significantly different levels of pollution.

Table 13.3. Pollution abatement input-output structure (based on monetary valuations of abatement)

	Economic activity	Government abatement activity	Final uses
Inputs	50	4	
Abatement cost	10	1	
Value added	40	6	
Compensation of employees	35	6	
Environmental subsidy	-10		
Operating surplus	15	0	
Output	100	11	
Fixed capital requirement		30	

Table 13.4. Economic impact on institutional accounts

		Non-financial corp. sector	Government sector
Production account	Output	100	11
	Intermediate consumption (inputs + abatement cost)	60	5
	Value added (including environmental subsidy)	40	6
Income accounts	Operating surplus	15	0
	Environmental subsidies		-10
	Net savings	15	-10
Capital account	Capital formation		30
	Net lending(+)/net borrowing(-)	15	-40

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