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PROBLEMS OF INPUT-OUTPUT TABLES AND ANALYSIS

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PREFACE

0.1 The compilation, publication, and use of input-output tables has advanced rapidly in the last decade. Experience accumulated in the national studies undertaken by official statistical agencies and by private institutions has resulted in a growing international exchange of information and ideas concerning the methods and problems of input-output analysis. In co-operation with the Harvard Economic Research Project, the United Nations sponsored the third International Conference on Input-Output Techniques, held in Geneva in September 1961,[1/] as well as the publication of a comprehensive input-output bibliography.[2/] Among other international organizations, the question of the international comparability of input-output tables has recently received the attention of the Conference of European Statisticians,[3/] the Statistical Office of the European Communities has recently published tables for five member countries,[4/] and there has been an organized and detailed exchange of experiences among countries with centrally planned economies.[5/] Appendix II to this manual surveys in some detail the experience gained by many countries in this area of economic and statistical analysis.

1/ Barna, T. (ed.), Structural Interdependence and Economic Development, New York, 1963.

2/ Taskier, C.E., Input-Output Bibliography, 1955-1960, United Nations, 1961 (ST/STAT/7), and Input-Output Bibliography, 1960-1963, United Nations, 1964 (ST/STAT/SER.M/39).

3/ Statistical Commission and Economic Commission for Europe, Conference of European Statisticians, Report of the Working Group on Input-Output Statistics (Conf. Eur. Stats/WG.19/5).

4/ Statistical Office of the European Communities, Note on the Input-Output Tables for the Countries of the European Economic Community (3673/ST/64-E).

5/ Lukacs, O. (ed.), Input-Output Tables - Their Compilation and Use, Budapest, 1961.

0.2 The Statistical Commission of the United Nations, during its thirteenth session held in New York from 20 April to 7 May 1965, discussed the study on "Problems of Input-Output Tables and Analysis" (E/CN.3/317 and Add. 1). This study was prepared in response to resolution 8 (XI) of the eleventh session,[6] to serve as a reference source and aid to compilers and users of input-output tables. It outlined the principal problems of methodology, compilation, and application of the tables; in addition, appendices dealt with the comparability of input-output tables and outlined the national practices of selected countries.

0.3 The Commission agreed that the study was valuable as a basic guide to the concepts and methods of input-output tables and analysis. It was felt that it was particularly useful for statistical organizations which are either beginning or developing their work in this field, and also for those which are familiar with input-output theory but have had little experience in the practical problems of actually constructing the tables. It was considered that the study should be published after revision taking account of the Commission's discussion and other consultation with national statistical offices. The present study accordingly represents the revised version of document E/CN.3/317.

0.4 Official agencies and private institutions which have compiled input-output tables will find it descriptive of the sources and the uses to which these tables have been applied in other countries.

0.5 Official statistical agencies may find it useful in developing their activities in this field.

0.6 Through systematic review of practices adopted in the compilation of input-output tables in various countries, the comparability and therefore the usefulness of future tables may be improved. It is not however the purpose of the present manual to suggest a particular design for international standardization of national input-output tables.

0.7 The present manual is designed primarily for the official statistical authorities, whose responsibility is to make decisions on the compilation of inter-industry transactions tables. It is not designed for the input-output expert, nor

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6/ Official Records of the Economic and Social Council, Thirteenth Session, Supplement No. 12, para. 78.

is it meant to be a substitute for the textbooks and scholarly works which are available. The manual does not assume, on the part of the reader, the working knowledge of linear algebra which has become a prerequisite of the detailed operation of intersectoral models in economic analysis.

0.8 The topics covered in the manual may be considered to fall under three headings for purposes of presentation, although they are in practice inseparable: the form of input-output tables; problems associated with their compilation; uses of the tables. The theme which recurs throughout is that all statistical problems arising in the preparation of an input-output table can only be resolved by a knowledge of the specific purposes which they are intended to serve.

0.9 Chapter I describes the typical input-output transactions table and its relation to the theory of the open static input-output system.

0.10 Chapter II is devoted to selected methodological questions. Given the theoretical scheme outlined in chapter I, there are a number of ways in which the statistics available may be adapted for a table, depending upon the uses of the table and the nature of the data.

0.11 Some problems encountered in the collection and processing of data from the statistical sources are discussed in chapter III.

0.12 Various uses of input-output analysis are surveyed critically in chapter IV; this chapter discusses the variety of applications which are possible within the framework of the open static system. Linear programming, dynamic and regional analysis and other extensions of the input-output system in its simplest form are not considered in the present paper. Appendix I contains a note on the comparability of input-output tables among countries. The practices adopted by each country in the compilation of its tables are summarized in Appendix II.

0.13 In the preparation of this manual, the Secretariat has received the assistance of Dr. David Simpson of The Economic Research Institute, Dublin.

* * * *

CHAPTER I

INTRODUCTION TO THE FORMAL LOGIC OF INPUT-OUTPUT TABLES

I. Input-Output Tables and Input-Output Analysis

1.1 It is helpful to distinguish at the outset the input-output table from the analytical system to which it is related. The table is a statistical description of the inputs and outputs of the different branches of an economic system during a particular period of time. The input-output system is a theoretical scheme, a set of simultaneous linear equations in which the unknowns are the levels of output of the various branches, and in which the parameters are to be empirically estimated from the information contained in the input-output table. Accordingly, the assumptions of the theoretical scheme strongly influence the accounting conventions used in the table.

II. The Transactions Table

1.2 Table 1.1 is an actual input-output table, in which the number of sectors of production has been reduced to six for purposes of illustration. In all other respects, Table 1.1 is a typical[1/] example of an input-output transactions table or flow matrix. The economic system is visualized as consisting of a number of sectors each of which is represented in the table by a row and column. Along each row is distributed the current output of a sector, while the corresponding column records the current inputs to that sector. Thus the entry in the cell at the intersection of the 'i'th row and the 'j'th column represents that quantity of the output of sector 'i' absorbed as input by sector 'j'. Such a transaction between two sectors of production is usually denoted by the symbol x_{ij} while the total output of sector 'i' is written x_i.

1.3 The distinction commonly made in economic analysis between the production of goods and services and their final disposition is reflected in the division of the sectors of the input-output table into two groups, the production or intermediate

1/ Although the form of Table 1.1 is quite typical, specific entries may be peculiar to the Netherlands. For example, the entry at the intersection of the row Employees' Income and the column Gross Domestic Fixed Capital Formation is unusual.

TABLE 1.1

Simplified Input-Output Table (Netherlands 1956)
(unit: millions of guilders)

			Intermediate Demand							Final Demand						
			Agriculture, Fishing, Food 1.	Metals and Construction 2.	Textiles and Apparel 3.	Mining, Chemicals and Utilities 4.	Trade 5.	Services 6.	Intermediate Demand (Sub-total)	Exports	Household Consumption	Government Consumption	Gross Domestic Fixed Capital Formation	Net Increase in Stocks	Final Demand (Sub-total)	Total Demand = Total Output
Intermediate Inputs			I. Intermediate Production and Consumption							II. Final Output of Production Sectors						
	Agriculture, Fishing, Food	1.	6,419	-	39	175	1	352	6,986	3,532	5,576	15	-	-33	9,090	16,076
	Metals and Construction	2.	422	3,446	62	399	163	856	5,348	2,747	842	903	5,339	302	10,133	15,481
	Textiles and Apparel	3.	25	38	1,177	55	21	39	1,355	790	2,146	22	10	94	3,062	4,417
	Mining, Chemicals, and Utilities	4.	700	1,438	322	2,210	448	704	5,822	2,630	1,722	341	147	47	4,887	10,709
	Trade	5.	404	685	131	274	66	89	1,649	1,483	3,833	37	509	10	5,872	7,521
	Services	6.	268	516	141	417	1,241	1,046	3,629	3,893	3,735	225	248	65	8,166	11,795
	Intermediate Inputs (Sub-total)		8,238	6,123	1,872	3,530	1,940	3,086	24,789	15,075	17,854	1,543	6,253	485	41,210	65,999
Primary Inputs			III. Primary Inputs to Production							IV. Primary Inputs to Final Demand						
	Imports		2,547	3,293	1,161	3,016	348	1,614	11,979	368	1,683	319	1,856	238	4,464	16,443
	Depreciation		403	287	95	623	268	1,128	2,804	-	-	179	-	-	179	2,983
	Net Indirect Taxes		638	525	50	492	1,165	224	3,094	-	-	-	-	-	-	3,094
	Employees' Income		1,385	3,352	807	1,964	1,239	3,238	11,985	-	-	2,766	10	-	2,776	14,761
	Profits		2,865	1,901	432	1,084	2,561	2,505	11,348	-	-	106	-	-	106	11,454
	All Primary Inputs (Sub-total)		7,838	9,358	2,545	7,179	5,581	8,709	41,210	368	1,683	3,370	1,866	238	7,525	48,735
	TOTAL INPUT		16,076	15,481	4,417	10,709	7,521	11,795	65,999	15,443	19,537	4,913	8,119	723	48,735	

sectors on one hand, and the final sectors on the other.

1.4 The first quadrant shows the intermediate transactions, i.e. the flows of goods and services which are both produced and consumed in the process of current production. Since it is precisely upon these relations between the sectors of production that input-output analysis focuses attention, they are shown in greater detail, so that quadrant I usually occupies the largest part of any table.

1.5 The number of production sectors in input-output tables is usually in the range of 30 to 200; but even where that number becomes as high as 450, as in the most detailed table compiled hitherto, each sector represents the sum of a larger number of economic activities. Needless to say, there is not necessarily any correspondence between the detailed schemes of sector classification used in different countries. The composition of each sector is in practice governed by the industrial classification system in each country, since the information presented in input-output tables is largely derived from industrial censuses. However, the theoretical input-output system imposes certain requirements upon the table which may be formulated as classification criteria. This question is taken up in the following chapter.

1.6 The transactions table may be regarded as a disaggregation of the production account of a national accounting system. In that account, all intermediate flows are netted out on the grounds that they represent double-counting, but it is precisely this "double-counted" production which is the concern of the input-output system.

1.7 Corresponding to the expenditure side of the production account are the transactions recorded in the second quadrant of the input-output table, while the third quadrant represents the primary input side of the account. It should be observed that for each of the production sectors, the total value of output (the row total) must be equal to its total expenditures (the column total), while no such equality is imposed upon the individual final and primary input sectors. It is sufficient that the total of all the final sectors taken together should be equal to the total of the primary inputs. Total primary input is here defined to be equal to all factor payments plus depreciation plus net indirect taxes and imports. In the case where the entire table, or some of its rows, are described in the appropriate physical rather than monetary units, the balancing of row and column totals is of course impossible.

1.8 That part of the output of each of the sectors of production absorbed by consumption, investment and other uses defined as final is shown in quadrant II. Consumption by households makes up the largest part, but four other components of final demand are commonly distinguished: Consumption bv Government (i.e. all the purchases of goods and services by the Government and its agencies, excluding production activities); Gross Domestic Fixed Capital Formation; Net Additions to Stock; and Exports. Each of these sectors is highly aggregated in comparison to the sectors of production, yet each is conceptually quite distinct and corresponds closely to the related national accounting category.

1.9 Corresponding to the final demand columns there are rows showing the primary inputs. These inputs are usually described as primary because they are not part of the output of current production. Primary inputs into current production, shown in quadrant III, represent the value added in each sector of production as well as imports. They can be divided into the following categories: (a) Imports; (b) Depreciation; (c) Net Indirect taxes; (d) Income of Employees, and (e) Profits of Enterprises and Income of the Self-Employed, (or Operating Surplus). Not all actual tables present primary inputs in such detail but occasionally they are shown in an even finer breakdown.

1.10 The fourth quadrant is sometimes omitted from published input-output tables but for the sake of completeness it deserves to be mentioned. It records the primary inputs into final demand sectors, including such typical entries as the income of government employees and imports consumed directly by households.

1.11 Looking at the end of the first row in Table 1.1, it can be seen that the total output of the Agriculture, Fishing, and Food industries (hereafter referred to as the Agricultural sector) in the Netherlands in 1956 amounted to 16,076 million guilders. The first entry in this row is in column one, and indicates that the value of output produced and consumed within that sector itself was 6,419 million guilders. This includes such items as the value of animal fodder produced by farms and the value of livestock products and foodgrains consumed by the food manufacturing industries. The second entry in the row of the First Sector is blank, indicating, as one mignt expect, that none of this sector's output is used by the Metal and Construction industries. Further along this row, the entry in the sixth column shows that the Services sector absorbed 352 million guilders worth of output of agriculture, fish and food products, (purchased by hotels and restaurants) so that the total value of output of the first sector consumed by all production sectors amounted to 6,986 million guilders. Exports of these products accounted for 3,532 million guilders worth of output, while 5,576 million guilders worth was directly consumed in private households. Depletion of stocks to the value of 33 million guilders added that amount to total supply. But, although total deliveries for final use amounted to only 9,090 million guilders, the total value of gross output was much larger - 16,076 million guilders. The difference is accounted for by the value of output absorbed by all kinds of intermediate use. Thus in order to provide a given amount of its output for final use, any sector actually has to produce more than that amount in order to satisfy intermediate as well as final demand. This observation points to one of the fundamental features of the input-output system.

1.12 Just as row 1 records the distribution of the output of the Agricultural sector so column 1 lists the different inputs absorbed by the agricultural, fishing, and food industries. The first entry in the column is the intra-sectoral transaction already encountered in the sector row. Other entries in the column show that inputs of tools, other metal products, and services worth 422 million guilders were obtained from metal and construction industries, 700 million guilders worth of insecticides, chemical fertilizers and other products were inputs from the fourth sector, while the wholesale and retail trade margins upon goods purchased by the Agricultural sector amounted to 404 million guilders.

1.13 The primary input categories show that the total value of imports used by the sector in 1956 was 2,547 million guilders. Depreciation of capital equipment in the sector during the year amounted to 403 million guilders, while the value of indirect taxes paid to the Government by sector producers less the value of subsidies received amounted to 638 million guilders. Wages, salaries and other compensation paid to employees amounted to 1,385 million guilders, while the entry of 2,865 million guilders represents profits of enterprises and income of self-employed producers. The total recorded expenditures of the sector (column total) is necessarily equal through the accounting balance of current operating costs and revenues, to the value of gross output of the sector (row total).

1.14 This explanation of the row and column of the sector Agriculture, Fishing and Food can be extended to all other rows and columns of the table of transactions.

III. The Input-Output System

1.15 Having described the table of transactions, it is appropriate to turn at this point to the underlying theoretical scheme. Its elements can be defined in the following way:

x_{ij} = quantity of output of sector 'i' absorbed as an input by sector 'j'.

x_i = total output of sector 'i'.

y_i = quantity of output of sector 'i' absorbed by final demand.

a_{ij} = quantity of output of sector 'i' absorbed by sector 'j' per unit of output of sector 'j'.

r_{ij} = quantity of output of sector 'i' required directly and indirectly to satisfy one unit of final demand for sector 'j'.

F_{hj} = quantity of primary factor 'h' absorbed as input to sector 'j'.

f_{hj} = quantity of primary factor 'h' absorbed in sector 'j' per unit of output of sector 'j'.

F_h = total output (utilization) of primary factor 'h'.

y_h = quantity of primary factor 'h' absorbed in final demand.

m_{ij} = quantity of import of type 'i' absorbed as an input to sector 'j'.

1.16 It is important to emphasize that these variables represent flows which in theory are in physical units, and not in money values. Not only product flows but also the primary inputs of factor services are considered to be measured in physical units.

1.17 In its simplest form, the input-output system is derived from a set of accounting identities, and from a special assumption concerning the relations between the sectors of production in an economy.

1.18 Given an economy divided into n sectors then the total disposition of the physical output of each sector can be described by the following set of n equations:

$$
\begin{aligned}
x_1 &= x_{11} + x_{12} + \dots\dots\dots + x_{1n} + y_1 \\
x_2 &= x_{21} + x_{22} + \dots\dots\dots + x_{2n} + y_2 \\
&\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (1.1) \\
x_n &= x_{n1} + x_{n2} + \dots\dots\dots + x_{nn} + y_n
\end{aligned}
$$

1.19 The 'i'th equation in this system states that the total output of sector 'i' is equal to the sum of the quantities consumed by each production sector, including sector 'i' itself, plus the quantity consumed by all components of final demand. This row balance is necessary whatever units are chosen for each sector; note, however, that it is impossible to sum the elements of each column since each represents different physical units. In fact, such vertical summation is unnecessary for many of the analytical uses to which these figures lend themselves.

1.20 It is the specific assumption of the input-output system that the input from production sector 'i' to production sector 'j' is directly proportional to the output of sector 'j'. This assumption can be expressed in the following equation:

$$x_{ij} = a_{ij}x_j \qquad (i,j = 1\dots\dots n) \qquad (1.2)$$

where, using the standard notation, x_{ij} designates the flow from sector 'i' to sector 'j' x_j designates the total output of sector 'j', and therefore a_{ij} represents the input from sector 'i' to sector 'j' per unit of sector 'j''s output. The set of n^2 such equations is known as the set of <u>structural</u> equations, while the n equations (1.1) are known as <u>balance</u> equations.

1.21 The input-output system, in its simplest form, is designed to provide a solution for the n unknown levels of output of the production sectors in terms of the final demand for each sector, which is assumed to be known.

1.22 The desired solution can be obtained by substituting for each x_{ij} in the balance equation (1.1) the corresponding structural equation from (1.2), which yields the set of n equations:

$$
\begin{aligned}
x_1 &= a_{11}x_1 + a_{12}x_2 + \dots\dots\dots + a_{1n}x_n + y_1 \\
x_2 &= a_{21}x_1 + a_{22}x_2 + \dots\dots\dots + a_{2n}x_n + y_2 \\
&\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (1.3) \\
x_n &= a_{n1}x_1 + a_{n2}x_2 + \dots\dots\dots + a_{nn}x_n + y_n
\end{aligned}
$$

Transferring the x_i's to the left side this becomes:

$$
\begin{aligned}
(1-a_{11})x_1 - a_{12}x_2 - \dots\dots & -a_{1n}x_n = y_1 \\
-a_{21}x_1 + (1-a_{22})x_2 - \dots\dots & -a_{2n}x_n = y_2 \\
\dots\dots\dots\dots\dots\dots\dots & \dots \quad (1.4) \\
-a_{n1}x_1 - a_{n2}x_2 - \dots\dots & + (1 - a_{nn})x_n = y_n
\end{aligned}
$$

The general solution for the n unknown x's in terms of the given y's can then be written:

$$
\begin{aligned}
x_1 &= r_{11}y_1 + r_{12}y_2 + \dots + r_{1n}y_n \\
x_2 &= r_{21}y_1 + r_{22}y_2 + \dots + r_{2n}y_n \\
&\dots\dots\dots\dots\dots\dots\dots \quad (1.5) \\
x_n &= r_{n1}y_1 + r_{n2}y_2 + \dots + r_{nn}y_n
\end{aligned}
$$

where each coefficient r_{ij} represents the amount of output of sector 'i' required directly and indirectly to satisfy one unit of final demand for sector 'j'.

1.23 Before explaining the distinction between the coefficients a_{ij} and r_{ij} the method of calculating the level of utilization of the primary inputs associated with the computed levels of output of the sectors of production should be indicated. Defining F_{hj} to be the quantity of any primary input 'h' (for instance, man-hours of labour) absorbed in sector 'j', and assuming that this quantity is directly proportional to the level of output of sector 'j', then it can be written as:

$$F_{hj} = f_{hj}x_j \qquad (1.6)$$

where f_{hj} is a primary input coefficient showing the quantity of factor 'h' absorbed by sector 'j' per unit of output of sector 'j'.

1.24 Only the levels of output of the sectors of production, $x_1, x_2, \dots x_n$, appear as the unknown variables on the left hand side of (1.5), but when a solution is obtained the corresponding level of output or utilization of any primary factor can be derived from the equation:

$$F_h = f_{h1}x_1 + f_{h2}x_2 + \dots + f_{hn}x_n + y_h \qquad (1.7)$$

1.25 If the factor is labour, for example, then the expression (1.7) simply states that the total sum of man-hours of labour absorbed in the system is equal to the sum of the amount absorbed in each sector of production plus the known quantity absorbed in final demand sectors.

1.26 If the n x n set of coefficients a_{ij} is detached from (1.3):

$$\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \qquad (1.8)$$

(1.8) is known as the matrix of input coefficients. Since the value of these coefficients in the theoretical scheme is entirely independent of changes in relative prices, (although the prices might be considered to depend on the magnitude of the input coefficients; <u>see below</u>), and is held to be determined by technology alone, they are sometimes known as structural or technical coefficients. Typically, in input-output operations, they play the part of parameters, i.e. they are held constant while output is allowed to vary. The stability of the coefficients, i.e. the extent to which the coefficients remain constant as output levels of the production sectors vary, is an issue of critical importance which is discussed in chapter four.

1.27 The numerical value of the coefficients a_{ij}, is, of course, determined by the units used to measure the output of sectors 'i' and 'j'. For example, doubling the size of the physical unit which measures the output of any sector doubles the value of all the coefficients of that sector's column, and halves the value of all coefficients in that sector's row. This observation makes it possible to bridge the gap between the theoretical input coefficients described here, which represent purely <u>physical</u> relations in production and coefficients which can be derived from the actual <u>value</u> relations recorded in an input-output table of transactions. Equality of the two sets of coefficients can be demonstrated as follows.

1.28 Recall from (1.2) that the physical input coefficient is defined as:

$$a_{ij} = \frac{x_{ij}}{x_j} \qquad (1.2a)$$

1.29 Now any element of a transactions table such as Table 1.1 can be defined as $x_{ij}p_i$, a physical flow times its price; if each element in the table is divided by $x_j p_j$, then the result will be a set of value coefficients, which can be designated $\bar{a}_{ij}$ such that

$$\bar{a}_{ij} = \frac{x_{ij} p_i}{x_j p_j} \qquad (1.9)$$

Substituting from (1.2a)

$$\bar{a}_{ij} = a_{ij} \cdot \frac{p_i}{p_j} \quad (1.10).$$

1.30 Consequently, the observed coefficient $\bar{a}_{ij}$ will have the same value as the physical coefficient if the price at which a unit of output of each sector is valued is equal to unity. This simply means that if the physical unit of each sector is defined to be equal to that quantity which can be sold for one guilder (or any other money unit), then the physical input coefficient, if it could be actually observed, would have the same numerical value as the coefficient, $\bar{a}_{ij}$, derived from an input-output table of transactions in the manner described.

1.31 Measured in that particular way, the coefficients in each column of the matrix may be added. When all of the primary input coefficients are included the sum of each column is equal to 1, since the aggregate value of all the inputs of each sector in the table is defined to be equal to the total output of each sector. Since each column of the input coefficient matrix shows the distribution of the total cost of the corresponding sector in proportions which are, by assumption, invariant with respect to changes in the sectors' output levels, it is often referred to as the input structure or cost structure of the sector. It should be clear from the construction of the coefficients that no particular meaning can be attached to the composition or sum of any row of the matrix.

1.32 The transactions table performs the function of providing the statistical data from which the input coefficients, which are the parameters of the input-output system, are computed. It is true that there are usually modifications and variations in the way in which a transactions table is compiled so that variants of the coefficient matrix are possible, but such methodological issues may be left to the following chapter. For the present, it is easy to see how the input coefficient matrix, Table 1.2, is computed from the input-output table of

TABLE 1.2

Input Coefficient Matrix, (Netherlands 1956)

	1	2	3	4	5	6
1. Agriculture, Fishing, Food	.3993	-	.0088	.0163	.0001	.0298
2. Metals and Construction	.0263	.2226	.0140	.0373	.0217	.0726
3. Textiles and Apparel	.0016	.0025	.2665	.0051	.0028	.0033
4. Mining, Chemicals and Utilities	.0435	.0929	.0729	.2064	.0596	.0597
5. Trade	.0251	.0442	.0297	.0256	.0088	.0075
6. Services	.0167	.0333	.0319	.0389	.1650	.0887
All Primary Inputs	(.4875)	(.6045)	(.5762)	(.6704)	(.7420)	(.7384)

TABLE 1.3

Inverse Coefficient Matrix, (Netherlands 1956)

	1	2	3	4	5	6
1. Agriculture, Fishing, Food	1.6700	.0078	.0271	.0382	.0124	.0580
2. Metals and Construction	.0673	1.3020	.0396	.0699	.0513	.1111
3. Textiles and Apparel	.0049	.0060	1.3650	.0097	.0056	.0063
4. Mining, Chemicals, Utilities	.1071	.1632	.1399	1.2790	.0978	.1016
5. Trade	.0486	.0632	.0474	.0379	1.0160	.0177
6. Services	.0466	.0664	.0643	.0651	.1904	1.1100

transactions, by dividing each entry in Table 1.1 by the total of the column in which it is recorded. For example, the input coefficient from Metals and Construction into the Agriculture, Fishing, Food sector has the value of $\frac{422}{16,076}$ = .0263 which means that .0263 million guilders worth of Metal Products and Construction Services are directly required to produce 1 million guilders worth of the output of the Agriculture, Fishing and Food sector.

1.33 But this is only the direct requirement: in order to produce the necessary output of Metals, row 4 column 2 of Table 1.2 shows that, among other inputs, Chemicals are required, and chemicals cannot be produced without direct input from the Agricultural sector, as the element in column 4 of row 1 indicates. Evidently, the sectors of the input-output system are mutually interdependent, so that the production of a unit of agricultural output for final use requires not only the direct inputs listed in column 1 of Table 1.2, but also indirectly the inputs necessary to produce those inputs. The indirect requirements of any output for final use extend in a series which converges rapidly, as the following example illustrates.

1.34 Suppose it was desired to export 10,000 million guilders worth of output of the Agriculture, Fish and Food sector from the Netherlands economy in 1956. According to Table 1.2, this would require, in the first instance, production of 3,993 million guilders of agricultural output (in addition to the amount finally exported), 263 million guilders worth of Metals and Construction, 16 million guilders worth of Textile and Apparel, etc. etc. The further output necessary as inputs to produce these immediate requirements can be computed by multiplying each figure by the elements of the corresponding column of the matrix. Thus the further agricultural output required to produce the 3,993 million guilders of agricultural output directly required is (.3993 x 3,993) million guilders, while the amount of Metals and Construction output required is (.0263 x 3,993) million guilders. Likewise, the production of 263 million guilders worth of Metals and Construction output requires, in turn, (0 x 263) million guilders worth of agricultural output, (.2226 x 263) million guilders more of its own output, etc. etc. This procedure can be continued until the successive increments of output required of every sector become insignificant. If this procedure were actually followed to work out this example, the final conclusion would be that the delivery to a final use of 10,000 million guilders worth of agricultural output would directly and indirectly require production from each sector of the following amounts: From sector one, 16,700 million guilders; from sector two, 673 million guilders; from sector three, 49 million guilders; from sector four, 1,071 million guilders; from sector five, 486 million guilders; and from sector six, 466 million guilders.

1.35 These figures were simply written down from column one of Table 1.3. Each element in this matrix, designated r_{ij}, represents the quantity of output of sector 'i' required directly and indirectly to satisfy one unit of final demand for sector 'j'. Accordingly, each column of the matrix shows, for a unit final demand by the corresponding sector, the total output required from each sector represented by its row. Each element of a row shows the amounts required from that sector to satisfy a unit final demand for the output of each sector.

1.36 The matrix of coefficients shown in Table 1.3 corresponds to the matrix of coefficients

$$\begin{bmatrix} r_{11} & r_{12} & \cdots\cdots & r_{1n} \\ r_{21} & r_{22} & \cdots\cdots & r_{2n} \\ \vdots & \vdots & & \vdots \\ r_{n1} & r_{n2} & \cdots\cdots & r_{nn} \end{bmatrix} \qquad (1.11)$$

in the set of equations (1.5). These coefficients are computed from the input coefficients, a_{ij}, in (1.3) by inverting the matrix of coefficients on the left-hand side of (1.4). For this reason they are frequently known as the <u>inverse</u> matrix coefficients, although the name <u>total</u>, (i.e. direct <u>plus</u> indirect), input coefficients may be more descriptive in distinguishing them from the direct input coefficients.

IV. <u>The Price System</u>

1.37 The input-output analysis of the price system begins with the recognition that the unit cost of any good is composed of its material costs (the purchase of inputs from other sectors) and its direct primary costs, which include such items as wage costs, taxes, imports and other non-wage costs such as profits and amortization. If unit price is defined to be equal to unit cost, then the relations between the price of different goods can be expressed in the following way:

$$
\begin{aligned}
p_1 &= a_{11}p_1 + a_{21}p_2 + \dots\dots + a_{n1}p_n + v_1 \\
p_2 &= a_{12}p_1 + a_{22}p_2 + \dots\dots + a_{n2}p_n + v_2 \\
&\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (1.12) \\
p_n &= a_{1n}p_1 + a_{2n}p_2 + \dots\dots + a_{nn}p_n + v_2
\end{aligned}
$$

where p_i is the price of good 'i', a_{ij} is the familiar input coefficient representing the quantity of output of sector 'i' consumed per unit of sector j's output, and v_i is the sum of all primary costs, i.e. imports plus value added. Thus the 'i'th equation in (1.12) states that the price of a unit of good 'i' is equal to the value (price times quantity) of good 1 absorbed in one unit of its output, the value of all other inputs from sectors 2, 3, 4, etc. plus the primary costs incurred in its production.

1.38 The foregoing system consists of n equations with 2n unknowns - the n prices of goods and the n primary costs in each sector. Accordingly, if all of the primary costs per unit in each sector are known, that set of goods prices which is consistent with the specified primary cost can be determined. Conversely, if all goods prices are given the system of equations (1.12) determines the corresponding primary costs per unit of output in each sector. In fact, any combination of n prices or primary costs may be specified and the system may be used to determine the remaining n unknowns.

1.39 The analogy between the system (1.12) and the system (1.3) described above should be clear by now. When the terms of (1.12) are rearranged, and the general solution for the price system,

$$
\begin{aligned}
p_1 &= r_{11}v_1 + r_{21}v_2 + \dots\dots + r_{n1}v_n \\
p_2 &= r_{12}v_1 + r_{22}v_2 + \dots\dots + r_{n2}v_n \\
&\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (1.13) \\
p_n &= r_{1n}v_1 + r_{2n}v_2 + \dots\dots + r_{nn}v_n
\end{aligned}
$$

where r_{ij} represents the dependence of the price, p_j, of the product of sector 'j' on the primary cost, v_i, earned per unit of its output in sector 'i', is compared to the general solution for the output system,

$$
\begin{aligned}
x_1 &= r_{11}y_1 + r_{12}y_2 + \dots\dots + r_{1n}y_n \\
x_2 &= r_{21}y_1 + r_{22}y_2 + \dots\dots + r_{2n}y_n \\
&\dots\dots\dots\dots\dots\dots\dots \qquad (1.5) \\
x_n &= r_{n1}y_1 + r_{n2}y_2 + \dots\dots + r_{nn}y_n
\end{aligned}
$$

it can be seen that the rows and columns of the matrix of inverse coefficients, r_{ij}, have been interchanged, i.e. the inverse matrix in the price solution is the transpose of the inverse matrix of the output solution. With matrix algebra the following identity can be derived from (1.13) and (1.5)

$$x_1v_1 + x_2v_2 + \dots\dots + x_nv_n = y_1p_1 + y_2p_2 + \dots\dots + y_np_n \qquad (1.14)$$

This simply states that the sum of value added and imports in each sector is equal to the sum of all final demand times their prices.

1.40 The price and quantity solutions are independent of one another in the sense that changes in the relative price of the output of any sector are assumed not to affect the disposition of that sector's output, and the price is assumed to be unaffected by changes in the level of output. If the input coefficients, a_{ij}, are not interpreted as physical constants but as value ratios dependent upon price changes, the two solutions cease to be independent, and the system loses the simplicity which is essential for empirical applications.

1.41 Operations with the inverse matrix in cost-price problems are analogous to those performed in analysing the relations between output and final demand. Using the (transposed) inverse matrix the effects of changes in wages and other factor costs upon the relative prices of each sector's output may be calculated. Just as the level of output of a particular sector may be specified, so that the sector inputs are effectively moved to the final demand category and the equation for that sector is eliminated from the system determining the output solution, in the same way one of the links in the chain of cost-price relations may sometimes be disregarded.

1.42 In its usual form price analysis assumes that if wages or other factor costs rise uniformly through the economy, each industry passes on its increased costs plus the rise in the cost of inputs purchased from other industries.

1.43 However, it may be that one sector, let us say the 'j'th, absorbs the increased cost without raising the unit price of its output. Being known, p_j is moved from the category of dependent to independent variable and all the items of expenditure by other industries on sector j, $a_{j1}p_j$, $a_{j2}p_j$, ... $a_{jn}p_j$, are added to the primary costs (i.e. the independently determined cost) in the respective sectors 1, 2, ... n. At the same time, the equation defining the unit cost of sector 'j' is eliminated. When the price increases for each sector have been determined by multiplying the column of primary costs in each sector (except 'j') by the inverse of a matrix from which the 'j'th row and 'j'th column have been eliminated, then the solutions can be used to determine the unit primary cost in sector 'j'. This is the difference between the unchanged price and the inputs per unit from other sectors times their new prices. A numerical example of this procedure is given in chapter four.

1.44 Unit primary cost can be split into several items, wages, profits, imports, taxes, each of which, except taxes, may be written as the product of their price and quantity.

$$v_i = p_l l_i + p_k k_i + p_m m_i + t_i \qquad (1.15)$$

where l_i, k_i, and m_i are respectively the quantities of labour, capital and imports absorbed per unit of output of sector 'i' and p_l, p_k and p_m are the respective factor prices. t_i is the tax per unit of output paid by the producer. If the component factors are substituted for v_i in (4.1) the result is a system of equations in which there are many more unknowns than equations.

1.45 If the number of primary costs are reduced to two, labour and non-labour costs, so that

$$v_i = p_l l_i + \pi_i \qquad (1.16)$$

where π_i = all non-labour cost elements

then both p_l and π_i must be given in order to obtain a general solution to (4.1) if all other prices are unknown. Since l_i is also assumed to be a given coefficient, this is tantamount to a single unknown factor input. In practice, the distinction between labour and non-labour cost is useful because of the size of the labour cost element and the possibility of its measurement in physical units.

1.46 Consequently, an empirically useful system for analysing price-cost relations might be of the following form:

$$p_1 = a_{11}p_1 + a_{21}p_2 + \cdots\cdots + a_{n1}p_n + l_1p_1 + \bar{\pi}_1$$
$$p_2 = a_{12}p_1 + a_{22}p_2 + \cdots\cdots + a_{n2}p_n + l_2p_1 + \bar{\pi}_2 \qquad (1.12a)$$
$$p_n = a_{1n}p_1 + a_{2n}p_2 + \cdots\cdots + a_{nn}p_n + l_np_1 + \bar{\pi}_n$$

1.47 In this sytem, the elements a_{ji}, l_i and $\bar{\pi}_i$ are all constants, while there are 'n' equations and n + 1 unknowns (n p_i's and p_1). Accordingly, it is necessary to specify one price in order to obtain a numerical solution. Alternatively, a solution can be obtained for all other prices as a ratio of one price. In the latter case, the price of labour is often selected as numéraire.

1.48 The effects of changes in wages can be computed by specifying appropriate values for p_1, while the effects of changes in taxes, depreciation, imports and other elements of primary cost can be determined by specifying changes in π_i.

In summary,

$$p_j = \sum_j r_{ji} v_i \qquad (1.13)$$
$$= \sum_j r_{ji}(l_i p_1 + \bar{\pi}_i) \qquad (1.17)$$
$$= \sum_j r_{ji} l_i p_1 + \sum_j r_{ji} \bar{\pi}_i \qquad (1.18)$$

choosing $p_1 = 1$ as numéraire, then

$$p_j = \sum_j r_{ji} l_i + \sum_j r_{ji} \bar{\pi}_i \qquad (1.19).$$

1.49 This formulation, which follows from (1.12a), can be used in the applications of input-output analysis to the price system, described in chapter 4.

V. The Open Static System

1.50 The theoretical scheme described above has been referred to as "the input-output system". More precisely, it should be referred to as the "open static input-output system" to distinguish it from the variants and extensions of this analytical method. The open static system described here is in fact the core of all forms of input-output analysis. Typically, a transactions table is compiled for a certain year, known as the base year, and the coefficient matrices derived from the table are used to perform operations upon data which may relate either to the base year or to later years. In these operations, the levels of output of the n sectors of production are usually taken to be the dependent or unknown variables, while the items of final demand are usually specified from a separate computation and are thus constants in the input-output analysis. From the algebraic point of view, it does not matter whether it is the outputs or the final demands of each sector which are specified: any h of the n output variables and k of the final demand variables may be regarded as unknown so long as $h + k = n$. The designation of variables as dependent or independent depends entirely upon the particular problem studied: in the majority of cases it may be appropriate to treat the output level of a sector of production as unknown, but for other purposes, it may be appropriate to regard the output of the same sector as independently determined. Consequently, the assignment of sectors to the category of production sectors or autonomous sectors in a transactions table is somewhat arbitrary. For example, the Households sector in table 1.1 is included in the autonomous category, so that inputs into Households are recorded in a final demand column while the outputs provided by Households in the form of labour services are entered in a primary input row. If the inputs into Households (private consumption expenditures), are assumed to be dependent upon the level of output of that sector (the volume of employment), as for certain purposes they may be so considered, then Households becomes, in effect, a sector of production and both row and column should be moved into the first quadrant so that the appropriate coefficients may be included in the matrix. So long as there is at least one sector remaining in the autonomous category the input-output system is known as an open input-output system; if all of the sector outputs are regarded as dependent variables, the system is said to be closed.

1.51 While the distinction between production or intermediate and autonomous sectors in an input-output table is an arbitrary one depending upon the uses of the table, the analagous distinction between intermediate and final consumption is a crucial one in national income accounting, for the value of the national income[2] depends precisely upon where the line is drawn. Consequently, it is customary in the presentation of input-output tables to use the division of economic activity between intermediate and final consumption prescribed by national accounts.

1.52 To the extent that definitions of national income differ between countries, the boundaries drawn in the input-output tables of countries will also differ. For example, countries with centrally planned economies adhere to the Net Material Product concept, which excludes non-material services from the category of production. An input-output table drawn for such an accounting system in the form of table 1.1 would include in the row and column of sector six the outputs and inputs of material services only. The output of non-material services would be entered in a primary input row while inputs absorbed by non-material services would be recorded in a final demand column. Such differences are matters of definition only, and the input-output tables of countries with market ec onomies can be reconciled with the tables of countries having centrally planned economies if the former group would distinguish in separate rows and columns material and non-material services while at the same time the latter would record the inputs and outputs of non-material services as a distinct (autonomous) sector.

1.53 The intersectoral transactions recorded in an input-output table, such as table 1.1, are confined to currently produced goods and services: transfers[3] of income and financial flows are excluded from the table entirely. The table does not show the sector of destination of currently produced capital goods - they are assigned to Gross Fixed Capital Formation or another of the columns of final demand. A table showing the flows of capital goods combined with current goods and services from sector of origin to sector of use would be of little value in input-output analysis. Since there is no reason to expect any stability in the relationship between investment and output observed in one year, input coefficients computed from this more general matrix would have little plausibility.

2/ The expression "national income" is used here and elsewhere in the text to refer to the concept of the annual flow of goods and services, which is measured in many different ways. The measure yielded by an input-output table depends upon the arrangement of the table. Typically, in market economies the measure would be gross domestic product at market prices; in centrally planned economies, net domestic (material) product at market prices.

3/ Payments of indirect taxes less subsidies received by sectors of production are recorded as primary inputs, however.

1.54 Dynamic input-output systems introduce explicitly periods of time into the relationship between capital and output. The factor of time is an essential ingredient of any model which tries to explain the accumulation of capital. The system described in this chapter takes capital accumulation as independently determined and is therefore a static as well as an open input-output system.

1.55 The transactions table, which is the statistical foundation of the open static input-output system, is the table of principal importance in input-output studies. Other supporting tables which often are compiled simultaneously include tables of transactions in physical units and tables of imports as well as more specialized tables dealing in detail with the transactions of particular sectors, regions, and organizations. The latter are described in the fourth chapter: this chapter concludes with an account of two common forms of supporting tables.

VI. Tables in Physical Quantities

1.56 Almost all transactions tables are prepared in money values. The reasons for using value rather than quantity units are strictly practical: for one reason, most statistics relating to inter-industry transactions are available only in money values, e.g. the purchases of materials by enterprises. The truly compelling reason, however, is that value is the simplest common denominator of the various different commodities which constitute a sector in an input-output table, and it is logical to perform the necessary aggregation using prices as weights for physical units.

1.57 Theoretically, however, it is essential that input-output tables be interpreted in physical units. The input-output system depends for its solution upon the assumption that inputs are dependent upon the level of the corresponding output in physical terms alone, and that inputs are invariant with respect to change in prices.

1.58 Clearly it would be desirable to isolate possible changes in physical input coefficients from changes in relative prices, yet input-output tables in value units combine the influence of both factors. To eliminate the effect of price changes, a series of tables may be prepared for different years in the constant prices of some given year. But often price data do not exist in sufficient detail for these comparisons to be helpful; furthermore, changes from year to year in the proportions of the different components of each sector affects the value of the coefficients.

1.59 To estimate actual physical relations in production and their changes, a number of countries have prepared transactions tables for selected commodities. These are usually rectangular, specifically they have more rows than columns, since data on the distribution of commodities among sectors are usually more easily available than information about the physical composition of individual commodities. For example, a table was prepared in the Soviet Union showing the production and distribution in 1959 of 157 products of major importance in the form of aggregates such as coal, rolled iron and steel goods, sawn timber, etc. The information necessary to prepare this table was derived from a sample survey covering 20% of all industrial enterprises and construction sites. The advantage of such tables is that they do show the structure of actual physical inputs independently of changes in relative prices and in product mix. The drawback is that it is impossible to give a complete picture of the economic system in such detail. Therefore tables in physical quantities, while preferable in theory, have always lacked the scope and therefore the applicability of tables compiled in values. However, tables showing some inputs in value and some in physical units (e.g. output of electric energy in kilowatt-hours and labour in man-years), are sometimes used to provide supplementary information.

VII. Tables of Imports

1.60 In table 1.1 all imports were entered in a primary row in the column of the purchasing sector. While this is a common convention for treating imports, it has the disadvantage of concealing the nature of the imports, information which is useful if some of the imports are competing with domestically produced goods. If an import is a substitute for a domestically produced good then an increase in purchases of the domestic good may occur at the expense of the import (or vice versa), thus causing a drastic change in the domestic input coefficients. Accordingly, some countries have prepared special tables which in form resemble the first two quadrants of table 1.1. Each element, m_{ij}, in the table represents the flow of imports which are substitutes for goods produced in domestic sector 'i', absorbed as inputs by domestic sector 'j'. Non-competing imports, i.e. imports for which no comparable domestic sector of production exists, are relegated to a primary input row. The sum of each column of a table of this type would be equal in value to the entry in the corresponding column of the import row of a table such as table 1.1 The various methods of treating imports in an input-output table are described in greater detail in the next chapter.

VIII. Some Uses of Input-Output Tables

1.61 Although the methods of input-output analysis are discussed fully in later chapters, it is important to emphasize at this stage that there is no unique method of analysis, and that methods differ according to the particular uses. Each specific problem governs the method of analysis and ultimately the selection and arrangement - or the rearrangement - of the basic data. However, the type of transactions table described in this chapter has been the fundamental chacteristic of all input-output analysis, because of the relative simplicity of its statistical requirements compared to other intersectoral models, and because of the range of uses to which it may be adapted. Two broad uses to which the transactions table is commonly applied may be mentioned.

1.62 An interesting and simple application of input-output analysis is to the relationship between the various components of final demand and various primary inputs such as labour, capital, or imports. To make a final delivery of a given quantity of the output of sector 'k' requires the output of a number of sectors, the exact quantities being computed by multiplying column 'k' of the inverse coefficient matrix by the number of units of final demand. Each of the required outputs absorbs in the process of its production a certain amount of primary inputs. (By definition, the use of primary inputs does not establish any further demand: the fact that labour requires sustenance and that capital must be replaced is ignored.) Consequently, the use of a calculable quantity of primary inputs can be attributed to a given amount of final demand for the output of a particular sector. The relationship can be expressed more exactly as follows:

1.63 Let f_{hj} again represent the quantity of primary input 'h' absorbed per unit of output of sector 'j', and that

$$F_{hj} = f_{hj}x_j \qquad (1.6)$$

where F_{hj} is the quantity of primary input 'h' absorbed in sector 'j'. But the total amount of the output of sector 'j' required to satisfy 'y' units of final demand for sector 'k' is

$$x_j = r_{jk}y_k \qquad (1.20)$$

Therefore, the total amount of factor 'h' required to produce the output of sector 'j' satisfying 'y' units of final demand for sector 'k' is

$$F_{hk} = f_{hj}r_{jk}y_k \qquad (1.21)$$

Therefore, the total amount of factor 'h' required to satisfy the final demand for 'y' units of sector 'k' is

$$\sum_{j=1}^{j=n} f_{hj} r_{jk} y_k \qquad (1.22)$$

where 'n' stands for the total number of sectors of production. Dividing this term by y_k results in the term

$$\sum_{j=1}^{j=n} f_{hj} r_{jk} \qquad (1.23)$$

which represents the total amount of factor 'h' required per unit of final demand for sector 'k'. This is sometimes known as the factor content of sector 'k'.

1.64 The transactions table may be viewed, on the other hand, independently of any functional relations as **one comprehensive, detailed and consistent framework** for organizing economic statistics. In the process of assembling the table, inconsistencies, gaps and redundancies in the statistical system of the economy are revealed when data which are usually prepared independently (e.g. national accounts, industrial production, foreign trade, and employment statistics) are incorporated in a common classification. Such a statistical or accounting function has perhaps been the most common first application by government statistical offices of a new table.

1.65 Considerable scepticism has often been expressed concerning the usefulness of input-output analysis in developing economies, notably in those which have a large subsistence agricultural sector. It is argued, on the grounds of cost, that the statistical resources required to compile an input-output table could be better applied to preparing simpler information which is more immediately applicable. On the other hand, the value of input-output studies has been questioned in an economic system where there is so little interdependence between sectors. These issues can only be settled in particular cases. However, it may be observed (a) that the cost of gathering the necessary data in such economies may not be very great, (b) that the input-output table may provide a suitable framework for organizing economic statistics, and (c) that it may be possible to infer something about the likely <u>future</u> structure of the developing economy from a knowledge of the structure of more advanced economies, and that the value of the influence may be enhanced by a comparison with the present input-output structure of the economy.

1.66 Despite the simplicity of the concepts in input-output analysis, formidable problems arise in the empirical measurement of the variables. Those are discussed in the following chapter. There are no absolutely "correct" methods of selecting, measuring, and classifying data in input-output tables; the criteria always depend upon the ultimate uses of the table. For this reason compilers of input-output tables should always have in mind their particular uses before undertaking the necessary statistical work.

CHAPTER II

THE METHODOLOGY OF INPUT-OUTPUT TABLES

I. General

2.1 In Chapter I, the open static input-output system was developed from the statistical table of transactions. Logically, however, the direction of this procedure is just the reverse: the table itself cannot be prepared without rules which can only be derived from some theoretical conceptions. This chapter demonstrates the influence of input-output theory upon the methods adopted in compiling the statistical tables, and shows not only that the result is necessarily a compromise between considerations of theory and feasibility but also that alternative methods of arranging the basic data may be desirable. The usefulness of any applied analysis depends upon the relevance of the data as well as upon the appropriateness of the theoretical assumptions. In both respects, the particular application of input-output analysis governs the preparation of the statistical table of transactions. In Jaffé's words:

> "It is therefore appropriate to look at a study of inter-industry relations ... as embracing a set of general purpose tabulations which can be regrouped or reorganised to best fit the requirement of any analytical uses for which the interindustry approach is proper." 1/

2.2 The static input-output system in its simplest form is founded upon three assumptions:

(i) Each sector produces a single output, with a single input structure, and there is no automatic substitution between the outputs of different sectors;

(ii) The inputs into each sector are a linear function only of the level of output of that sector; i.e. the amount of each kind of input absorbed by any particular sector goes up or down in direct proportion to the increase or decrease in that sector's total output.

(iii) The total effect of carrying out production in several sectors is the sum of the separate effects.

1/ Sydney A. Jaffé, "Final Demand Sectors", in Input-Output Analysis, Technical Supplement, N.B.E.R. New York, 1954, Chapter I, p. 4.

2.3 The first assumption, known as the homogeneity assumption, requires (a) that all products of a single sector should either be perfect substitutes for one another or they should be produced in strictly fixed proportions; (b) that each sector should have a single input structure[2/] and (c) that there should be no substitution between the products of different sectors. The second assumption is known as the proportionality assumption, since the relation which in practice is assumed to hold between inputs and output is a linear homogeneous one. The third assumption is known as the additivity assumption and rules out any form of external interdependence between the sectors other than that specified by the input-output system.

II. The Statistical Unit

2.4 The extent to which these assumptions hold depends largely upon the nature of the statistical entities or units between which the transactions are recorded and the way in which these units are grouped. The most evident difficulty is presented by the first assumption. Even if each commodity could be represented by a separate sector, so that both inputs and outputs were perfectly homogeneous, there would be considerable substitution between sectors. This is quite independent of the fact that it would not be feasible to assemble the necessary information for a table consisting of tens of thousands of sectors. On the other hand, if the number of sectors is small, the assumption that each sector represents a homogeneous product and a homogeneous set of inputs is untenable.

2.5 A more detailed classification always provides greater information and up to a certain point it may actually be easier to compile, since many statistics are available only at a very detailed level. But, in general, the greater degree of detail the greater is the cost of preparing the table, and the greater is the likelihood of substitutability and the prevalence of "external" effects

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2/ A proposition can be deduced from the assumptions of the input-output system which shows that, if there is only one scarce factor, (or one group of factors whose relative prices remain unchanged), then there is only one efficient combination of inputs into each sector. Even if several alternative input combinations exist only one will ever be efficient, regardless of changes in the composition and level of final demand, and that is the one which minimizes the use of the scarce factor.

between sectors. Since the number of sectors is limited for these reasons, each one necessarily is composed of groups of statistical units. How these groups or sectors should be formed is the problem of classification, but before considering this problem it is necessary to describe the component statistical unit. A statistical unit may be any of the following: (a) a commodity group; (b) an establishment such as a farm, a mine, or a factory; (c) an activity such as trade or construction; or (d) an institution organizing a branch of the economy such as enterprise or government agency.

2.6 Each of these units is homogeneous in the sense that there exists a common factor in each one, but they may not have the attribute of homogeneity as it is used in the input-output sense to refer to the first of the fundamental assumptions.

2.7 It is conceivable that a grouping of commodities might satisfy most of those assumptions, at least approximately. Accordingly, a commodity classification of sectors is perhaps the most desirable, even if it is seldom attained. While industrial statistics make it rather easy to trace the output distribution of commodities among broadly defined units, it is usually more difficult to discover the commodity input structure of detailed commodities or commodity groups.

2.8 On the other hand it is relatively easy to trace the inputs of materials absorbed by a plant or other establishment since it forms a conventional accounting unit. This is perhaps why the industrial statistics gathered in the censuses of production of most countries take the establishment as the statistical unit. The disadvantage of the establishment as a statistical unit is that more than one activity may take place, producing more than one commodity. In this case one should then ideally break down the establishment into its constituent activities, and group together all activities producing a single commodity, but the necessary information generally does not exist. Consequently, establishments are usually classified according to their principal activity and its corresponding product, so that the statistics for each establishment include the inputs and the outputs of secondary products. Methods of dealing with these secondary products are described below.

2.9 Often, establishments constitute a unit of specialized equipment and manpower, within which rapid substitution possibilities are limited in the short run. To the extent that an establishment represents a combination of products and processes it is likely that this combination will be stable, i.e. all the elements will change in proportion. In this respect, the establishment is a more appropriate statistical unit for manufacturing than the enterprise which combines several (not necessarily related) establishments.

2.10 For certain economic activities, such as transport and wholesale and retail trade, which consist of a change in the location of commodities rather than their physical transformation, statistics are often available on an activity basis (e.g. number of freight ton-miles hauled by railroads). This may also be true of construction (number of houses built).

2.11 In other activities, such as agriculture and mining, the available statistics have frequently been compiled on a commodity basis.

2.12 In practice, a variety of statistical units are usually used in the preparation of an input-output table, which typically depends for its data upon existing sources of information. In order to approximate more closely an ideal classification, from the input-output viewpoint, supplementary statistical studies of a sampling kind might usefully be carried out to distinguish, for example, two important activities carried on within the same type of establishment, or to go a stage further, the statistical units which form the basis of the industrial data might be revised.

III. Classification and Aggregation

2.13 Ideal criteria for classification cannot be consistently applied since no commodity is truly homogeneous. An average ton of steel, yard of cotton cloth, or ton of coal are all aggregates of a variety of qualitatively different grades whose content (input structure) and uses (output structure) differ. The prices per ton of different grades of steel reflect in part the different quantities of labour and raw materials used in their production, and it is therefore preferable to aggregate them according to value rather than according to physical quantity.

2.14 Since classification implies grouping, the question of classification of economic activities for input-output tables can be regarded as a problem of aggregation. It is useful to divide the aggregation problem in input-output analysis into two parts - the aggregation which is implicit in the initial decision establishing the degree of detail of the worksheets, and that which occurs when an original input-output table has a number of its sectors consolidated. In both cases, the method of aggregation determines the values in the aggregated table, but only in the latter case is it possible to actually calculate the bias introduced, by comparing, for example, the inverse matrix of the aggregated version of the table, with the aggregated inverse of the original table. In this way we can test criteria of aggregation, and draw conclusions which are applicable to the question of classification.

2.15 It is easily shown that the input coefficients of an aggregated input-output sector are weighted sums of the constituent coefficients of the original sectors, the weights being the relative size of each sector's output. So that even if the original input coefficients are all stable, the aggregated coefficients therefore have a numerical value which depends on the relative value of the output of each original sector, which in most applications of input-output analysis are taken to be the unknown variables. There are only two cases in which the values of the aggregated coefficients will not be affected by changes in the level of output, (i) if all corresponding input coefficients in the sectors being aggregated are of equal value, and (ii) if the output of all the original sectors within each aggregated sector changes in equal proportion. If all sectors could be grouped so that they satisfy these two conditions then the aggregation could be termed "acceptable". Acceptability is the requirement that for all possible variations in final demand, the total output, when aggregated, of the original sectors should be equal to the total output of the aggregated sectors.

2.16 These two aggregative criteria may be translated into two criteria for classification of units in input-output sectors:

(i) units which have a similar input structure should be grouped together even if they have different uses, e.g. cars and tanks;

(ii) units whose output is likely to change in equal proportion should be grouped together. For example, this might be true of such consecutive stages of the productive process as the carding, spinning, weaving, and dyeing of textile fabrics.

2.17 If units are classified in a sector so that neither of these conditions is fulfilled, whenever the output levels of the constituent activities change, the inputs will not remain in the proportionate relation to output recorded in the base year. In practice, experience in the preparation of input-output tables has shown that most existing industrial classifications are remarkably satisfactory because they tend to group activities with homogeneous input requirements. However, since the aforementioned conditions are never obtained exactly other considerations enter into the determination of the classification scheme for an input-output table.

2.18 At this point, the distinction between horizontal and vertical aggregation should be made clear: horizontal aggregation involves the aggregation of parallel stages in the process of production, in contrast to vertical aggregation, the aggregation of consecutive stages in the process of production. Both types of aggregation are usually implicit in the data relating to that basic statistical unit, the establishment, to the extent that within each establishment a set of vertically integrated activities takes place and more than one commodity is produced.

2.19 The grouping of activities on the basis of the homogeneity of their input structure is an example of horizontal aggregation while a grouping of activities which are related by consecutive stages in the process of production illustrates the principle of vertical integration.

2.20 Chenery and Clark distinguish two broad areas of production; first, the successive operations on a single raw material, and secondly, the processing of intermediate goods. For the first they suggest that vertical aggregation is appropriate and for the second horizontal aggregation.

2.21 It is sometimes argued that the alternative method of horizontal aggregation, i.e. of grouping activities which have a homogeneous output structure, should be undertaken. It happens frequently that two commodities may be excellent substitutes for one another in consumption, but may have quite different input structures. To aggregate them is evidently to violate the classification criterion which requires the homogeneity of input structures, yet to classify them in separate sectors is to violate the assumption that there is to be no substitution between sectors. For example, if the two commodities in question are wool and a synthetic fibre, and the table is to be used to determine output requirements for consumer demand projected five years ahead, it is sometimes argued that it is wiser to aggregate the two commodities on the grounds that if they are really close substitutes in consumption, the distribution observed in the base year may simply reflect a temporary division of the market. This argument is misleading, however. Even if the estimated demand for the individual commodities is not accurate, the estimate of the combined demand can be obtained as the sum of both. Furthermore, if the object of the study were to estimate the demand for imports, and, assuming further, that the total import requirements of a unit of synthetic fibre and wool are quite different, then the correct decision would be to separate the two commodities.

2.22 The most common form of vertical aggregation occurs within the establishment, where several consecutive processes of production may occur. So long as all of the intermediate commodities are produced and consumed entirely within the establishment, the original inputs to the establishment are likely to stand in a stable proportionate relation to the establishment's final output. But if a substantial part of the intermediate commodity is sold to, or purchased from, establishments in other sectors, then vertical aggregation of the processes may introduce a serious error since the proportion purchased or sold by the establishment may easily vary. The usefulness of vertical aggregation is also dependent upon the purpose of the analysis. If the object is to study technological change, it would probably be desirable to distinguish successive stages in the production processes and to combine parallel stages, since inventions often affect individual processes one at a time.

2.23 Even "acceptable" forms of aggregation involve a loss of information; in determining the degree of detail in various parts of the table, the cost of obtaining the necessary additional information must be set against its usefulness, i.e. the uses of the table as well as the quality of the data should be taken into account. In general, relatively fine detail in some parts of the table combined with considerable aggregation in other parts is undesirable unless it reflects the relative significance of the sectors for the purpose of a particular study.

2.24 However, there is a third criterion for aggregation - irrelevancy. If the analysis is primarily concerned with a few sectors, then other sectors which are only weakly related can often be aggregated without introducing significant errors into the result. "A system of aggregation which can serve as an acceptable basis for the analysis of the interdependence between the paper and the automobile industries might prove to be completely inefficient if one tried to use it in estimating, say, the indirect effects of housing construction upon rubber imports."3/

2.25 Two further points may be mentioned in this connexion: in examining the classification of commodities, it may be worth considering not only the relations presently existing within the economic system, but also those likely to prevail in the future as a result of technical progress or the introduction of new industries into the region in question. Secondly, aggregation of sectors is sometimes adopted as a solution to the problem of secondary products, a problem which is discussed later.

2.26 In practice, the nature and detail of the classification scheme in an input-output table depends on an appreciation of specific data availability and upon the purposes of the study rather than upon an automatic imposition of ideal criteria.

IV. Valuation of Transactions

2.27 In theory, there should be no ambiguity about recording transactions between sectors in an input-output table. In practice, the attempt at measurement reveals a number of problems, many of which can be resolved by reverting to the theoretical framework which the table is designed to fit, and others which can only be decided arbitrarily.

2.28 First of all, it should be clear that not all monetary transactions are relevant to an input-output table, but only those which have a direct bearing on current production. Consequently, all purely "financial" transactions, such as loans, advances, sales and purchases of securities should be excluded. The transfer of ownership of assets produced in the domestic economy before the period to which the table refers should also be excluded.

2.29 Currently produced capital goods, except when used for routine replacement, cannot be regarded as standing in any proportionate relation to the base-year output of the sectors which utilize them, so they must be allocated to capital formation or one of the other final demand sectors. The distinction between

3/ W.W. Leontief, "Structure of American Economy" 2nd edition, New York 1951, p. 207.

capital goods and others is evidently an arbitrary one which is frequently determined by the nature of existing accounting methods, but any good which is expected to have a life of more than one year may be classified in principle as a capital good.

2.30 Just as all monetary transactions are not included in an input-output table, so all non-monetary transactions are not excluded. Thus, in principle, the value of animal fodder grown on farms and consumed by farm stock should be counted as well as such income in kind as consumption of farm produce by farm families and consumption of coal by coal miners. Likewise, the transactions in kind of a peasant or small handicraft economy might well be shown in the table. Whether or not such items are in practice included in an input-output table depends upon the statistical practices of the country in question and the relative significance of such transactions.

2.31 The sales of sector (i) to sector (j) are not necessarily equivalent to the inputs from sector (i) to sector (j). Adjustment in data concerning sales and purchases must be made to take account of changes in stocks. Inputs can be defined to be equal to the purchases of all materials less additions to stocks of materials. Output can be defined to be equal to value of shipments plus additions to the stock of final products plus net additions to stock of goods-in-progress. The additions to stocks of materials can be entered in a special column in the final demand sector of the row corresponding to the industry of origin of the materials. The problem of work-in-progress makes output estimates difficult in the case of industries, such as ship building and aircraft or construction, which have long periods of production.

V. Producer's and Purchaser's Prices

2.32 Any transaction, if described in monetary rather than physical units, may be valued at either the price received by the producer or the price paid by the purchaser; the difference is composed of marketing costs, which include such items as transport costs, wholesale and retail trade mark-ups, insurance and warehouse costs, and net indirect taxes.

2.33 An input-output table may accordingly be valued either in producer's or in purchaser's prices. Under the former system, each of the marketing cost items is shown as an input from the appropriate sector, Transport, Trade, Finance, Services and Government respectively to the purchasing industry. Under the system where every transaction is valued at the purchaser's price, the elements of marketing cost are shown as inputs to the producing industry. In both systems, the inputs of marketing costs measure only the margins added to the producer's price by the various elements. The reason for this is clear: if all goods delivered by the transport system were regarded as the inputs to that sector, the homogeneity of the sector and thus the usefulness of the table would be entirely lost.

2.34 Since most statistics record transactions at the price paid by the purchaser, tables using that system of valuation are more easily prepared. And for certain purposes, the table in purchaser's prices may even be more useful. But such a table suffers from three disadvantages, which in general are sufficient to make producer's prices the preferred system of valuation in an input-output table. Under the purchaser's price system, the row total of each sector, which forms the output control total for computing input coefficients, includes the marketing costs incurred in each delivery of that sector's output. Now marketing costs will probably vary as the output distribution changes, and thus lead to variations in the value of total output even if actual production of that sector remains unchanged. This means that coefficients estimated in the base year are likely to be unstable.

2.35 Secondly, under this system, all marketing costs are counted twice, in the value of output of the producing industry and as inputs to that industry from the marketing cost sectors. Under the producer's price system, on the other hand, all outputs including the control totals, are valued f.o.b. plant, and marketing costs are therefore counted only once.

2.36 Thirdly, under the system of producer's prices, marketing costs will vary with the input structure of an industry, which is generally more stable than the output structure, so that coefficients computed in the base year from a table valued under this system are likely to be more stable than those valued under the purchaser's price system. Finally, the system of producer's prices explicitly separates each element which makes up the final purchaser's value so that the value of each transaction corresponds more closely to the flow in physical units.

2.37 Thus the added stability of the coefficient matrix usually justifies the extra statistical information necessary to compile the table in producer's prices. Ideally, all the important marketing cost elements should be identified in order to reconcile completely the accounts of each sector. Supporting tables should be prepared, showing the marketing costs entering into each transaction, in the row of the producing industry, and the column of the purchaser's industry. If this can be done, it is possible to translate a given table of transactions into whichever price system is most appropriate for the purpose at hand.

VI. Net or Gross Sector Output

2.38 Some input-output transactions tables exclude intra-industry transactions, so that all cells on the principal diagonal of the table are blank. This method of counting net rather than gross industry output is justified on the grounds that the value of the diagonal element is dependent on the number of establishments within the industry. Nevertheless, if the appropriate value is recorded no information is lost, and the element may easily be omitted for particular applications of the table, if necessary.

2.39 Furthermore, the method of entering output on a net basis leads to difficulty when sector aggregation takes place, as the following example illustrates. Consider a simple 3 sector system of accounts in which the gross output of each is recorded.

	1	2	3	
1	40	40	20	100
2	20	10	30	60
3	40	10	20	70
	100	60	70	230

The sum of all transactions in the system is equal to 230. If row sectors 1 and 2 are aggregated, this sum remains unchanged.

	1 2	3	
1 2	110	50	160
3	50	20	70
	160	70	230

If, on the other hand, the same transactions are recorded on a net basis

	1	2	3	
1	-	40	20	60
2	20	-	30	50
3	40	10	-	50
	60	50	50	160

then, if two sectors are consolidated, the total sum of recorded transactions changes.

	1 2	3	
1 2	-	50	50
3	50	-	50
	50	50	100

There are other reasons why gross accounting is preferable. As Section VIII below shows, the diagonal entry may be useful in making secondary product transfers.

VII. Taxes

2.40 Direct taxes, i.e. taxes levied on factor services, are usually not distinguished in input-output tables, since the value of the services before taxation are entered in the table. Sometimes, however, social security and other payroll taxes are entered separately, where this is made possible by enterprise accounts.

2.41 Net indirect taxes, (i.e. taxes minus subsidies) form part of the margin between the producer's price and the purchaser's price, and consequently under the former system of valuation they are generally entered in a special primary input row and the column of the purchasing industry. Thus, all general sales taxes levied upon consumer goods are usually recorded at the intersection of the Net Indirect Taxes row and the Household Consumption column. Under the purchaser's price system, indirect taxes, like the other margin items, are shown as inputs to the producing industry.

2.42 Some input-output tables are prepared in "market prices", i.e. producer's prices plus net indirect taxes. Under this system, the row total of each sector represents the value of the sector output including the value of indirect taxes levied on that output. In order that the column sum of total costs should balance the row sum of total output, the value of taxes levied on the sector's output must be entered again as part of the input of that industry. Furthermore, each intermediate entry in the column includes the value of the net indirect taxes levied on each input to that sector. Whereas, under the system of producer's prices proper, the entry in the primary row records the total value of all indirect taxes levied on the inputs to the sector, while the value of the sector output is measured net of indirect taxes.

2.43 An intermediate system of treatment is possible, in which some indirect taxes are included in the price of the producing sector's output, while others are charged as margin items to the consuming sector. The price may be defined to include a general tax on all commodities in the sector, but to exclude any taxes which are specific to some commodities or to some transactions. For example, a tax on liquor may form a large fraction of the domestic price but may not be levied on exports. In order to preserve homogeneity in the valuation of liqour output, such a tax should be entered separately as a charge to the consuming sector. Practices in this respect differ from country to country. In general, however, the separation of the tax element from price is desirable before computing the input coefficient matrix, particularly if the tax structure is likely to change.

VIII. Secondary Products and Joint Products

2.44 According to the homogeneity assumption, the products of any sector (1) should have a single input structure, (2) should not be produced in other sectors, and (3) should be perfect substitutes in all uses, whether intermediate or final. The importance of the first of these conditions has been demonstrated in the discussion of aggregation. It is equally important to rule out production of a given product in more than one sector,[4/] otherwise it would be impossible to predict which sector would satisfy demand requirements for that product. Even if it were possible to establish, in the base year, the shares of each sector in the deliveries of the product, this would probably reflect no more than the division of the market in that year. If the third condition is not satisfied, a demand created for one product will appear to lead to an increase in the output of other products in the sector. The latter two conditions taken together may be described as the condition of homogeneity of output.

4/ Except in the special case where the output of the secondary product is strictly proportional to that of the primary product. See para. 2.56.

2.45 While the establishment is the fundamental unit in the industrial statistics of most countries, many establishments produce more than one product. An establishment is often a single plant with one or more principal or primary products, and other products of secondary importance. It is customary to classify establishments according to their primary products, with the result that, when establishments are aggregated to form a sector, the output of the sector consists of one or more primary products and several secondary products. Several classes of secondary products can be distinguished. Strictly speaking, only those classes of secondary products whose production is technologically independent of the primary product should be referred to as secondary. Products which are the output of a single technical process fall into the category of joint products.

2.46 When the statistics from which the input-output table is to be compiled have been collected on an establishment basis, (i.e. net inputs and outputs of the establishment as a whole), then the allocation of an establishment having several products[5/] to one particular sector will inevitably impair the principle of sector homogeneity. In order to obtain a more homogeneous sector composition for input-output analysis, a number of procedures have been devised, some of which are described in the following paragraphs. These procedures involve the application to the original input-output table of schemes of reclassification, artificial transfers, and mathematical techniques. It is essential to understand the distinction between the original table and one which has been transformed as a result of these procedures.

2.47 The most satisfactory solution which applies equally to all classes of secondary products requires the separation of the inputs used in the production of secondary products from the inputs used in the establishment's primary products, and the rearrangement in one sector of all products of a given type, regardless of where they may have been produced. This procedure is usually known as redefinition. It is frequently adopted in the case of "own-account" construction activities, where establishments in many different sectors use their own labour and purchase materials to carry out construction work. Redefinition means that the value of the construction work done in any sector would be shown as an input to

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5/ Products which are produced and then consumed in a set of vertically-related production processes within establishments are 'netted' out in the establishment data, and therefore do not give rise to the statistical problems of secondary products.

the final demand sectors, while the materials and labour used would be added as inputs to the construction sector.

2.48 Another method of redefining secondary products is based upon the assumption that the input structure of secondary products in any sector is the same as the input structure of the sector in which they are primarily produced. This is a less satisfactory solution; most sectors may include inputs of several secondary products in their input structure. It is usually difficult, therefore, to record the "true" input structure of any primary product from establishment data without additional information.

2.49 A second procedure is the method[6/] of adding artificial entries to the original table as a device to transfer secondary products from the sectors in which they are actually produced to those sectors in which they are primary. There are two alternative conventions:

(i) Products are transferred from the producing sector A to sector B by means of a positive entry in the row for A and the column for B with an offsetting negative entry in the diagonal element of B. This procedure is followed when the output of the secondary product varies with the output of the sector to which it is to be transferred.

(ii) Products are transferred from the producing sector A to sector B by means of a negative entry in the row for B and the column for A with an offsetting positive entry in the diagonal element of A. This procedure is followed when the output of the secondary or joint product varies in proportion with the output of the actual producing sector.

2.50 Where the original data are recorded in the form of flows of commodities to or from establishments, rather than in the form of flows from establishments to establishments, as assumed here, then different techniques for treating secondary products become relevant[7/].

6/ As described here this method owes much to Alan M. Strout, "Disaggregation of an Industry Production Function when it is Desired to Treat Individual Industry Joint Products in Separate Input-Output Table Rows", (Mimeographed. Harvard Economic Research Project, 24 October 1962), and, "A Flexible Input-Output Convention for Secondary Product Transactions", (Mimeographed. 14 January 1963).

7/ A thorough survey of commodity-establishment classification problems is given in a mimeographed paper by Terry Gigantes and Paul Pitts of the Dominion Bureau of Statistics, Ottawa, Canada, entitled "An Integrated Input-Output Framework and Some Related Analytical Models", June 12-13, 1965.

2.51 The effect of the first convention is to make sector B the sole distributor of its primary product, but part of the demand for B becomes a demand for the output of A via the fictitious input coefficient from A to B. Thus A and B will share the demand for the given product in proportion to their production of it in the base year. But if the share of production reflects only a temporary division of the market, then the fictitious coefficient will be extremely unstable. The second convention has the effect that an increase in demand for the output of A leads to an increase in the supply of sector B.

2.52 While the method of fictitious transfers does diminish the problem of output homogeneity, it does nothing to diminish the heterogeneity of the input structure. In certain circumstances this may not be a problem - if the input structure of the secondary product does not differ significantly from that of the primary product, or if the two are always produced in fixed proportions. If it is considered to be important, for reasons of policy or data availability, to emphasize industry rather than production distinctions in the analyses, then the fictitious transfer method may be justifiable. For stability of the input-output model over a number of years, however, it will undoubtedly be preferable to redefine the basic data so as to improve homogeneity.

2.53 Since the availability of data limits the scope for redefinition, and since secondary products are often important in practice, it is worth-while describing some of the principal types. In the following paragraphs, it is assumed that redefinition is ruled out as a solution.

2.54 One class of secondary products consists of those which are produced with the principal object of supplying the establishment in which they originate, while part of the supply is distributed outside the establishment. An example is the industrial plant which generates electricity for its own use but disposes of some for local consumption. A similar case is that in which part of the supply is received from outside the establishment. For example, a metal-fabricating plant may have its own captive iron-foundry whose output of castings is used in the plant, but sometimes inputs of castings purchased from other establishments may be substituted for the output of its own foundry. There, convention (ii) is appropriate in both cases.

2.55 The output of most secondary products, however, is probably related more closely to the output of similar products produced elsewhere, and convention (i) should then be used.

2.56 A third class of secondary products are those which are demanded in strict proportion with the establishment's primary products. Common examples are the equipment installation services provided by manufacturers of specialized machinery such as conveyor belts, cranes, etc. In this case the solution is simple. So long as the relative proportions of primary and secondary products are invariant in all their uses, there is no reason to distinguish them.

2.57 Finally, there are secondary products which are not the primary product of any sector. Since there is no other sector with which they may be classified or into which they may be transferred, the creation of a separate sector is evidently desirable. But precisely because this class of products does not appear as the primary product of any significant number of establishments, the essential data are usually lacking, even in an otherwise complete system of industrial statistics. For example, the miscellaneous stationery and equipment used in offices is hard to trace in the purchases of any individual establishment, yet the total is large in value and consists of a variety of products secondary to several sectors. The practice in this case is to create an artificial sector which represents no real production but merely permits an accounting balance. In the present example, the row would represent the purchases of miscellaneous stationery by different sectors, while the column would show the inputs of paper, etc. attributable to the production of these miscellaneous goods.

2.58 The general characteristic of <u>joint products</u> is that they are the output of one production process, i.e. they share a common input structure. Consequently there is no possibility of redefinition. The supply of one cannot usually be increased without a corresponding increase in the supply of others, so that all classes of joint products lend themselves to treatment by convention (ii).

2.59 The first class of joint products consists of those in which each is of relatively equal importance and where the products are not produced elsewhere - they might be described as multiple primary products. Examples are the joint production of mutton and wool, petroleum refinery products, and of various types of rolled steel products. So long as each delivery to an intermediate or final demand sector consists of a fixed proportion of the common inputs, then the homogeneity assumptions are not violated if all of the products are included in a single row. If, as is likely, the different products have a different output distribution, construction and checking of the table is made easier if an additional row is created for each commodity. This case can be conveniently handled by recording the output of each product as a negative entry in the sector column and corresponding row, offset by an equal positive sum of the entries in the producing sector's diagonal. Thus the total of the rows showing the distribution of all but one of the products would be zero, while the entries in the corresponding columns, other than the column of the actual producing sector, would be all zero. Under this procedure, a demand for any one joint product would increase in proportion the supply of the others. The supply determined in this way can be compared with the actual demand pattern, the discrepancy being reflected in the non-zero output levels of the product sectors, so that conclusions could be drawn about possible changes in inventories or imports.

2.60 A second class of joint-products is the class of by-products in which one of the products is of distinctly lesser importance, so that it is undesirable to use any accounting convention which would indicate that an increase in demand for the by-product would lead to an increase in the output of the principal joint product. By-products may, as in the case of coke, be the principal products in other establishments (coke from coke-ovens) or, in the case of hides produced by the livestock industry, they may be produced solely in one sector. In the former case, the familiar device of the negative input coefficient in the row of the industry of primary production and the column of actual production can be used to "transfer" the coke to the coke-producing sector, not omitting the offsetting positive entry in the diagonal of that sector. The effect is to confine the demand for coke to the sector of its primary production, while the total supply of coke is in part dependent upon the total output of the industry in which it is a by-product. In the latter case, it is desirable to establish an artificial row for the product hides, which can be transferred from the livestock industry to an artificial sector again by means of a negative production coefficient with an offsetting positive entry in the diagonal. The result is that an increase in deliveries of hides to the leather industry does not lead to an increase in the output of the livestock industry, whereas an increase in the output of that industry brought about, for example, by an increase in demand for meat products will increase the supply of hides. The necessary reconciliation of supply and demand can then be assumed to occur through changes in inventories or imports.

2.61 Scrap and waste products form the third class of joint products. These are the by-products of all industries, the primary products of none, and are consumed by a number of industries. Information on flows of scrap products between industries suffer from the same difficulties as does information about office materials, and the same treatment is often adopted. An artificial sector is created, into which all scrap produced is allocated, and from which all consumption of scrap is absorbed. It may be desirable to distinguish particular types of scrap products, such as metal and non-metal scrap. Automotive spare parts are often treated in the same way as scrap products and office materials for similar reasons.

2.62 Finally, it may be the case that several products can be produced in a limited number of alternative but fixed proportions using common or different production processes. So long as the number of alternative production processes is not greater than the number of products this case may be handled in an ordinary input-output table, by the methods described. If the number of production processes exceeds the number of products, then a linear programming formulation is appropriate.

2.63 The foregoing discussion of secondary and joint products can now be summarized. When it is desirable, or necessary because of the available data, to maintain industry distinctions rather than create a table of homogeneous production activities the method of fictitious transfers is appropriate for dealing with secondary products. In general, it is the most effective method of handling joint products. The method can be generalized in the following way:

2.64 All secondary or joint product flows can be transferred to a dummy column, as a positive entry in the row of the producing sector. In the same dummy column there is an equal flow of negative sign in the row of each sector to which the secondary product is to be transferred. Each dummy column consists only of these two entries, so that the column sum is always zero.

2.65 Each of the dummy columns can be added to the original "primary" transactions table in either of two ways:

(i) When the output of the secondary product changes proportionately with the output of the actual producing sector, the dummy column should be added to the column of that industry. This corresponds to the treatment of all classes of joint products and also to the class of secondary products, sometimes described as "own-account activities".

(ii) When the output of the secondary product is dependent on the output of the industry to which it is to be transferred, the dummy column should be added to the column of the primary producing industry.

2.66 A third possibility, which has not been discussed, is that the dummy column might be added to one of the final demand sectors. This treatment would be appropriate where secondary product output could not be related to the output level of any sector: in this way the output level of the secondary product is determined outside the system.

2.67 All of the dummy columns together constitute a secondary transfer matrix which can be analysed and operated upon independently of the primary transaction matrix. When added to the primary table, the secondary transfer matrix leaves primary coefficients unchanged by leaving all column sums unaffected. For example, suppose that in a 3 sector system, sectors A, B, and C produce respectively 70 units of x_1, 100 units of x_2, and 70 units of x_3, but sector A produces in addition 20 units of x_2 as a secondary product which it delivers to sector C. The flow table might appear as follows:

	A	B	C	Total Output
A	40	30	20	90
B	10	60	30	100
C	40	10	20	70

2.68 In order to transfer from sector A the 20 units of x_2 produced to sector B, where x_2 is primarily produced, a dummy column can be introduced:

	A	B	C	D	Total Output
A	40	30	0	20	90
B	10	60	50	-20	100
C	40	10	20	0	70

In this formulation, which corresponds to the third general method of treating secondary products, the level of secondary production is stipulated and sector C receives no direct inputs from sector A.

2.69 In another formulation, the dummy column is added to sector B:

	A	B	C	Total Output
A	40	50	0	90
B	10	40	50	100
C	40	10	20	70

In this case the output of x_2 in sector A depends upon the level of output of sector B.

2.70 Finally, when the output of x_2 in sector A is proportionate to the level of output of sector A, then the dummy column should be added to sector A so that the flow table is of the form:

	A	B	C	Total Output
A	60	30	0	90
B	-10	60	50	100
C	40	10	20	70

IX. The Treatment of Imports and Exports

2.71 A Foreign Trade sector is a necessary part of all input-output tables. It is necessary in order to obtain an accounting balance of inputs and outputs in current domestic production, since some of the inputs absorbed are imported from abroad, while part of the output is exported abroad. For those economies in which foreign trade is particularly important, one of the most likely applications of input-output analysis will be to the problems of exports and imports.

2.72 The method of recording exports is perfectly straightforward: that part of the output of a given sector which is exported is entered in a final demand column. Whereas this treatment of exports is universal, several methods are used for recording imports. The difference between them rests upon the meaning of the input coefficients which result in each case.

2.73 In discussing imports in the context of input-output analysis it is helpful to begin by making a distinction between competing and non-competing imports. Even if this distinction is not always made in practice,[8/] it throws light on the merits and demerits of the alternative conventions used to record imports.

2.74 A competing import can be defined as a commodity which is a good substitute for some domestically-produced commodity. Clearly, the interpretation of the phrase "a good substitute" is a matter of judgement. A non-competing import, on the other hand, is one for which there is no domestic counterpart. As an example of the distinction one might consider a European country importing agricultural products: wheat would be a competing import while raw cotton would be a non-competing import.

2.75 If the supply of a competing import is distributed along any row other than that of the corresponding domestic product, then substitution which may easily

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8/ It often requires expert knowledge of individual industrial processes to draw a precise distinction between competing and non-competing imports. Qualitative differences within commodity groups may rule out certain uses. For example, a country which produces only brown coal must import a different grade of coal to make steel. Imports of coal of this type are "non-competing", since the domestic product cannot be regarded as a substitute for the import. In less industrialized countries, the task of making the distinction may be easier, but in all countries the lists should be revised periodically to take account of extensions in the range of domestic production.

occur between these two sources as inputs to some third sector will cause variance in the two input coefficients - from the competing import and from the domestic product - to the third sector. Constancy, or stability, of the input coefficients is of critical importance, yet substitution between a domestic product and a competing import may take place in a short period of time. If, however, the competing import and the domestic product are distributed along the same row, substitution between them will not affect their joint input to a third sector, which is technically determined. Thus the 'technical' coefficient is likely to be much more stable than either of its two components, the domestic input coefficient and the competing import coefficient.

2.76 If, on the other hand, a non-competing import is distributed along a row with a broadly similar (but non-substitutable) domestic product, the coefficients formed from their joint flow create an indirect demand for domestic output which in fact is a demand for imports. If, for instance, raw cotton and wheat are both distributed along the same row then the resulting input coefficient matrix which is computed may lead to the conclusion that consumer demand for cotton textile products will stimulate the output of the domestic fertilizer industry by creating a demand for domestic agricultural output which in reality is satisfied by imports. But if the non-competing import is distributed along an entirely separate row, then the input coefficients formed by its flow will be quite stable in the sense that they are not substitutable for the outputs of other sectors.

2.77 These observations should be borne in mind when considering the alternative treatments of imports:

Method 1. All imports are allocated in a single row to the consuming sectors. This treatment is perfectly acceptable to the extent that imports are non-competing; to the extent that they are competing, substitution will tend to occur, restricting the usefulness of the input coefficient matrix as time passes. In this case, all intermediate flows are of domestic products only, and the construction of the import row requires an identification of the destination of imports. Note that this method of recording imports has been adopted in the Simplified Table for the Netherlands 1956, Table 1.1 in Chapter 1.

Method 2. All imports are distributed along the row of a similar domestic sector. Unlike the previous convention, this means that flows contain imported and domestically-produced elements without distinction. In this case there is no problem of instability, but the presence of non-competing imports in the rows may give rise to inaccurate estimates of output requirements when the inverse matrix computed from this version of the table is post-multiplied by a bill of goods comprising final domestic demand and exports. To avoid this error one has to change the final bill of goods by redefining each entry as containing domestic final demand plus exports minus imports. But this, in effect, means specifying in advance part of the solution (the level of imports) which one wishes to compute.

Two slightly different coefficient matrixes may be computed from a flow table of this type: in the first case the row total, i.e., the sum of all imports and domestic output, may be taken as the denominator in forming the coefficients. In this case, a further instability is introduced since there is no necessary relation between changes in total supply, which may be confined to imports, and changes in domestic inputs. Furthermore, this instability will affect the value of every coefficient in any column where significant substitution between imports and domestic production takes place. The second possibility is that if the total imports in each row are known, they may be entered with a negative sign in the final demand quadrant, so that the value of the row total equals domestic output: Coefficients computed on this base should be 'well-behaved'. One advantage of this method is statistical simplicity. No information is needed on the destination of imports, only on their origin and this can usually be easily obtained from customs sources.

Method 3. The third method tries to combine the virtues of the previous two while avoiding their faults, by distributing only those imports which are judged to be 'competing' along the rows of the corresponding domestic sector, (thus obtaining stable input coefficients) and distributing the non-competing imports as a separate row (thus preserving the homogeneity of the output structure). All intermediate flows thus consist of domestic product plus competing imports, and the total of the latter are entered as a negative column in the final bill of goods. In this case, as in Method 2, it is necessary to specify the actual import requirements in any computation. However, it seems likely that this can be done more accurately with competing imports. If not, a simple adjustment to the diagonal elements in the coefficient matrix makes it possible to compute a solution on the assumption that the supply of competing imports will be in some proportion (which may be varied for each sector) to the corresponding domestic output. Since the data requirements for this method are not too demanding, and since it is more accurate than the previous method it is the one which can be most highly recommended.

Method 4. A final possibility is that all imported goods can be distinguished both by industry of origin and by industry of destination. This is equivalent to the preparation of two tables - one for domestic flows and one for imported products. Naturally, the statistical requirements are demanding, but the results make possible a considerable flexibility in the treatment of imports. It is certainly worthwhile making the marginal effort to distinguish between competing and non-competing imports, and relegate the latter to a row in the foot of the table.

An immediate advantage of this method is that information about import substitution in particular elements can be accurately incorporated in the table. Thus a domestic flow matrix can be constantly revised, so that the problem of substitutability can be minimized. Imports can either be aggregated by column, and treated as in Method 1, or aggregated by row, and treated as in Method 2.

2.78 The difference between these four alternative methods of entering the same basic set of figures into an input-output table can best be illustrated by a numerical example. Such an example appears below, following an account of the alternative methods of valuation of exports and imports.

X. Valuation of Imports and Exports

2.79 The value of imports c.i.f. comprises three items - (a) the foreign port value; (b) freight charges to the domestic port of entry, and (c) insurance charges. A fourth item, import duties levied by the domestic government may be added to give what we shall call the domestic port value of imports, i.e. the value of imports as they enter the domestic economy.

2.80 Likewise the value of a country's exports f.o.b. at the port of embarkation consists of the producer's value plus the various marketing costs necessary to get the goods to the port.

2.81 The way in which the different elements are entered in an input-output table depends upon the system of valuation (producer's or purchaser's prices) used as well as upon the method adopted for recording imports. The domestic port value (i.e. including import duty) is often preferred for valuing imports, primarily because this is comparable to the value of domestic products at producer's prices. Furthermore, it is fairly easy to obtain c.i.f. values from the records of the Customs authorities, and to add the necessary duties.

2.82 It should be observed, however, that the domestic port value falls between a pure producer's price valuation and a complete purchaser's price valuation. In addition to the basic foreign port value it contains three margin items but it does not include the margin items associated with the transfer of the imports from the domestic port of entry to the consuming industry. As a result of including three "international" margin items in the domestic port value, these margins represent an element of possible instability in the table, (see para. 2.36). Furthermore, the domestic port value overstates the value of imports in the balance-of-payments sense if any of the margin items are charges against domestic producers.

2.83 Assuming, however, that this system of valuing imports is adopted, and assuming further that flows of domestic products are being valued at producer's prices, then imports can be treated in the following manner.

2.84 The domestic port value of competing imports of type 'i' consumed by domestic industry 'j' is entered in the cell at the intersection of row 'i' and column 'j'. The costs incurred in transferring the imports from domestic port to point of consumption are treated in exactly the same way as the costs incurred in transferring a domestic product from the producer to the purchaser according to the producer's price system, i.e. the trade and transport margins are entered as inputs to industry 'j'.

2.85 That fraction of the costs incurred in moving the import from foreign port to domestic port which is borne by domestic transport and insurance services requires special treatment if the total value of imports is not to be overstated. These items may conveniently be entered as exports of the respective services[9/]. In this case, the margin items are double-counted, being included in both the total imports of sector 'i' and in the output of domestic services.

9/ An alternative convention deducts these margins directly from competing imports, by entering them with a positive sign in the negative column of imports.

2.86 A similar treatment can be adopted for imports judged to be non-competing. In this case, all such imports are relegated to a single row.

2.87 This system of valuation and the alternative methods of treating imports are illustrated in the following example. Suppose that a consignment of imports of type "i" which is consumed by domestic industry 'j' has a foreign port value of 100 units. The cost of transport to the domestic port of entry, 10 units, is borne by a foreign carrier; the cost of insurance, also 10 units, is borne by a domestic enterprise, and an import duty of 5 units is levied by the domestic government so that the domestic port value of the imports is 125 units. Of this value, 15 units have been contributed by domestic sources, and 110 units represent claims by foreigners against the domestic economy.

2.88 A complete table of import flows recording this transaction would look like Table (i), if the margins are charged to exports,

Table (i)

		j	Exports	Total D	Total M
i	D				
	M	125			125
s	D		10	10	
	M				
g	D		5	5	
Total		125			125

where the symbols 'i' and 'j' designate the respective sectors of production, D and M designate domestic and imported flows, 's' stands for services, (transport and insurance), and 'g' represents government. In these and subsequent examples the margins incurred in delivering the goods within the country are ignored.

2.89 The method of treating imports outlined in Table (i) corresponds to Method 4, (para. 2.77). Two variants of the table can be shown according to whether the import is regarded as competing (Method 2) or non-competing (Method 1). If the import is competing it is recorded as in Table (ia), whereas if it is non-competing it would be recorded as in Table (ib).

Table (ia)

	j	Exports	Total D	Total M
i	125			-125
s		10		
g		5		
Total	125			-125

Table (ib)

	j	Exports	Total
s		10	10
Imports	125		125
g		5	5
Total	125		

2.90 The treatment described in the previous examples has been concerned with the valuation of imports at their domestic port value.

2.91 Alternatively, one may enter imports in an input-output table at the foreign port value. This is harder to implement in practice, because it is more difficult to obtain data on foreign port values and it involves ascertaining the earnings of foreign shippers in the country's import trade. The result escapes, however, the double counting of the previous examples.

2.92 A complete table of imports at foreign port values, showing separately the imported domestic components of the illustrative transaction would look like Table (ii).

Table (ii)

		j	Total D	Total M
i	D			
	M	100		100
s	D	10	10	
	M	10		10
g	D	5	5	
		125		110

2.93 The same transaction may also be recorded in two other ways, depending upon whether the import is considered to be competing or non-competing. This is illustrated in Table (iia) for competing imports, and in Table (iib) for non-competing imports.

Table (iia)	j	Total D	Total M
i	100		-100
s	20	10	-10
g	5	5	
Total	125		-110

Table (iib)	j	Total
s	10	10
Imports	110	110
g	5	5
Total	125	

2.94 The treatment of exports is much simpler. Two procedures are possible according to whether the table is to be prepared in producer's prices or in purchaser's prices. Under the producer's price system, the entry in the export column and the row of any sector shows the value (at the producer's price) of that commodity's output which is exported. The various charges incurred in moving the goods from the plant to the port of embarkation plus that share of the international shipping and insurance charges accruing to domestic producers should be entered in the appropriate rows of the export column.

2.95 Under the purchaser's price system, export of a particular sector include the costs necessary to bring the merchandise to the port of departure. This is the value commonly recorded by Customs officials, and therefore is easily obtained, but its usefulness is limited by the consideration that, in order to obtain a row balance, the output of a sector must be fully allocated at producer's values. Thus the more difficult valuation of exports at the producer's price must be obtained in any case. It should also be noted that under the purchaser's price system the export column contains inputs from the trade and transport sectors representing (a) the value of these services in delivering domestic merchandise to the port of departure, plus (b) the value of services in delivering domestic merchandise abroad, plus (c) the value of the international distributive services provided in delivering imports to domestic producers.

XI. Input-Output Tables and National Accounts and Balances

2.96 In theory, the aggregate value of total final expenditure which, in an input-output table, is equal to the sum of the column totals of final demand minus imports should be equal to the equivalent gross domestic expenditure concept established in the systems of national accounts or balances. The sum of the row totals of the primary inputs (excluding imports) in the typical table should likewise be equal in value to the corresponding income flow aggregate.

2.97 For example, in countries with market economies the aggregate value of the final demand columns minus imports usually constitutes the gross domestic product at market prices. The same aggregate can be shown in an account derived from the SNA accounts:[10/]

Table 2.1

1. Private Consumption Expenditure	7. Compensation of Employees
2. Government Purchases of Goods and Services	8. Operating Surplus
3. Gross Domestic Fixed Capital Formation	9. Depreciation
4. Net Additions to Stocks	10. Net Indirect Taxes
5. Exports of Goods and Services	
6. Less Imports of Goods and Services	
Expenditure on the Gross Domestic Product	Gross Domestic Product at Market Prices

2.98 In practice, a difference may exist between the estimates of the two systems, which may be due either to differences in the methods of valuation or differences in methods of accounting, or both. The nature and extent of the differences vary naturally between countries. Some of the more common sources of difference are considered below.

2.99 Although the concepts of gross domestic product in market economies and net material product in centrally planned economies differ, the problem of reconciliation between these aggregates and input-output statistics really depends upon the respective methods of estimation. If, as in Norway, the statistical sources of the national accounts and the input-output tables are the same, then no problem exists. On the other hand, if the same transactions are valued differently in the two systems, (for example, if there is a difference in timing), or if certain transactions are excluded from one system which are included in the other, then the problems of reconciliation may be formidable.

10/ United Nations, A System of National Accounts and Supporting Tables, Studies in Methods, Series F, No. 2, Rev. 2, p. 18, account number 1.

2.100 Given an aggregate income and product concept, such as Gross Domestic Product at Market Prices, two sufficient conditions for consistency with the corresponding input-output aggregate may be stated: (a) all transactions must be valued on the same basis; and (b) the same transactions must be included in the aggregate.

2.101 These conditions would require, for example, that the system of national accounts or balances adopt the same conventions for valuing foreign trade, income-in-kind, the services of owner-occupied dwellings, the services of financial institutions etc., as the input-output table. It would also require that the two systems draw the same line between transactions considered to be intermediate, and those regarded as final. For example, the same treatment must be accorded the travel expenditures of businessmen in both systems

2.102 If a more detailed reconciliation is required, for example, if the various components of domestic expenditure are to be reconciled with the final demand column totals of the input-output table, and the primary input row totals with the distributive shares of the income aggregate, still more detailed adjustments might be required to ensure that condition (b) held for each component separately.

2.103 If the production account were disaggregated by sector of production some major adjustments would be required so that the totals of the production sectors in the resulting table would be consistent with those of a typical input-output table of transactions. In particular, (c) it would be necessary to have an auxiliary table of marketing costs, in order to transform the table from purchaser's to producer's prices; (d) secondary and joint products would have to be transferred or redefined into existing or additional sectors. For these and other reasons, it is often difficult to link input-output tables with other published industrial statistics. This makes it harder for users of the table to do their own detailed updating. Accordingly, it may be suggested that subsidiary tables should be published, showing, where necessary, a reconciliation between the figures in the input-output table and those shown in the principal statistical sources.

2.104 Proposals[11/] which have been put forward for the revision of SNA include a scheme for the integration of national accounts with input-output statistics, thus satisfying the conditions laid down in 2.100 above. While these proposals are of enormous value so far as statistical uses of input-output tables are concerned, they are of less significance for the analytical uses of the tables. The ultimately different purposes of national accounts and input-output tables necessarily means that the data themselves should differ. For the purposes of input-output analysis, it is desirable to have a classification of economic activity which is as detailed as possible and as close to a commodity classification as possible, even at the cost of not preparing such a table every year. On the other hand, it is important that national accounts should be compiled annually.

2.105 The form of input-output table proposed is a rectangular one: groups of commodities are entered in rows, while the columns are classified by establishments. So long as a correspondence exists between the row and column sector classifications, this offers in principle a convenient and flexible framework for recording the basic data. The proposed scheme is not elaborated in the present paper because tables in this form have not yet been officially prepared by any country, although there have been experiments along these lines in Canada and other countries.

XII. Other Problems

2.106 A number of miscellaneous problems arise often in input-output tables: The Undistributed sector which exists in some tables is simply a device to provide an accounting balance and absorb otherwise inexplicable statistical discrepancies.

11/ Proposals for the revision of the System of National Accounts are presently under discussion. An earlier draft of these proposals is contained in document E/CN.3/320, 9 February 1965, which is shortly to be further revised.

For example, when only a part of the known total supply of a sector can be traced to specific consuming sectors the residual is allocated to the Undistributed column. Likewise, if all known material purchases and factor payments of a particular sector have been accounted for, and the total falls short of the total outlays of that sector, a balancing item is entered in the Undistributed row.

2.107 Since final demand and primary input entries are usually accounted for satisfactorily, the undistributed flows represent flows between production sectors, and it is for this reason shown as an intermediate sector in the table of transactions. While it is always possible to mechanically distribute the elements of the undistributed sector among the other production sectors, there is no satisfactory solution to the problem, other than its elimination by an improvement in the statistical system.

2.108 A table showing in detail the transactions between a particular group of industries may contain a row and column showing inputs from and outputs delivered to all other industries. In this case, these miscellaneous inputs and outputs pose the same problem as do the undistributed flows in a table of the whole economy.

2.109 The existence of such undistributed or miscellaneous rows and columns is embarrassing in analytical applications of the input-output table, since no meaning can be attached to any coefficients computed for these sectors. If the analysis is confined to a group of industries whose principal miscellaneous inputs are derived from sectors outside the group, other than those which receive the outputs of the group, then it may be permissible to ignore that part of the interdependence within the group which arises from transactions without the groups i.e. the miscellaneous transactions may be ignored. In the economy as a whole, however, the interdependence represented by the undistributed sectors cannot be ignored: each undistributed flow correctly belongs in some other part of the flow table, and the problem becomes one of distributing the undistributed flows among the already recorded flows.

2.110 It should be observed here that this problem is formally analogous to the problem which often arises in updating matrixes, (see chapter IV). In the absence of a new input-output table, the table relating to a previous year may be revised in the light of intermediate row and column totals obtained for a later year from industrial censuses etc. The interindustry flows for the later year can be approximated by distributing the difference between the old and the new subtotals among the flows observed in the earlier year.

2.111 In both cases, the most satisfactory solution requires specific information about the location of revisions in the interindustry flows. If this information is not available, the second best solution is for the economist to use his judgement in allocating the undistributed flows. If this is impossible then recourse must be had to a mechanical solution, which distributes the undistributed according to some formula; for example the residual may be distributed evenly among all the other cells, among the non-zero cells, or in proportion to the value of the entries in the non-zero cells. The distribution should be carried out by those who prepare the table because they are likely to know best how it should be done. At the same time, the undistributed items should be published separately together with an account of the methods used to distribute them. Although a mechanical solution has no virtues except convenience, it is frequently adopted, and a numerical example of one method follows.

2.112 The table represents a table of flows between two sectors of production and an undistributed sector, 'u'. Since it is assumed that all primary inputs and final output have been recorded completely, attention can be concentrated on the first quadrant of the table: the row and column totals of the undistributed sector are necessarily equal, but not those of the two real sectors.

	1	2	u	Intermediate Total
1	40	30	28	98
2	20	10	42	72
u	56	14	0	70
Intermediate Total	116	54	70	

In the first step, the elements of the undistributed column are distributed by multiplying each other element of the respective rows by the ratio of the row total divided by the row total less the undistributed flow. Thus in this example, elements 1 and 2 of row 1 are multiplied by $\frac{98}{98-28} = \frac{98}{70}$ and the two elements of row 2 are multiplied by $\frac{72}{72-42} = \frac{72}{30}$. The table then becomes:

	1	2	u	Intermediate Total
1	56	42	0	98
2	48	24	0	72
u	56	14	0	70
Intermediate Total	160	80	0	

Finally, the elements of the undistributed row are distributed by multiplying each element of the two other columns by the ratio of the column total divided by the column total minus the undistributed element. Thus, the table, with all undistributed elements now distributed, becomes:

	1	2	u	Intermediate Total
1	86.2	51.0	0	137.2
2	73.8	29.0	0	102.8
u	0	0	0	
Intermediate Total	160	80	0	

2.113 While second-hand goods are in principle excluded from the transactions table, it is impossible to do this in practice. Second-hand materials are frequently used as inputs in the construction industry, and a significant amount of income is derived from trading in second-hand goods. The first case might be treated as a stock depletion, while in the second case the trade margin can be charged to the sector consuming the second-hand goods. However, only the margin on the exchange of existing assets should be counted in the table; the exchange itself is regarded as unrelated to current production.

2.114 In establishing the gross supply of a given commodity or commodity group it is clearly necessary to count only changes in the quantity of stocks, and to rule out changes in the value of stocks which may have occurred. If such an adjustment is made, the accounting balance between the Total Revenues and Total

Outlays of the sector will probably require that an equal and offsetting adjustment be made in the sector column to the profit element. Such an adjustment is known as an inventory revaluation.

2.115 Problems often arise in the valuation of services provided to households by governments, since the charge (if any) which is made to the individual consumer may not correspond to the cost of providing the service. Medical and educational services are two important examples. The problem is compounded if similar services are provided under different institutional arrangements. For example in some countries medical and educational services are provided by enterprises and private non-profit-making institutions as well as by governments. These, and other such problems of classification and valuation of economic activity are dealt with in some detail in the proposals for a standardized treatment.[12/]

2.116 For input-output purposes it is usual to define medical and educational services on an activity basis i.e. the total value of these services wherever they occur is included in one sector. Then the costs of providing the services (including operating surplus, if any) represent the inputs, while the entire output can be charged to households and government. Consumers are charged for that part of the value of services they pay for directly while government is charged with the rest.

2.117 Payments by consumers to government for which no direct service is provided in return to the individual consumer - for example, fees for a driving licence - are best regarded as a transfer payment.

2.118 The total value of output of each production sector in the transactions table is defined in terms of its operating revenues; all revenues of a purely financial type, such as capital gains and interest and dividends received are specifically excluded. Since financial revenues are the principal income source of financial institutions, the valuation of the output of these institutions is a problem for those countries which include non-material services in their input-output tables. So far as banks are concerned, their operating costs can be taken as the total value of output. Two methods of measuring this output may be suggested. One is to ignore the interest receipts and record only the actual service charges, leaving a large negative element in the operating surplus. The other is to impute to business and households a banking service charge equivalent

12/ See p. 60, footnote 11/.

to the difference between the monetary interest received and paid by banks.

2.119 The output of life insurance carriers can likewise be measured by expenditures, the service charge to households being equivalent to the excess of premiums paid by households over the sum of benefits received in addition to actuarial reserves held against policy. The total output of non-life insurance carriers is usually measured on a net basis, i.e. premiums earned less benefits paid. This total output can be allocated among sectors in proportion to the amount of insurance held.

2.120 The services associated with the use of building-space for dwellings or offices can be treated by setting up a real estate and rental sector. The output of the sector then consists of all rents paid on real property plus an imputed rental for owner-occupied dwellings. The various expenses of property ownership - maintenance, costs, taxes, interest, depreciation, and net rental income constitute the inputs of the sector.

CHAPTER III

COMPILATION OF THE TABLES AND SOME IMPORTANT STATISTICAL SOURCES

I. General

3.1 In compiling an input-output table the work must be planned well in advance. Since the table can incorporate many forms of economic statistics, in designing a statistical system the data requirements of an input-output table should be borne in mind. There are several important points which must be considered before the work of compilation is begun.

3.2 The ultimate users of the table should be consulted, since the uses of the table determine its design and provide the criteria for the methodology of its compilation. In many countries, committees composed of the representatives of such organizations as the Ministries, the Planning Board, and the Economic Research Institutes are set up to deal with the methodological questions.

3.3 The availability of the basic material must be considered: a comparison of the available data with the requirements of the table indicates the further information which must be obtained. Frequently, data may exist in published or unpublished form which can be recompiled or reclassified Decisions must be made on the scope and methods of special surveys necessary to fill the statistical gaps. When this has been done a preliminary estimate can be made of the costs of compilation.

3.4 The timing of the table and the speed with which it is published is extremely important, since its usefulness tends to diminish as time passes.

3.5 In a task requiring attention to such varied detail, there must be effective co-ordination of effort between the organizations and individuals responsible. A common pattern of division of labour is to assign responsibility for a sector or a number of related sectors to one group, or organization. The central co-ordinating authority may be a census office, national accounts office, or planning office.

3.6 So far as the classification of sectors is concerned, the level of detail of the worksheets must be determined, even if it is expected that the table in its final form will be more aggregated. Frequently, a more detailed classification (at the level, for instance, of the industrial census classification) makes it easier and improves the quality of the results. "Some other advantages of working on a detailed basis may be noted. Completed input-output tabulations will always be historical in nature. In their application to analytical problems an effort will ordinarily be made to take into account the technological and other changes occurring after the base period of the study. It is obviously easier to revise and maintain detailed tabulations. Furthermore, a highly detailed tabulation permits adaptation to particular needs.[1/] In most countries the existing data makes it necessary to adhere to an establishment classification in mining and manufacturing industries. For the same reasons, the agricultural sectors represent a commodity classification, while construction is classified on an activity basis.

3.7 Control totals should be determined if possible for every sector in value and in physical units. (The data in physical units usually help to establish the distribution pattern of the sector.) When a sector consists of a group of establishments, then the value of gross output (total shipments plus change in inventories), can be taken as a convenient control total. Since total output is defined to be equal to total input, then the establishment of a control total for output automatically provides a control total on the input side as well. In addition, intermediate input control totals which are often established are the total value of cost of materials and value added, which are usually available from industrial censuses. Bearing in mind that consistency between the input-output table and national accounts is desirable, the principal items in the national accounts (for instance, consumption, new fixed assets, and changes in inventories) should be estimated on the same basis for the input-output table.[2/]

3.8 There are two general approaches to the task of obtaining a complete description of interindustry flows in an input-output table. One approach is to begin by distributing the output of each sector to all other sectors, a second is to fill out the columns of the chart from cost data. In other words, one

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1/ "The Interindustry Relations Study for 1947", W. Duane Evans and Marvin Hoffenberg, Review of Economics and Statistics, May 1952, page 114.

2/ See the methods outlined in the study, Methods of National Income Estimation. United Nations Statistical Office, Studies in Methods, Series F, No. 8.

can analyse the sales pattern of an industry or the cost structure. It is even more satisfactory if both approaches can be adopted, so that two independent estimates are made for each cell. This makes necessary what is perhaps the most difficult part of the compilation of the table - the work of detailed reconciliation. Given sufficient information, a third approach is to fill in simultaneously row and column data for particular groups of commodities. If only one approach is used, the work of reconciliation becomes much easier. Usually, the cost structure is the only existing source of information. The lack of sufficiently detailed information on the distribution of output to consuming industries in most countries is one of the major problems in completing the tabulation of inter-industry flows. The statistical reconciliation of all the rows and columns is a delicate task: a change in any one cell may lead to changes throughout the entire table. Accordingly, it should be carried out by some highly qualified officers of the unit responsible for the final drawing up of the table.

3.9 At the time of planning the entire study, it is worthwhile drawing up a list of the worksheets and tables which will be used. For example, the following set of tables may be prepared:

A. Worksheet Tables

Transaction table
Domestic products table
Import table
Quantity table
Commercial margins table
Transportation charge table

B. Tables for Publication

Transaction table
Quantity table
Domestic products table
Import table
Commercial margins table
Transportation charge table
Row Percentage Distribution table
Direct input coefficient matrix
Inverse coefficient matrix

Naturally, the tables for publication may be slightly more aggregated than the corresponding worksheets. In the following section, the principal data problems in each of the different branches of the economy are outlined.

II. Manufacturing, Mining and Energy

3.10 A fundamental problem is to establish a uniform system of accounting to ensure that the data developed in each industry be, as far as possible, consistent with each other.

3.11 The manufacturing sectors of input-output tables prepared in most market economy countries are based upon establishment data (the only exception being Japan, which uses the commodity approach) while most of the centrally planned economies use the enterprise as the basic statistical unit. So far as homogeneity is concerned, the enterprise unit in the centrally planned economies is not very different from the establishment unit in market economies.

3.12 Usually an industrial census, which in some countries is an extremely detailed annual inquiry, supplies the basic information for the manufacturing, mining, and energy sectors. According to international recommendation,[3] the census should supply the following data:

3.13 (a) Gross output, which is defined as the sum of the value of all output of the statistical units produced during the period in question, the value of goods shipped in the same condition as purchased, the value of industrial services rendered to other units, and changes in the stock of goods in process. Gross output (or gross output and import of similar commodities) gives the control totals for the sector rows and columns.

(b) Value and quantity of output of each of the principal products.

(c) Cost of materials consumed and payments for services rendered during the period, and

(d) Value Added.

(e) Value and quantity of the principal fuels and raw materials used.[4]

(f) Wages and Salaries and other compensation paid to Employees.

3/ United Nations Statistical Papers, Series M, No. 17, Rev.1, Add.1.

4/ See Conf. Eur. Stat. WG/13/15 and Statistical Papers, Series M, No. 17, Rev.1.

From this information, the following control totals and sub-totals can be established:

Input	Output
Cost of materials etc. consumed	Gross value of output
Individual materials	Primary products
Fuels	Secondary products
Purchased electrical energy	Miscellaneous receipts
Expenditures on contract work	Contract work
Census Value Added	Repair work
	Sale of scrap, etc.
	Non-industrial activities
Total Input	Total Output

3.14 The classification of the individual materials should be detailed enough so that materials produced in different industries can be distinguished, and yet it should be sufficiently broad so that there is not a large residual "Miscellaneous" category of inputs. As a guide, the "Classification of Commodities by Industrial Origin"[5/] may be used.

3.15 It should be noted that, where data are collected on the basis of shipments and purchases rather than production and consumption, the necessary adjustment should be made to take account of possible inventory changes.

3.16 Hitherto no mention has been made of the valuation of output. As observed in Chapter II, most countries use producer's prices (including net indirect taxes), in the construction of the tables, which means that the distribution charges on the materials are shown as if they were purchases by the consuming industry from the industry performing the distribution function. But statistics of material inputs are naturally available in the prices paid by the purchaser.

3.17 When the basic data sources are inputs it is often impossible to separate imported from domestically-produced elements. This is particularly true in the case of competing imports, although it is less true of non-competing imports.

5/ "Classification of Commodities by Industrial Origin. Relationship of the Standard International Trade Classification to the International Standard Industrial Classification", ST/STAT/9. Statistical Office of the United Nations, 11 September 1964.

Usually only the total supply of a competing import is known (from customs sources), although often the nature of the good (e.g. a consumer good or investment good) permits the identification of its destination.

3.18 To trace the distribution of the output of one sector to others requires a knowledge of its intermediate and final uses. Estimates of final uses can be obtained from statistical surveys of retail sales, household expenditures, new fixed assets, foreign trade, etc. The feasibility of tracing the intermediate uses depends upon the organization of the different channels through which goods reach their final consumers. In the United States a sample inquiry was made to obtain information on the disposition of the output of the principal products of each industry. Data were classified according to the following eleven types of consumers: company-owned sales branches, sales offices, and administrative offices; company-owned merchant wholesale establishments; all other wholesalers; other manufacturing plants of the same company (interplant transfers); all other manufacturers; company-owned retail stores; all other retailers; individuals (household users) and farmers; industrial, construction, institutional, and commercial users; state and local and federal governments; exports. In Hungary, statistics of the distribution of the output of industrial enterprises were expressly designed to satisfy the requirements for the preparation of the input-output table. Industrial units record their sales according to the sector to which the purchasing enterprise belongs. To facilitate this procedure, the Statistical Office provides the producing enterprises with a classification scheme, showing the sector to which each enterprise belongs.

III. Agriculture

3.19 The procedure for estimating input and output totals in agriculture are similar to those used in estimating the contribution of agriculture to the national income. In most countries, the contribution of agriculture to the national income is estimated by the "product method", according to which the gross value of output for each product is estimated, and value added is obtained after the deduction from the sum of all output value of the cost of all non-factor inputs. These three national accounting measures, gross value of production, total cost of non-factor inputs, and value added can be used directly as control totals for the input-output table. Naturally, the disaggregation of the costs of non-factor inputs is unnecessary in national accounting whereas it is essential for input-output analysis. The input structure of agriculture sectors tends to be rather simple compared to that of manufacturing sectors: the principal materials used consist of seeds, fertilizers, feeding stuffs, pesticides and fuel for agricultural machinery.

3.20 The total consumption of seeds can be estimated from sample surveys of areas sown under each crop to get information about the consumption of seeds per unit of crop area. Consumption of feeding stuffs can be estimated from the number of head of livestock, and that of fuel from the stock of agricultural machinery on farms. Consumption of fertilizers and pesticides may be estimated from domestic production and net imports. The 1960 World Census of Agriculture proposed that the following items should be enumerated: crops (area and production), livestock and poultry (numbers), agricultural employment, power, machinery, and transport facilities. In countries such as Belgium, where the cost of non-factor inputs is estimated by the commodity flow method, data used in preparing the national accounts may also be used for the estimation of input structure in agriculture and other sectors.

3.21 The estimation of the distribution of output of agricultural products is more difficult. In many countries, statistics showing the distribution of agricultural products are lacking, so that it is frequently a matter of balancing the data estimated from the input side. According to the definition in the System of National Accounts, agricultural products consumed on farms and changes in farm inventories should be included in the value of total output while the growth of standing crops should be excluded. Where the total output of agriculture is estimated on a commodity basis, as is generally the case, those activities which are primarily agricultural but are carried on in non-agricultural establishments, such as fruit-packing or contracted agricultural services should also be included in total output.

IV. Construction

3.22 Construction is one of the industries which in most countries is measured on an activity basis. The reasons for this are twofold: first, because there is a considerable volume of maintenance construction work carried out by non-construction establishments on their own account; and secondly, because the measurement of construction activity is usually based on the output of the activity (number of houses, etc.) rather than on the enumeration of some organization, such as establishment or enterprise.

3.23 One possible course of input and output data is a census of the construction industry. In this case, the same recommendations as were made for industrial censuses in section (1) apply. The gross value of production should exclude the value of sub-contracted work and thus eliminate any double-counting. The distinction between new construction work done and repair and maintenance work is extremely valuable in allocating output, since all new construction output is considered to be final (a delivery to Gross Fixed Capital Formation). In the absence of direct information, such as a Sample Survey, repair and maintenance work can be allocated to each intermediate sector according to the distribution of buildings in each sector. Like the censuses of other industries, the census of construction should enumerate the most important materials consumed.

3.24 Where there is no census of construction, data for the construction sector in an input-output table must be estimated indirectly. One approach is to use the number of licences or permits which are usually issued to new private buildings; another estimate of building activity can be obtained from the consumption of building materials. Information on public works can be derived from the accounts of national and local governments. In the absence of a construction census, the input structure of the industry may be estimated by the commodity flow method. The input structure may be compiled in yet another way: knowing the composition of construction activity (i.e. number of dwellings, offices, factories, hospitals, highways, etc.) and then estimating from a sample survey the input requirements of each type of building, the total volume of inputs required for construction as a whole may be approximated.

V. Trade

3.25 The value of output of the trade sector is universally taken to be the difference between the total values of goods and services bought and sold, not the gross value of sales. Thus the sector, which is sometimes sub-divided into wholesale and retail sectors, is shown as selling to other sectors the value of the trade margin on each transaction. To make available this service, the trade sector absorbs as inputs some materials (fuel and paper) as well as factor and non-factor services. Unfortunately, the accounting practices of establishments and enterprises and the officially published statistics in most market economies do not permit the direct estimation of the inputs (materials costs) and outputs (margins) of the trade sector. International recommendations[6] also follow this practice. In centrally planned economies, the trade margins and cost structure of the sector can usually be derived from the balance sheets of trading enterprises. But even this information is usually insufficiently detailed, since to complete the row of the trade sector in an input-output table in which transactions are valued at producers' prices, it is necessary to know the destination as well as the origin of all merchandise passing through the trade sector. In fact, the most desirable solution calls for the preparation of a complete table of trade margins.

3.26 In the absence of direct information, it is possible to estimate the trade margin by commodity groups and to distribute it among the sectors according to the commodity distribution. Another method is the so-called "mark-up" method, which is based upon a knowledge of both the producer's value and the purchaser's value of any flow, as well as the excise tax and the transport costs involved. Subtracting the latter two items from the difference between the producer's and purchaser's values gives the trade margin as the residual.

3.27 According to international recommendations[7] on the census of distribution (trade), sales should be enumerated by type of commodity and wages and salaries and purchases should also be recorded. Although these recommendations are of some value, countries wishing to compile input-output tables should bear in mind the further statistical requirements of input-output tables in designing their census of distribution.

VI. Foreign Trade

3.28 Foreign trade statistics are everywhere amongst the most complete of all types of statistics. They generally show a detailed commodity composition of exports and imports by quantity and value. So far as imports are concerned, this

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6/ United Nations International Recommendations in Statistics of Distribution, Statistical Papers, Series M, No. 26.

7/ Ibid.

detailed classification makes it simple to distinguish competing imports from those commodities which are not domestically produced, and to allocate the correct values of competing imports to the corresponding domestic sectors for distribution. The commodity distribution of competing imports may not fit exactly into the sector classification if there is a significant volume of secondary production which has not been transferred or redefined. In this case some arbitrary distribution may have to be made of the commodities between sectors.[8/]

3.29 The value of imports recorded by customs authorities is usually the c.i.f. valuation, i.e. excluding import duties. Exports are typically valued f.o.b., thus including the domestic transport and trade margins involved in shipping the commodities from the producer to the port of departure. These trade margin items must be subtracted from the export values in order that they should be consistent with the data showing the output distribution of the sector concerned, which is valued at producer's prices in most tables.

VII. Transportation and Related Services

3.30 The total value of output of transport services should be defined to be equal to the sum of charges paid (received by carrier as actual revenues or as imputations) by the users of transport services. The total operating revenues of transport enterprises (rail, road, air, and water) are usually available from the transport statistics. These figures will provide the control totals but not the necessary sector breakdown.

3.31 The problem of allocating transport costs is similar in many respects to the problem of allocating trade margins among the various sectors. A complete matrix is desirable showing in each cell the transport costs incurred in the flow from sector i to sector j. Each column total in such a table indicates the total

8/ In the absence of a national alignment between commodities and the industrial classification shceme, the aforementioned (para. 3.14) document "Classification of Commodities by Industrial Origin" may be useful. Naturally, any adjustments which are made in the industrial classification scheme in establishing the input-output sector classification must be reflected in the allocation of commodities.

transport costs involved in shipping all the various inputs to each sector. The total of each row is equal to the total transport costs involved in distributing the output of the corresponding sector to its various destinations.

3.32 It can be assumed that data can be provided showing the sectors of origin of the principal commodities, and that the purchases of the transportation service on the same commodities may be established. The difficulty arises in allocating the transport costs among the industries purchasing the commodities. The output of a given sector may embrace several different commodities which fall into separate freight classifications and travel at substantially different rates, while the product mix of the sector may not be known. Furthermore, significant differences may occur in the transport costs of the same commodity because of differences in destination, size of shipment, etc. Bearing in mind these problems it is usually necessary to collect additional information, perhaps by sample survey, from the transport, producing and purchasing enterprises.

3.33 Operating revenues from the transport of passengers can be divided between households and business expenditures of the various sectors. It is sometimes possible to estimate the individual items of business travel expenditures from the accounts of enterprises.

3.34 Warehousing and storage margins are usually estimated for those commodities which are principally marketed through channels involving storage in warehouses.

VIII. Services

3.35 Services comprise an extraordinary heterogeneous group of activities, including education, health, research institutes, libraries, recreation services, personal services, etc. Generally, the output levels are measured by gross receipts. Control totals may often be provided by general economic and business statistics, but very little information is available on the output distribution of services to intermediate sectors. However, most services sectors distribute their output entirely to final demand categories which are fairly easily identified. Those services which distribute their output to other intermediate sectors must be the object of special studies. Likewise, the input side of the services sectors usually requires detailed investigation, since in very few cases are the statistical data available for this purpose.

3.36 In some countries the advertising industry is defined on an activity basis, and the advertising revenues of newspapers etc. are transferred to the advertising industry. The total expenditure of non-profit education and hospital services is taken to be the value of the output of these sectors, including the depreciation of building and equipment.

CHAPTER IV

USES OF INPUT-OUTPUT ANALYSIS

4.1 Perhaps the most important uses of input-output analysis by Governments hitherto have been statistical. Recently, however, the emphasis has shifted towards the application of input-output analysis to economic forecasting and planning. Whereas, ten years ago, the usefulness of input-output as a method of analysis of the economy as a whole was thought to be limited by the rigidity of its assumption, its widespread acceptance since then in countries with varying political systems and at different levels of economic development constitutes convincing evidence of its efficacy.

4.2 Paradoxically, the success of input-output analysis can be attributed to its flexibility. Because of the simplicity of the method, combination with other methods of analysis can enormously extend the range of its usefulness. Where greater detail is desired in specific sectors of the economy, partial optimization methods which take account of alternative production possibilities and capacity constraints can be reconciled by iteration with a comprehensive input-output framework. Such ad hoc adjustments as linear but non-homogeneous production functions and variable primary input coefficients are easily made.

4.3 This chapter describes some common uses of input-output analysis, beginning with the standard analysis of the relations between final demand and primary inputs. The analysis of prices and costs is considered in the next section, followed by an account of applications in forecasting and planning. Then statistical uses are described, and the comparative analysis of economic structure is discussed. Finally, the applicability of input-output analysis to developing economies is considered. The discussion throughout is confined to applications of the open static input-output system. Linear programming, dynamic and regional analysis and other extensions of the system in its simplest form are not considered here.

I. The Analysis of Quantity Relations

(a) Primary Input Requirements

4.4 One of the most common uses of input-output analysis has already been indicated in chapter I - the calculation of the quantity of each primary input absorbed directly and indirectly in the final delivery of one unit of output of a specified sector. In the standard notation, this quantity can be represented as:

$$\Sigma_j \, f_{hj} r_{jk} \qquad (1.15)$$

where f_{hj} is the quantity of primary input 'h' absorbed directly in sector 'j' per unit of output while r_{jk} stands for the element in the 'j'th row and 'k'th column of the inverse matrix.

4.5 If, for example, it were desired to compute the import content of a unit final delivery from the agricultural sector, this can be obtained by multiplying the elements of column 1 of table 1.3 by the corresponding import coefficients, (the entry in the import row of each column of table 1 divided by the column total), and summing the result. Thus the solution would be $(\frac{2547}{16076} \times 1.6700) + (\frac{3293}{15481} \times .0673) + (\frac{1161}{4417} \times .0049) + (\frac{3016}{10709} \times .1071) + (\frac{348}{7521} \times .0486) + (\frac{1614}{11795} \times .0466) = 0.319$ million guilders worth of imports are directly and indirectly consumed in the final output of 1 million guildersworth of the agricultural sector.

4.6 This elementary computation may be extended in two directions, by introducing greater detail in the specification of the primary inputs and of final demand.

4.7 If a similar computation is performed for each of the four other categories of primary input distinguished in table 1.1, the sum of the five solutions will be found to add to one: in this way the unit value of the final output can be reduced to its component inputs. More generally, the sum of the primary inputs required to satisfy all final output will be exactly equal to the total primary input.

4.8 If this procedure is applied to the final output of all sectors, the primary input content of the unit final output of each sector is the result. From this it is only a matter of multiplication to find the primary input content of any combination of final output such as Exports or Household Consumption. In such calculations, the primary inputs which go directly to the final demand sectors should not be overlooked. When the primary input values corresponding to all final deliveries are computed, they will be found to be equal to the row totals recorded in table 1.1. This result simply reflects the identity between the total value of final output (national expenditures) and the total value of factor payments (national income). Such an identity, in this instance, depends upon the definition of all physical units as being equal to the amounts purchasable for 1 guilder at base year prices.

4.9 These relations between sector final outputs and primary inputs can be worked out for any desired combination of final outputs, but they can be conveniently summarized in a table of the form of table 4.1. Each element in this table shows the amount of the primary input at the left actually absorbed in the total component of final demand represented above. For example, the figures shown in the column Exports in table 4.1 were obtained by multiplying each element of the Exports column in table 1.1 by the corresponding column of the inverse matrix, (table 1.3), to derive the total output associated with this component of final demand; and then multiplying, for each sector, the computed total output required of that sector by each of the primary input coefficients. The amount of each category of input is added across all the sectors and the sum is entered in table 4.1 in the Exports column. Exactly the same procedure is repeated for each of the final demand components of table 1.1. The sum of each row of the table equals the total value of that category of primary input as shown in table 1.1, while the sum of each column equals the total value of that component of final demand. The value of the sum of the row and column totals is theoretically equal to the gross domestic product, and will be equal to that figure in practice if the accounting conventions used in the preparation of the input-output table are the same as those used in the estimation of the national accounts.

TABLE 4.1

Total Primary Input Requirements by Final Demand Components (from Table 1.1)

	Exports	Household Consump-tion	Government Consump-tion	Gross Domestic Fixed Capital Formation	Net Increase in Stocks	Total Primary Inputs
Imports	5,907	5,822	709	3,613	392	16,443
Depreciation	1,042	1,387	276	254	24	2,983
Net Indirect Taxes	1,073	1,350	105	533	33	3,094
Employees' Income	3,902	5,019	3,342	2,332	166	14,761
Profits	3,519	5,959	481	1,387	108	11,454
Total Final Demand	15,443	19,537	4,913	8,119	723	48,735

TABLE 4.2

Ultimate Disposition of the Output of the Metals and Construction Industry by Consuming Industry and Final Demand Component

	Agriculture, Fishing, Food	Metals and Construction	Textiles and Apparel	Mining Chemicals and Utilities	Trade	Services	Total
Exports	238	3,577	31	184	77	433	4,540
Household Consumption	375	1,096	85	120	197	415	2,288
Government Consumption	1	1,176	1	24	2	25	1,229
Gross Domestic Fixed Capital Formation	0	6,954	0	10	26	28	7,018
Net Increase in Stocks	-2	393	4	3	1	7	406
Total	612	13,196	121	341	303	908	15,481

All units are millions of guilders.

(b) Disposition of Output

4.10 The calculations in the preceding section used the columns of the inverse matrix to trace the ultimate origin of the inputs required to satisfy the final outputs of specific sectors. Likewise, the rows of the inverse matrix may be used to find the ultimate destination of the output of particular sectors.

4.11 This type of market analysis can be illustrated by analysing the total disposition of the output of the Metals and Construction sector, shown in table 1.1.

4.12 Each element in row 2 of table 1.3 shows the value of Metals output ultimately absorbed in a unit final delivery of each sector. If these figures are multiplied by the respective numbers of units actually delivered to each component of final demand by each sector of production as shown in the second quadrant of table 1.1, the results can be set out in the form of a table (see table 4.2). This table shows that while the direct dependence of Metal and Construction output upon the demand for investment goods is very important, 415 million guilders worth or about 2.7 per cent of the total market depends ultimately upon the consumption of services by Households. Tables such as 4.2 (naturally much more detailed), have been prepared for the Iron and Steel sector in the United States and in Italy and for the Petroleum sector in Australia. The information it contains is obviously useful to the enterprises of the sector in question. It indicates their ultimate dependence for markets upon the final outputs of other sectors, a dependence which cannot be directly observed.

(c) Special Input Coefficients

4.13 The computations in the preceding two sections have utilized information derived solely from the original input-output table. For this reason the solutions illustrated in tables 4.1 and 4.2 above have the quality of consistency, which is easily confirmed. (On the other hand their accuracy depends upon the fulfilment of the assumptions of input-output analysis). However, the inverse coefficient matrix which is derived from table 1.1 may often be used in conjunction with other input coefficients and hypothetical final demand components.

4.14 Although table 1.1 is typical of input-output flow tables in measuring the primary inputs of labour and capital in value terms, it is frequently desirable to specify labour in real terms (i.e. in man hours) or man years in order to distinguish clearly real inputs from the price of labour (wages per man hour or per man year). Consequently, many studies have been published showing not only the total man hours of labour expended in each sector of the input-output table during the year for which the table was prepared but sometimes also a distribution of the labour inputs by category of skill or occupation class. In the latter case, this takes the form of a special table showing in each column, the input-output sector and in each row the occupation class. Such special tables are desirable for any detailed analysis of employment, whether it be a study of past changes in the industrial distribution of skills or a projection of the pattern anticipated. When detailed information about inputs of labour is available, whether it be compiled as part of the input-output study or separately, it may be applied in conjunction with the inverse matrix in several ways, depending upon the particular purpose.

(a) An average labour input coefficient may be computed directly for each sector by dividing the actual labour input in real terms by the value of total sector output. This coefficient may then be used in computations similar to those illustrated in section (Ia) to estimate the total labour content of some specified final outputs.

(b) For an analysis involving small changes in sector output levels, a marginal - or more exactly, an incremental - labour coefficient may be more appropriate. It can be computed as the ratio of an observed change in labour input corresponding to an observed change in the output level of a specific sector. Incremental coefficients would be used in conjunction with the inverse matrix and a set of final outputs expressed in small changes. They will be different at different scales of operation and thus might be determined separately for the low, intermediate, and high levels of output.

(c) The most appropriate assumption would perhaps be that of a linear but non-homogeneous relation between labour inputs and output. This is much harder to estimate empirically, in the absence of a series of comparable observations. For the purposes of a particular study, however, it might be considered necessary to undertake some such estimate.

4.15. The contribution of capital to the process of production is represented in the input-output table by an amount attributed to the depreciation of the capital stock in the sector and in the period in question, as well as in the elements of Profit. The estimation of depreciation is notoriously difficult and the consistency which the accounting method imposes is a dubious virtue indeed. Several tables have been prepared showing the distribution and composition by industry of origin of the capital stock in each sector of the economy. A typical table of capital stock shows the capital goods produced by the industry at the left which are used in the production of the output of the industry at the top. A table such as this is the basis for dynamic models, in which additions to capital stock in one period are associated with output in later periods. However, in the static input-output system of capital stock coefficients are not broken down by their sector of origin and are used in the same way as other primary input coefficients.

4.16 Perhaps the classic example of the use of labour and capital stock coefficients with the open static input-output system is the estimation by Leontief of the factor content of the foreign trade of the United States. This analysis has since been repeated for the foreign trade of other countries including Japan, Canada, Israel and India.

4.17 The computation is designed to estimate the quantity of labour and the value of capital stock embodied in, respectively, the exports and imports of the country in question. The procedure in Leontief's original computation was as follows. First, the output required to produce 1 million dollars worth of exports was calculated by multiplying each column of the inverse by the share of the corresponding sectors' deliveries to exports expressed as a fraction of $1 million. Then the output required of each sector was multiplied by the appropriate labour and capital coefficients to obtain an estimate of the total amounts of each factor absorbed. A similar calculation was performed to estimate the amounts of labour and capital required to replace with domestic production $1 million worth of competing imports. It was found that whereas 1 million dollars of exports required directly and indirectly $2.55 million of capital and 182,313 man years of labour, import replacements required $3.09 million of capital and 170,004 man years of labour. Leontief accordingly concluded that the United States was a net importer of capital in its Foreign trade. The same procedure has been applied to the trade of one country with another rather than with the world at large, but the results in this case have little immediate application. An interesting by-product of the computations was the illustration of the way in which accounting conventions may influence the numerical solutions. The successful application of input-output analysis requires an understanding of the meaning of the data: a purely mechanical calculation can be dangerously misleading.

4.18 More urgent because of their policy implications, have been investigations of the Foreign-exchange requirements of different items of final demand; for example, the capital goods required for an investment programme, or exports of manufactured goods which may contain, directly or indirectly, imported raw materials. Once imports have been distinguished according to the foreign currency required for their purchase, it is easy to compute in the manner of section (a) above the imports and thus the foreign exchange required to implement various alternative programmes of expenditure. Studies of this type have been carried out in Italy, Hungary, Israel, and several Latin American countries.

4.19 Other primary input coefficients have been devised for natural resources and taxes. The advantage of primary input coefficients is that they can usually be compiled and revised independently of the complete input-output table. In fact, the only constraint upon their use is the judgement of the user: their effectiveness will only be as good as the appropriateness of the input-output assumptions, implicit in the use of the inverse matrix, to the particular problem studied. The possibility of combining special primary input coefficients in a number of forms significantly improves the flexibility and scope of the open static input-output system.

(d) The Specification of Final Demand

4.20 In chapter I it was pointed out that the designation of certain sectors as 'final' in the input-output table usually followed the convention of national-income accounting.

4.21 It is essential to appreciate the implications of treating certain sectors as 'final' within the framework of input-output analysis. Recall the system of equations:

$$\begin{aligned}
(1 - a_{11})x_1 - a_{12}x_2 - \quad \cdots\cdots - a_{1n}x_n &= y_1 \\
- a_{21}x_1 + (1 - a_{22})x_2 - \cdots\cdots - a_{2n}x_n &= y_2 \qquad (1.4) \\
\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots & \\
- a_{n1}x - a_{n2}x_2 \cdots\cdots + (1 - a_{nn})x_n &= y_n
\end{aligned}$$

4.22 The 'i'th equation states that the output of sector 'i', less the amounts of its output absorbed by the sectors of production, including itself, is equal to the amount delivered to final demand. Thus the output level of all the production sectors are simultaneously determined while the final demand is independently specified.

4.23 The amount of output which is independently determined in this system can be augmented by specifying the level of output of the 'i'th sector. In terms of the system of equations (1.4) this implies transferring the column of elements $- a_{1i}x_i, - a_{2i}x_i, \ldots (1 - a_{ii})x_i, \ldots - a_{ni}x_i$, etc., (which all become constant since x_i is given to the right hand side. At the same time it implies the elimination of the 'i'th equation from the system. In mathematical terms, since x_i is specified it can no longer be determined as a dependent variable in the system. In terms of economics, the elimination of the 'i'th equation and the specification of its output means that the total input of the 'i'th sector is no longer held to be dependent in any way upon the level of its output. In other words, in the application of input-output analysis, the inclusion of a sector in the category of final demand (or independent variables) implies that any functional relation between that sector's input and output - if it exists at all - is being disregarded in the context of this particular computation. Conversely, the inclusion of a sector among the category of production sectors (or dependent variables) means that there is assumed a linear (usually homogeneous) relation between input and output. For any sector, the recognition of a relationship between input and output depends on the circumstances of the problem.

4.24 For example, the usual assignation of the Households sector to final demand means that the relationship between sector inputs (consumption) and output (employment) is ignored. Under this treatment (described above) the amount of employment or household income associated with various specified components of final demand, including consumption, is estimated without regard to the effect of changes in employment or household income upon consumption expenditures. While this procedure evidently underestimates the extent of interdependence in the input-output system, it usually produces more plausible results than the alternative method of including a Households row and column within the coefficient matrix. This has the following general weaknesses:

(a) Household expenditures form such an enormous proportion of the total value of transactions, that a small error in the estimate of an input coefficient for that sector might introduce a large error in estimates of output.

(b) The assumption of simple proportionality between household income and expenditure on individual items is implausible. A linear relation can be introduced within the theoretical framework of the model, but usually the empirical estimation of the parameters of such a relation is costly.

(c) With households included within the matrix, the input-output system logically leads to the conclusion that if investment, export, and government expenditures were reduced to zero, all output would cease in each sector of the economy.

(d) Empirical applications estimating the consequences for a national economy of changes in components of final demand, including the income-multiplier effect obtained through including households within the matrix have usually yielded numerical solutions which seriously over-estimate the actual consequences.

(e) Sometimes the input-output computation is undertaken in order to determine what level of consumption would be compatible with several prescribed levels of investments. In that case, the "input coefficients" of households have to be treated as unknowns rather than as given data of the problem.

4.25 For these reasons, households are generally treated as a final demand sector. However, in some applications the employment consumption relation cannot be ignored. For example, the output of local service industries in a region is dependent indirectly upon the region's exports through the income and expenditure of local residents. (The smaller is a region the greater in value are its exports in relation to household expenditures). In the input-output analysis of cities or other small regions, it is frequently desirable to take account of the employment-consumption relation and thus to include households within the matrix.

4.26 There is unlikely to be any simple relation between the inputs (expenditures) and outputs (respectively amortization and tax revenues) of the investment and government sectors as they are formulated in the open static input-output system, and for most applications it is appropriate to consider their expenditures as given. So far as investment is concerned, while an increase in capital utilization reflected in depreciation may very well lead to future investment, that investment will be primarily composed of capital goods obtained from future, not current production. The relations between capital accumulation, amortization and production in different periods of time is the concern of a dynamic input-output system. The equality of expenditures and tax revenues of the government sector is no longer the virtuous necessity it once was thought to be, and the items of government expenditure are mostly truly innocent of any dependent relation with other variables in the input-output system.

4.27 There is no physical relationship between the inputs and outputs (exports and imports) of the foreign trade sector but it might be appropriate on occasion to take into account the necessary financial balance between them. Most current applications of input-output analysis to development programmes have treated exports as being independent of the level of imports. Having specified exports with other categories of final demand they have computed the imports required, directly and indirectly, to satisfy the needs of consumption, government, investment and exports. If the computed import requirements exceed the expected exports further computations may be made with new parameters (reflecting, for example, import substitution) until a reasonable relation between the two is obtained. However, an alternative procedure is possible.

4.28 Exports considered to be independent of balance-of-payments considerations may be specified. The amount may be either positive or negative depending upon whether an export surplus or deficit is the objective. When these independent exports have been specified, the foreign trade sector may be included within the matrix, and the total level of exports necessary to obtain the imports required to satisfy the specified final demands can then be computed in the usual way.

4.29 Just as sectors which are traditionally autonomous can be moved into the matrix to solve particular problems, so the output of production sectors is sometimes treated as given. Agriculture, for example, is a sector for which it is often more useful to specify the level of output and leave the amount available for final demand to be determined. This is so because in addition to current inputs of all kinds and invested capital, such natural conditions as the available amount of suitable land put an upper limit on the level of agricultural output. In this case, a value (or a range of values) having been chosen for agricultural output, the amount of inputs required by the agricultural sector are immediately determined and added to the final demand column. The input-output system now consists of one less unknown and one less equation than before, and a solution can be obtained in the usual way. When the output levels of all non-agricultural sectors have been determined, the amount of agricultural output required to satisfy this intermediate demand can be estimated by multiplying the row of agricultural input coefficients by the column of sector output. The difference between the total agricultural output required to satisfy intermediate demands, and the total output originally specified is the amount available for all categories of final demand.

II. Uses in Price-Cost Analysis

(a) General

4.30 A characteristic difference between advanced and developing economies, which cannot fail to impress even the casual observer, lies in the price system. In general, the relative prices of a set of goods is quite different in the two types of economy, and, in particular, the price of labour with respect to the price of capital tends to be higher in the advanced economy.

4.31 Input-output analysis provides a method of examining in a simple but quantifiable way the relationship between prices (both of goods and of factors) in a particular economic system. It makes possible an estimate of the consequences of a change in any one price upon the others in the system, but it cannot be used to study the effects of a change in price upon the quantities of goods consumed or produced. For this reason, price calculations using input-output ethods have been much more widely adopted in centrally-planned economies than in market economies. Whereas input-output studies in market economies have typically made *ex post* comparisons of computed prices with those actually observed in different markets, input-output analysis has been used in centrally-planned economies to determine the system of prices which will be decreed by the planning authority.

4.32 Accordingly, there has been considerable discussion, in centrally-planned economies, about the correct basis for a system of planned prices. Perhaps the simplest theory is that the price of each commodity should be established in proportion to the total (direct and indirect) wage costs per unit of final output of that commodity. This implies that the profit element - the difference between price and unit total wage cost - is proportional to the wage cost for each commodity.

4.33 According to a second theory, the profit element in the price of each commodity should be fixed in proportion to the capital stock engaged in the production of the commodity.

4.34 The system of prices actually in use in the Soviet Union is based upon a concept of unit price according to which the profit element is fixed in proportion to the sum of total wage and direct amortization costs. It can be written as:

$$p_i = (1 + \pi) \quad (w_i + \mu_i \ \frac{k_i}{x_i})$$

where p_i = price of good 'i'

w_i = total wages (direct and indirect) per unit of final output of good 'i'

k_i = capital stock used in production of good 'i'

x_i = total output of good 'i'

π = planned profit margin

μ_i = rate of depreciation of k_i

(This formulation is due to Vitello)

4.35 Yet another basis for planned pricing (formulated by Brody) is a set of prices according to which the profit element in the unit price of a commodity is determined by the amount invested in the production of the commodity and the average rate of profit.

4.36 If the familiar matrix of input coefficients, A, is defined to include the households sector, then the current direct costs of production, including wage costs, of any commodity 'i' can be written as:

$$a_{11}p_1 + a_{21}p_2 + \ldots\ldots + a_{n1}p_n$$

In matrix notation, the row vector whose 'i'th element represents the cost of production in the above sense of commodity 'i' can be written:

$$p'A$$

Thus the difference between the vector of prices and the vector of costs of production, i.e. the row vector of profits can be written as:

$$p'(I - A)$$

And if the average rate of profit is denoted by π, and the amount of capital invested is equal to the cost of production $p'A$, then the equation

$$p'(I-A) = \pi p'A$$

states that the profit element in the price of each commodity is equal to the average rate of profit times the unit cost of production. But the amount of investment required to produce a unit of any commodity is more than the sum of the current costs of production: it includes also the costs of the various items of capital equipment. If the input coefficient matrix A is replaced by another C, which includes capital as well as current inputs, then a solution of the more general equation:

$$p'(I-A) = \pi p'C$$

for p' yields the desired set of prices.

4.37 In Hungary, there have been widespread experiments using input-output analysis to derive a planned price system. The price system which came into effect on 1 January 1959 was derived with the help of the inverse matrix obtained from the input-output table for 1957. The introduction of the new price system had the immediate effect of revealing hidden profits in certain branches of the economy which arose from discrepancies between costs of production and former prices. Later a 300 x 300 table of commodities was inverted: this table was not complete, but the typical inputs and outputs of each branch was represented. The resulting inverse showed the degree of interdependence between commodities with sufficient accuracy to permit qualitative judgements about the consequences of price changes in commodities upon one another.

4.38 This computation illustrates one of the limitations of input-output tables: sectors consist of aggregates of often heterogeneous commodities. Hence input-output provides a framework for computing consistent indexes of prices, rather than individual commodity prices. To the extent that the commodity composition of sectors change, to that extent will the inverse matrix specify inaccurately the relationships between sector prices. The assumptions of the input-output system enunciated in chapter two are equally as applicable in price as in quantity calculations.

4.39 There are other important limitations to the usefulness of input-output analysis in planning price systems, which reflect more upon the usefulness of planning price systems than upon the relevance of input-output analysis. They deserve to be mentioned, if only to point out the dangers of a mechanical application of a particular technique.

4.40 First, some prices, such as the prices of exports and of imports, are usually beyond the control of the planning authority, and therefore must be treated as given.

4.41 Secondly, many prices include elements of special taxes or subsidies so that they deviate from total factor costs; for example, in the Soviet Union, the prices of alcohol and tobacco are increased by taxes, whereas the rents of houses are usually much lower than the factor cost would warrant.

4.42 Thirdly, all of the bases for planned prices have in common the fact that they attempt to reflect the total direct and indirect factor costs of producing one unit of output. Yet an efficient price system cannot be based upon costs of production alone - some account must be taken of the usefulness of the output. A system of prices based solely on the theory that prices should be proportional to factor costs (somehow measured) clearly cannot do this. Consequently, the implications of a set of planned prices derived from given factor prices are quite different from the implications of a set of factor prices computed from a set of market-determined prices, even though both are related by the same input-output system.

4.43 In centrally-planned economies planned retail prices may deviate from factor costs because of market influences. In the case of agricultural products, some prices may even be determined entirely by market supply and demand.

4.44 For all of these reasons, input-output analysis can have only an advisory role in planning prices, ensuring over-all consistency but not necessarily efficiency. An efficient price system, i.e. that set of prices for which the quantity of each commodity produced will just equal the quantity consumed in all uses, might be approximated by successive adjustments, using a computer to simulate the economy, or using the economy itself.

4.45 Linear programming methods can, in theory, be used to compute an efficient set of prices. In practice, however, the importance of detailed specification of constraints makes this method unsuitable for economy-wide computations, and it is usually appropriate for analyses within sectors. The Russian authority on input-output analysis, Academician Nemchinov insisted that the acconnting prices which are the product of linear programming computations can only be used as indexes for distributing the profit element in prices and should not be used as prices themselves.

4.46 Among countries with market economies, the Netherlands and Norway have applied input-output analysis to price problems. In the Netherlands, the method has been used to estimate the effects of changes in the price of coal, equal pay for men and women, changes in import prices, wage increases greater than productivity increases, and changes in rates of taxation. In Norway, price changes were computed for all domestic production sectors, given changes in the prices of primary inputs, and the weighted average of price changes in each sector yielded a price index. Conversely, the implications for the prices of primary inputs were calculated for changes in export prices. The following is an example of the way in which input-output analysis can be used to indicate government policy alternatives. A price rise of 20 per cent in all imports was assumed, and it was further assumed that all wage earners and the self-employed in agriculture, forestry, and fishing were to be fully compensated for price increases; the consequence was found to be an average rise of 7.9 per cent in consumer goods prices and of 11.3 per cent in the prices of investment goods. If subsidies were increased sufficiently to maintain food prices constant, the increase in consumer prices would be only 4 per cent and in investment goods prices 9.7 per cent.

4.47 In these computations, which are typical of those carried out in market economies it is assumed that all increases in costs, direct or indirect, are passed on, i.e. that each sector raises the price of its output by just the amount of the increase (if any) in the price of its primary inputs plus the rise in the price of the inputs absorbed from other industries. The appropriateness of this assumption depends upon institutional conditions, but the possible limitations are evident. It is hard, for example, to envisage the absolute decrease in a commodity price being passed through many sectors.

4.48 The assumption of homogeneity of sector output composition rules out the possibility that the same output may be sold at different prices on different markets. The limitations of this assumption depend upon the industrial classification system which has been used in preparing the table.

4.49 The Netherlands Central Bureau of Statistics has used input-output tables to check the consistency of its index numbers. At the same time this procedure tests the usefulness of input-output tables by checking on the stability of the input structure. The exact procedure is illustrated with a numerical example below, but it may be briefly described here.

4.50 Three bills-of-goods (Exports, Consumption, and Capital Formation) were estimated for 1958 and 1959 according to the input-output classification, and were turned into 1957 prices by means of price-index numbers. The adjusted bills-of-goods were then premultiplied by the 1957 inverse matrix, to give estimates of total output of industries in 1958 and 1959 quantities at the prices of 1957. Using the primary input coefficients derived from the 1957 table, Gross Value Added was then estimated for each sector in 1957 prices. The quantum index numbers thus obtainable for Gross Value Added for 1957/58 and 1957/59 were then compared with production index numbers of the standard type.

4.51 The analytical work of the Netherlands Central Bureau of Statistics is closely related to the purely statistical work of collecting, arranging and checking data. For example, estimating the effects of annual changes in wage costs per unit of output requires estimates of the total wage bill and total output in each sector or indices thereof. Figures derived in this way can be checked for consistency with wage costs indexes obtained by dividing indices of wage-rates by the index numbers of average output per worker. Naturally, the assembling and processing of data for thirty-five sectors annually requires considerable work. The result is, however, that after preparing estimates of changes in the costs of primary inputs from changes in the price indexes of imports, wages, depreciation, taxes, etc., the consequent changes induced in the thirty-five sector price indexes are calculated, and compared with the actually observed prices in the various categories of final expenditure. (Lack of sufficient data makes it impossible in practice to compare specific interindustry transactions.) Differences which exist between the computed prices and the observed market prices can then be attributed to factors other than those which have been taken into account in the calculation.

4.52 The following section illustrates, with simple numerical examples, some common types of computation relating prices and factor costs, beginning with index numbers of price and quantity.

(b) Numerical Examples

i. The following illustration of the use of index numbers is adapted from T.M. Bouthoorn, "Some Uses of Quantum and Price Indices in Connection with Input-Output Data", (ST/STAT/CONF.10/L.7).

4.53 Suppose we are given a simple two sector table for the year 'o' with the following figures:

TABLE 4.3: Prices of Period 'o'
Quantities of Period 'o'

		Intermediate Demand		Final Demand				
		1	2	E	C	I	Total	Gross Output
Intermediate Inputs	1	40	40	30	70	20	120	200
	2	20	10	20	40	10	70	100
Imports		40	10					50
Value Added		100	40					140
TOTAL INPUT		200	100				190	

The resulting matrix of intermediate input coefficients, A, is:

$$\begin{bmatrix} 0.2 & 0.4 \\ 0.1 & 0.1 \end{bmatrix}$$

and the primary input coefficients are:

$$\begin{array}{c} m \\ v \end{array} \begin{bmatrix} 0.2 & 0.1 \\ 0.5 & 0.4 \end{bmatrix}$$

and the inverse of the intermediate coefficient matrix is:

$$\begin{bmatrix} 1.324 & 0.588 \\ 0.147 & 1.176 \end{bmatrix}$$

4.54 Suppose that the prices of goods imported by industry '1' increase by 20 per cent while those imported by industry '2' increase by 10 per cent, and that the prices of other primary inputs remain unchanged, then the increases in the price of the products can be calculated as follows:

4.55 The general equations for a two sector price system can be stated in the following way:

$$p_1 = a_{11}p_1 + a_{21}p_2 + m_1 p_{m1} + v_1 p_v$$

$$p_2 = a_{12}p_1 + a_{22}p_2 + n_2 p_{m2} + v_2 p_v$$

where m_i is the quantity of imports absorbed in sector i per unit of output, and V_i is the quantity of all other primary inputs absorbed in sector 1 per unit of output.

4.56 The coefficients, a_{ij}, obtained from the table of base year values are equivalent to physical input coefficients when all base year prices are unity. After the rise in import prices, however, the product prices take on new, unknown, values while the price of all other primary inputs, p_V, remains constant, (at 1). Accordingly, the new price system which arises as a result of the increased cost of imports can be determined from the following equations:

$$p_1 = 0.2p_1 + 0.1p_2 + 0.2\ (1.2) + 0.5\ (1.0)$$

$$p_2 = 0.4p_1 + 0.1p_2 + 0.1\ (1.1) + 0.4\ (1.0)$$

Rearranging terms,

$$0.8p_1 - 0.1_{p2} = 0.74$$

$$-0.4p_1 + 0.9_{p2} = 0.51$$

Solving for p_1 and p_2 yields the results

$$p_1 = 1.055$$

$$p_2 = 1.035$$

Thus, the increase in import prices has caused the price of the output of the first industry to rise by 5.5 per cent and the second industry's price to rise by 3.5 per cent.

4.57 The same result can be obtained by premultiplying the inverse matrix by the primary input coefficient adjusted for the import price changes, i.e.

$$\begin{bmatrix} m_1 p_{m1} & m_2 p_{m2} \\ v_1 p_{v1} & v_2 p_{v2} \end{bmatrix} \begin{bmatrix} r_{11} & r_{12} \\ r_{21} & r_{22} \end{bmatrix}$$

$$= \begin{bmatrix} 0.2\ (1.2) & 0.2\ (1.1) \\ 0.5\ (1.0) & 0.4\ (1.0) \end{bmatrix} \begin{bmatrix} 1.324 & 0.588 \\ 0.147 & 1.176 \end{bmatrix} = \begin{bmatrix} 0.3339 & 0.2705 \\ 0.7208 & 0.7644 \end{bmatrix}$$

The column totals represent the value of the price-increases induced by the increased prices of imports.

4.58 A new table can be drawn up (see below) showing the quantities produced and consumed in year 'o' at the new prices. It is obtained from the original table by multiplying rows 1 and 2 by 1.055 and 1.035 respectively, and by multiplying the import input into industry 1 by 1.20 and that into industry 2 by 1.10.

TABLE 4.4: Prices of Period 1
Quantities of Period 0

	1	2	Total Final Demand	Gross Output
1	42.2	42.2	126.6	211.0
2	20.7	10.4	72.4	103.5
Imports	48.0	11.0		59.0
Value Added	100.0	40.0		140.0
TOTAL INPUT	211.0	103.5	199.0	

4.59 If it is known that the quantity of production in both sectors has remained unchanged, then the table above could be compared with a table prepared from actually observed values. Ruling out possible changes in the physical input coefficients, any differences must be attributed to price-changes which were not induced by the rise in import prices. However, if the time periods 'o' and 1, before and after the price change, are far enough apart it is unrealistic to suppose that there would not also be a change in sector outputs.

4.60 If it is known that the quantity of final output has increased by a certain amount in each sector, then another table may be drawn up for period 1, incorporating both the price and quantity changes which have taken place since period 'o', (yet maintaining the assumption that the physical input structure represented by the coefficient matrix A remains unchanged). The way in which the total output is obtained from table 4.4 illustrates the relationship between quantum indexes of final output and quantum indexes of total production. This relationship is valuable since such indexes, prepared independently, can be checked with the indexes obtained from an input-output table.

4.61 If the quantity index of final output stands at 140.8 in period 1 for sector 1 and 134.3 for sector 2 (both are 100.0 in period 'o'), then the value of total output of each sector in the prices and quantities of period 1 may be computed as follows:

4.62 The final output in the previous table (at prices of period 1 and quantities of period 'o') is multiplied by the respective quantum index, and the resulting figures are premultiplied by the original inverse.

$$\begin{bmatrix} 1.324 & 0.588 \\ 0.147 & 1.176 \end{bmatrix} \begin{bmatrix} 1.408 \times 126.6 \\ 1.343 \times 72.4 \end{bmatrix} = \begin{bmatrix} 294.3 \\ 140.2 \end{bmatrix}$$

Since total output was previously, $x_1 = 211.0$ and $x_2 = 103.5$, the quantum index numbers for total output are, respectively:

$$\frac{294.3}{211.0} = 1.395 \quad \text{and} \quad \frac{140.2}{103.5} = 1.354$$

4.63 The new table in period 1 values can be completed by multiplying the input coefficients, both the A matrix and the primary coefficients, by the newly derived gross output levels. The value coefficients, however, must be adjusted to reflect the price changes. If $\bar{a}_{ij}$ represents the value coefficient, and a_{ij} the physical input coefficient, then

$$\bar{a}_{ij} = \frac{p_i}{p_j} a_{ij}$$

defines the value coefficient. In the original value table, from which the physical coefficients are derived, it is assumed that $p_i = p_j = 1$. When prices change, $\bar{a}_{ij}$ accordingly changes, although the physical input coefficient remains constant. Thus to form the table in period 1 values the sector outputs, computed above, should be multiplied by the adjusted coefficients. The following table for period 1 then obtains:

TABLE 4.5: Prices of period 1
Quantities of period 1

	1	2	Total Final Demand	Gross Output
1	58.9	57.2	178.2	294.3
2	28.9	14.0	97.3	140.2
Imports	67.0	14.8		81.8
Value Added	139.5	54.2		193.7
TOTAL OUTPUT	294.3	140.2		

This table can then be compared with a table prepared from directly observed values of transactions in period 1. Differences between the tables must be due to one of the following causes:

(a) Changes in the physical input coefficients between the two periods.
(b) Changes in the composition of the output of industrial sectors.
(c) Changes in price unaccounted for by the increase in import prices.
(d) Statistical discrepancies.

ii. Computing the Factor Cost Component of Unit Price of a Sector's Output

4.64 In paragraph 4.4 above, the relationship between primary input and final demand was described. In exactly the same way, the price of a unit of the final output of any sector can be transformed into its component factor costs using the appropriate coefficients of the inverse matrix. If a row of the transposed inverse matrix, which is the same as the corresponding column of the original inverse, is premultiplied by the various categories of primary input coefficient arranged in rows then a table may be drawn up showing, for the sector corresponding to that particular row of the transposed inverse, the distribution of the ultimate components of its unit price. In such a table, since unit price is defined to be equal to one, the row totals and column totals of the table will add to one.

4.65 The procedure can be conveniently illustrated using the numerical example of the previous section, multiplying the matrix of primary input coefficients,

$$\begin{array}{cc} & \begin{array}{cc} 1 & 2 \end{array} \\ \begin{array}{c} m \\ v \end{array} & \begin{bmatrix} 0.2 & 0.1 \\ 0.5 & 0.4 \end{bmatrix} \end{array}$$

by row 1 of the transposed inverse matrix (1.324 0.147) yields the following table. Table 4.2.4

TABLE 4.6

	Sector 1	Sector 2	
Import Cost	0.265	0.015	0.280
Value Added	0.662	0.059	0.721
	0.927	0.074	1.00

4.66 Here, the row totals indicate the share of each component of factor cost in the unit price, while the column totals illustrate the direct (sector 1) and indirect (sector 2) factor cost components in the unit price of sector 1.

iii. Computing the Effect of a Change in Price of one Sector upon the Value of Output in Other Sectors

4.67 In section i the method of calculating the effects of a change in unit factor cost was illustrated. In the present example, a slightly different procedure is required to calculate the consequences of a change in sector price. The procedure can be demonstrated with the help of the following 3-sector table.

TABLE 4.7

		1	2	3	Consumption	Other Final Demand	Gross Output
	1	60	60	60	75	45	300
Intermediate	2	30	15	40	15	50	150
Inputs	3	90	15	40	40	15	200
Value Added		120	60	60			
TOTAL INPUTS		300	150	200	130		

from which can be derived the coefficient matrix

$$\begin{bmatrix} 0.2 & 0.4 & 0.3 \\ 0.1 & 0.1 & 0.2 \\ 0.3 & 0.1 & 0.2 \end{bmatrix}$$

Suppose that the new price level of sector 3 is 5 per cent higher than the previous level, and suppose further that the price of factors in the other sectors is not permitted to change, the problem is then to determine the consequent new levels of prices in sectors 1 and 2. The set of price relations in a 3-sector economy can be written as follows:

$$p_1 = a_{11}p_1 + a_{21}p_1 + a_{31}p_3 + v_1p_{v1}$$
$$p_2 = a_{12}p_1 + a_{22}p_2 + a_{32}p_3 + v_2p_{v2}$$
$$p_3 = a_{13}p_1 + a_{23}p_2 + a_{33}p_3 + v_3p_{v3}$$

Since p_3 is given, the third row and column can be omitted from the transposed coefficient matrix contained in this system, so that it may be rewritten as:

$$p_1 = a_{11}p_1 + a_{21}p_2 + (a_{31}p_3 + v_1p_{v1})$$
$$p_2 = a_{12}p_1 + a_{22}p_2 + (a_{32}p_3 + v_2p_{v2})$$

and

$$v_3p_{v3} = (1 - a_{33})p_3 - a_{13}p_1 - a_{23}p_2$$

The solution of the third equation depends upon the solution of the first two equations which can be obtained independently:

$$\begin{bmatrix} p_1 \\ p_2 \end{bmatrix} = \begin{bmatrix} 1 - a_{11} & -a_{21} \\ -a_{12} & 1 - a_{22} \end{bmatrix}^{-1} \begin{bmatrix} a_{31}p_3 + v_1 p_{v1} \\ a_{32}p_3 + v_2 p_{v2} \end{bmatrix}$$

Substituting values of 1.05 for p_3 and 1.00 for p_{v1} and p_{v2}, and observing that the coefficient matrix is transposed, we have

$$\begin{bmatrix} p_1 \\ p_2 \end{bmatrix} = \begin{bmatrix} 1.324 & 0.147 \\ 0.588 & 1.176 \end{bmatrix} \begin{bmatrix} 0.3\ (1.05) + 0.4\ (1.00) \\ 0.1\ (1.05) + 0.4\ (1.00) \end{bmatrix}$$

or $p_1 = 1.021$ and $p_2 = 1.015$

Substituting for these values in the third equation, the value of p_{v3} is 1.103.

4.68 Thus the effect of an increase of 5 per cent in the price of the output of sector 3 has led to an increase in the price of sector 1 by 2.1 per cent and of sector 2 by 1.5 per cent. The price of the factor input in the third sector has risen by 10.3 per cent.

4.69 Table 4.7 can be expressed in the new prices by multiplying each row by the corresponding new prices, and changing the value added entry in sector 3.

iv. Computing an Index of the Cost of Living

4.70 Following directly from the previous example, an index for the average level of the cost of living can be computed by multiplying the fraction of consumer expenditure on the output of each sector by the corresponding price increase in that sector, i.e.

$$p_c = \frac{p_1^1}{p_1^o} \cdot c_1 + \frac{p_2^1}{p_2^o}\ c_2 + \cdots\cdots + \frac{p_n^1}{p_n^o}\ c_n$$

Substituting values from Table 4.7.

$$p_c = \frac{1.021}{1.0}\left(\frac{75}{130}\right) + \frac{1.015}{1.0}\left(\frac{15}{130}\right) + \frac{1.05}{1.0}\left(\frac{40}{130}\right)$$

$$= 1.021\ (0.580) + 1.015\ (.116) + 1.050\ (0.304)$$

$$= \underline{1.029}$$

Thus the rise in the cost of living, measured by the above index of prices of goods consumed, as a result of the increase in price of 5 per cent in the output of sector 1, was 2.9 per cent.

III. Economic Planning and Forecasting

(a) General

4.71 Despite the differences which exist between centrally planned economies and market economies in the institutional organization of their respective systems, the methods of application of input-output analysis to the future of these systems are quite similar. In fact, a difference in emphasis, which is reflected in a difference in vocabulary tends to obscure the similarity of the techniques.

4.72 In centrally planned economies, emphasis is placed upon quantitative output objectives which it is hoped will be realized in the future and for the attainment of which the planning authority is ultimately responsible. In market economies, forecasts are simply expectations about the future course of events, the realization of which depends upon decisions taken by a large number of individuals, decisions which are unco-ordinated except by the price system. Of course, neither plans nor forecasts are ever exactly realized, and there is even less difference between the two systems than is commonly supposed. In centrally planned economies consumer decisions play an increasing part in determining output, while in market economies the role of government as a central co-ordinator of economic activity is growing.

4.73 A variety of models has been derived for analysing the future of economic systems, and it is helpful to divide them into two classes, growth models and decision models. Growth models are generally designed to provide a unique solution about the future, given certain information a priori. Decision models are usually formulated in such a way that they yield alternative solutions corresponding to specific policy decisions. Models of both types commonly contain an input coefficient matrix as their core, since inter-industry relations represented by the matrix of technical coefficients are among the most commonly observed statistical regularities, and their changes are often more predictable than those of other relations.

4.74 Comprehensive models may incorporate equations determining other variables than the levels of output of the different sectors of the system: for example it is common to find an equation determining the rate of investment. But the open static input-output system itself can be used as a forecasting or planning model.

4.75 Using the word "projection" to describe all expected future values, whether they be known as "plans" or as "forecasts", then the formulation of the input-output system as a model for projection falls into two parts; (a) the projection of final demand, and (b) the projection of the coefficient matrix. When these two tasks have been performed, the estimated future levels of output can be derived in the familiar way by premultiplying the projected final demand by the inverse of the revised matrix.

4.76 The greater are the number of sectors in an input-output table, the more valuable are the results and the better the chance that their accuracy will not be diminished by changes in the composition of sector output. But the detailed results obtained can be no more accurate than the future values of the final demand for each sector's output, which must be estimated from sources outside the model.

4.77 The methods of projecting final demand for the short (one-two years) and long terms (three years or more) differ according to the information available. Typically, a short-term projection is based upon rather limited new information which permits an updating of existing data. The time which elapses in the compilation of an input-output table is rarely less than three years (usually longer in market economies than it is in centrally planned economies), and consequently the estimation of values of output for the recent past becomes an exercise in short-term projection. Until the new coefficient matrix has been prepared, input-output estimates must be based upon a previous table, which may be several years old. Estimates of present values then represent an exercise in long-term projection.

4.78 France provides an excellent illustration of the use of input-output tables for short-term projections. Twice each year an input-output table is calculated - more precisely revised - for three separate years - the preceding year, the current year, and the following year. The tables for any given year are first prepared about two months after the end of that year, at which time very little information relating to that year has become available. Consequently, the first table for that year must be projected from an earlier table taking account of whatever data is known. For example, household budget surveys, customs data, and the appropriations of government agencies and enterprises may be used to compute index numbers of consumption, exports, government and investment expenditures respectively. When these index numbers are applied to the corresponding categories in the previous table, new estimates can be derived, and thus a preliminary estimate of the total final expenditures for the year in question may be obtained: the existing inverse is used to obtain from the estimated final expenditures the first estimates of outputs for the year. Unless price changes between that year and the previous year are known, the estimates will be expressed in the prices of the previous year. (A numerical illustration of this procedure is given above.) The table is revised six months later but the first major revision comes one year later, by which time some information has become available about changes in intersectoral relations so that the coefficient matrix can be revised. Since the data is still incomplete, this estimate, like the first, requires considerable judgement in obtaining a balance between the total output and total consumption of each sector. The incorporation of new information from various sectors relating to their inputs and outputs to and from other sectors requires frequent iterations to obtain consistency in the table as a whole.

4.79 About three years after the year concerned, all necessary data have been compiled and the final table is prepared. Thus the table relating to any one year is computed twice a year over a period of three years, four times as a forecast and twice as a record of the past.

4.80 While techniques of short-term projection are necessarily pragmatic, one method of long-term projection using the input-output table is commonly followed by all countries, although several more or less elaborate variants of this method are practised. It consists simply of two stages (a) the projection of the coefficient matrix, and (b) the projection of final expenditures.

(b) Changes in the Input Coefficients Over Time

4.81 The stability or constancy of the input coefficients, a_{ij}, is one of the critical assumptions of input-output analysis. If this assumption is inappropriate then all estimates obtained by input-output analysis will be inaccurate. Strictly speaking, the assumption refers only to variations in output levels in the year to which the table refers and does not require that the input coefficients must be constant over time. However, the inescapable time-lag in the compilation of input-output tables and a practical concern with the future state of the economic system means that input-output coefficients computed in one year are used to obtain estimates for a later year. The validity of this procedure rests upon an appreciation of the behaviour of the input coefficient matrix over time. Even if this procedure is rejected, and an attempt is made to project an entire coefficient matrix for some future year, it is clear that this calculation depends upon an understanding of past changes in the matrix. In practice, of course, a projected matrix represents a combination of anticipated future changes in the economic system with information derived from the past.

4.82 In several countries, notably Norway, the Netherlands, the United States and Canada, studies have been made of the changes in input coefficients over time. Three sources of variation can be identified: (1) changes in prices; (2) changes in technology; (3) changes in the composition of sector output. (It is assumed that the coefficients represent both domestic and imported inputs: the possibility of nonlinearity in the production function is ignored in this context.

4.83 Changes in prices will cause changes in the coefficients derived from input-output tables in values, even if the physical input coefficients remain constant. Adjustments can be made for past or projected price changes by multiplying each row of the flow table by the appropriate price index. If the sector output is not homogeneous it may be necessary to form several price indexes.

4.84 Changes in the composition of sector output arise from an inadequate classification of economic activities so that some sectors contain products with different input structures. If the outputs of these products change non-proportionately the over-all input structure of the sector will change. If a re-classification of economic activity is ruled out, then changes in the output proportions within those sectors containing heterogeneous products should be anticipated, and changes should be incorporated in the corresponding columns of the projected matrix.

4.85 Changes in technology, by which is meant all changes in the physical input relations between economic activities, can be classified as (i) the substitution of some products for others in particular processes (e.g. the substitution of refined petroleum products for solid mineral fuels, or the substitution of synthetic for natural textile fibres), (ii) savings in material or energy input into processes (e.g. the constant decrease in the quantity of electricity required to manufacture a ton of aluminium), (iii) changes in the output composition of particular processes (e.g. increase in the proportion of special steels in iron and steel production).

4.86 While it is difficult to attribute observed changes in the values of input coefficients to particular causes the general consensus is that changes in technology exert only a gradual influence upon the coefficients and affect principally the inputs of energy and the inputs of primary factors such as labour and capital. Sometimes it is not particularly difficult to anticipate certain important changes in technology in the near future, and consequently the value of the projected coefficient depends to a large extent on the awareness of the economist. The incorporation of these specific changes within the general framework of the matrix is a computation which can be carried out in a number of different ways, each yielding different results. These procedures are often known as updating the coefficient matrix. With appropriate updating, a coefficient matrix may have a useful life of as much as ten years. Before turning to a description of the mechanical procedure, two comments upon the constancy of input coefficients are in order.

4.87 The size distribution of input coefficients in a matrix is skewed; specifically, there are a few large coefficients and a large number of small coefficients. Consequently, equal percentage errors in the estimation of large coefficients is likely to have a much greater influence on the estimates of output than the same error in the small coefficients. A sensitivity study performed on the 192 sector table for the United States, 1947, showed that only 320 coefficients were significant in the sense that a 100 per cent increase in their value would cause an unacceptable error in the sector output estimates. However, it is precisely the larger coefficients which are likely to be more accurately observed because of their importance.

4.88 The linear production functions of input-output analysis imply constant costs per unit of output. But if economies of scale are anticipated in particular sectors, the expected cost conditions can be incorporated into the projection in the following way. Instead of inverting the coefficient matrix an iterative solution can be obtained: at the end of each round, as the output of each sector reaches a particular level, the input coefficients of the corresponding column can be adjusted in accordance with the expected schedule of unit costs.

4.89 Undoubtedly the most effective, but most costly, method of projecting the input coefficient matrix is to make a detailed study of the input structure of the sectors relevant to the purposes of study, incorporating all available information known about future changes in the factors outlined above which determine the value of the coefficients.

4.90 On a simpler level, several more or less mechanical methods may be adopted. One method is an extrapolation of past changes in the coefficients, in which the change is related to investment in the industry concerned. An equation used for extrapolation can be formulated as follows:

$$a_{ij}^{t_1} = a_{ij}^{t_1 - t_o} c + a_{ij}^{t_o}(1 - c)$$

where $a_{ij}^{t_1}$ is the coefficient observed in year t_1

$a_{ij}^{t_1 - t_o}$ is the (unknown) change in the coefficient associated with investment in industry 'j' between the years t_o and t_1

$a_{ij}^{t_o}$ is the coefficient observed in year t_o

'c' is the fraction of total capacity in industry 'j' which was added in the period t_o to t_1.

4.91 This equation is used to estimate $a_{ij}^{t_1 - t_o}$, given the input coefficients of two previous years and the additions to capacity in the intervening period. If further additions to capacity up to the projected year are estimated and the computed parameter is applied, a projected value of the coefficient can be obtained. The weaknesses of this method need hardly be emphasized.

4.92 The second method requires only one independently observed coefficient matrix as a basis. This matrix is then revised systematically by multiplying each coefficient by three factors representing three sources of change.

4.93 The matrix is first corrected for changes in prices which are expected to occur from the base year to the projected year. This can be done by multiplying each element, a_{ij}, of the matrix by the ratio of the two new price indexes $\frac{p_i}{p_j}$, where p_i is the ratio of the new price of 'i' to its old price. This procedure simply describes the old technology in new units.

4.94 Secondly, technical change in intermediate products is projected by multiplying each row by a factor representing the expected change in the use of the corresponding product as an intermediate input. If the use of the product is expected to decline the factor is less than one, while if the use is expected to increase the factor is greater than one. The precise magnitude of the factors is determined by the value of total intermediate outputs (total output less final output), which must be projected.

4.95 The third stage of revision takes account of expected changes in the share of value added in total input, by multiplying each column of the matrix of coefficients by factors which are derived, this time, from projections of the value of total intermediate input in each column (the difference between total input and value added).

4.96 A third method of projecting input coefficients, which is a variant of the second, has been used in a Canadian study to estimate changes in a matrix of input coefficients over a seven-year period. When used for projection of a matrix, it would also require the projection of intermediate input and output flows. The changes in the original coefficients are then obtained as the solution to a linear programming problem formulated in the following way. The difference between the original and the projected coefficients is minimized, subject to the constraints that the intermediate flows implied by the projected matrix are consistent with the projected intermediate row and column totals. Further constraints, in the form of upper and lower bounds upon the changes in the coefficients, are imposed upon the coefficients.

4.97 All three methods can be made consistent with independent projections of particular coefficients (based, for example, upon knowledge of specific changes in technology). However, the latter two methods are open to the criticism that their solutions are sensitive to changes in the value of any independent projection.

4.98 The changes in input coefficients discussed in this section have made no reference to the problem of qualitative changes in a specific product, which is too complex an issue to be discussed here. The question of changes which may occur in a coefficient matrix as the result of the substitution of domestic production for imports, or vice versa, is discussed in the following section.

(c) Imports and Import Substitution

4.99 Imports occupy a place of special importance in applications of input-output analysis, for several reasons. A high level of imports is essential for a developing economy, and several methods of recording imports in an input-output table are possible. Since the level and composition of imports may vary considerably in the period of a few years, projections of a developing economy must be undertaken with particular caution.

4.100 Input-output analysis assumes constant returns to scale. In the absence of supply restrictions the determinants of the level of exports lie clearly outside the domestic economy; therefore the behaviour of exports poses no difficulties for the input-output system, however unpredictable it may be in practice. All that can be done in a long-term projection is to project a range of possible values for exports.

4.101 The treatment of imports presents a more complex problem. The course of development is generally associated with the gradual substitution of domestic production for imports. If, during the period of the projection, it is known that domestic production will begin of goods hitherto not produced in the economy, it will be necessary to add the appropriate rows and columns to the input coefficient matrix. One estimate of the coefficient columns, i.e. of the input structure of such not-yet-existing industries might be obtained by "borrowing" the input structure of the same industry from another economy where it already operates, or, even better, from the blueprints of the specific new projects.

4.102 As an economy becomes more advanced, more of its imports are of the competing category, e.g. the economy begins to produce steel goods which were formerly covered entirely by imports, and therefore its requirements are satisfied partly by domestic production and partly by imports.

4.103 The difficulty with competing imports is that, to the extent that they are good substitutes for domestic production, the share of each in the total supply of the commodity may be variable and difficult to anticipate. In terms of input-output analysis, the direct and indirect inputs necessary to satisfy a given quantity of domestic output may be quite substantial, whereas an equal value of imports creates no demand for domestic output of any kind.

4.104 It might be supposed that substitution over time in a developing economy will always favour domestic production at the expense of competing imports. But as an Economic Commission for Latin America projection of the economy of Peru to 1965 showed, the opposite may occur. In this case, the projected development of the Peruvian economy required refined petroleum in excess of domestic capacity, so that from a net exporter of petroleum in 1955, Peru became a net importer. Increase in the price of the domestic relative to the imported good might, in general, be expected to lead to a substitution of this type.

4.105 The way in which substitution between domestic production and competing imports can be incorporated in a projection of the coefficient matrix depends upon the method of treating imports in the original table of the base year.

4.106 For example, if competing imports have been recorded in the base year according to method 2, i.e. as a negative column in the final demand quadrant, then the quantity of each type of imports can be projected independently of the input-output analysis, in the same way that exports are projected. Frequently, however, the quantities of imports are related to the (unknown) levels of output of the corresponding domestic sectors. In this case, it is sufficient to specify the proportions which imports will form of the total supply of that sector. The balance between supply and demand in the 'i'th sector can be expressed by the equation:

$$m_i + x_i = a_{i1}x_1 + a_{i2}x_2 + \cdot\cdot\cdot\cdot\cdot + a_{ii}x_i + \cdot\cdot\cdot\cdot\cdot + a_{in}x_n + y_i$$

i.e. $-a_{i1}x_1 - a_{i2}x_2 - \cdot\cdot\cdot\cdot\cdot\cdot + (1 - a_{ii})x_i - \cdot\cdot\cdot\cdot\cdot\cdot - a_{in}x_n = y_i - m_i$

4.107 The quantity of imports can either be specified independently (and thus subtracted from the domestic final demand, y_i), or it may be assumed to stand in some proportion, k_i, to the output of the corresponding sector, i.e.

$$m_i = k_ix_i$$

Thus the equation can be re-written as

$$-a_{i1}x_1 - a_{i2}x_2 \cdot\cdot\cdot\cdot\cdot (1 + k - a_{ii})x_i - \cdot\cdot\cdot\cdot\cdot\cdot - a_{in}x_n = y_i$$

4.108 By making the appropriate adjustment to each diagonal element in the input coefficient matrix, it is possible to compute the level of competing imports as part of the solution to the problem.

4.109 If imports have been recorded in the base year according to method 1 (i.e. if they are non-competing), then the projection of the import input coefficients can be treated in the same way as the projection of the other intermediate input coefficients. The same factors - essentially technological - which determine changes in the matrix of intermediate coefficients will determine changes in the import coefficients.

4.110 In its projections of economic development, the Economic Commission for Latin America prepared tables of imports and domestic flows according to method 4. Then adjustments were made in each cell to take account of import substitution which was expected to place from the year in which the table was compiled to the year of projection.

4.111 Imports were then summed by columns and the totals expressed as a fraction of domestic output. The inverse of the adjusted domestic matrix was then used to compute the output estimates from the final demand projections. When the computed import requirements exceeded the projected foreign exchange available, revisions were made in the projected tables by increasing the extent to which domestic production would replace imports. Using the revised coefficient matrix, the output estimates were computed again until a consistent solution was achieved.

4.112 A quite different approach to estimating import requirements was adopted in a projection of the Italian economy. In this study, special incremental import coefficients were estimated, which expressed increases in imports as a fraction of increases in demand for the output of the corresponding domestic sectors. In the actual computation, output was calculated by an iterative process so that when it reached a certain level, the independently estimated domestic capacity in that sector, the marginal coefficient was increased to 100 per cent.

4.113 The future establishment of production for which there presently exists no domestic counterpart (i.e. substitution against non-competing imports) is likely to be easier to project at least in the short term, since such a change may often be foreseen. In this case, projections of the input coefficient matrix must take account of such changes by including an appropriate row and column in the projected matrix. The nature of such a change, which may be described as "structural", is considered in section V of this chapter.

(d) Projecting Final Demand

4.114 Since final demand is a datum in the input-output system, projection of final demand must be specified independently of input-output analysis. However, it is helpful to begin with information about the structure of each component of final demand - i.e. the size of each entry in each column of final demand - contained in some past input-output table. It is then only necessary to estimate expected changes in final demand between the year of the existing table and the year of the projection. A whole range of detail is possible. At one extreme, given sufficient information and the resources with which to compile it, it is possible to project independently each element of each category of final demand (and cost alone limits the detail to which each category may be disaggregated). The sector detail is of course determined by the classification of the input coefficient matrix. At the other extreme, a simple extrapolation of the final demand in the "base" year without any change in proportions is possible. Whichever method is chosen depends, as always, upon the purposes of the study and the resources available for its implementation.

4.115 When the projected final demand categories are added horizontally and premultiplied by the inverse of the projected input matrix, estimates of output by sector for the year in question are obtained. The values will be either in the prices of the base year - that year from which the input coefficients and the final demand have been projected - or the year of projection, depending upon whether or not price indexes have been applied to the base year values.

4.116 The estimates of output thus obtained should be regarded as preliminary. When multiplied by (projected) primary input coefficients, the requirements for labour, capital, foreign exchange, etc. in each sector can be checked against the available supplies. The estimated output can be compared to expected capacity levels in each sector. The total value of wage and salary incomes (output of the household sector) generated by the projected output levels may be found to be quite disproportionate to the total value of household consumption expenditures (input of the household sector) initially projected. Likewise, a reference to sector investment-output ratios may indicate a discrepancy between the computed sector output levels and the projected level of total investment.

4.117 The possible occurrence of such discrepancies arises from the very fact that the treatment of each category of final demand as independent ignores the relations which exist between household incomes and consumption, investment and output, etc. etc. In projecting consumption in some future year, household incomes are ignored. (Even if consumption is derived from some projected income there is no guarantee that the computed income generated will be the same as the initial projection.) In the same way, the projection of investment is designed to estimate only the value of capital goods which will be absorbed in the year in question. In its open static form, input-output analysis does not consider the relations between levels of sector output, capital consumption, and investment. Consequently, adjustments must be made outside the computation to take account of these factors. Revisions in the projected elements of final demand may be necessary in order to obtain a solution which reflects the desired consistencies. Of course, there is no unique solution, and any number of alternative projections may be made, representing a range of estimates from high to low.

4.118 The use of input-output analysis in the simple form described to make long-term projections can be illustrated by applications in Finland, Japan, the Soviet Union and the United Arab Republic.

4.119 In Finland, the input-output system was used as the core of a model designed to trace the effects of various alternative economic policies up to 1967. Forty-seven sectors were distinguished in the input coefficient matrix, and the following categories of final demand were specified: exports, government consumption, household consumption of agricultural products, government capital formation, housing and certain investments of enterprises which were known to be planned long in advance. Equations determining the level of household consumption of non-agricultural goods and residual capital formation of enterprises were added to the system, and the solution was computed.

4.120 A projection of the Japanese economy to 1967 was made in connexion with a study of the future of some energy industries. Having made the changes which it was assumed would occur in the input coefficient matrix, three estimates of total final demand were projected, corresponding to three different rates of growth of national income, 8.8 per cent, 6.5 per cent, and 4 per cent, in each case taking account of the limitations imposed by the availabilities of labour and capital and the balance of trade. When the results of this projection were compared with the results obtained by multiplying the projected final demand by the unchanged input coefficients, it was found that the projected changes in technology would lead to significant reductions in requirements for capital, energy, and imports, and only slight reduction in the requirements for labour.

4.121 The following example from the Soviet Union shows how only one component of final demand, consumption, is projected, but it illustrates the detail which is possible in the procedure.

4.122 The objective was to project household consumption to 1970, 1975 and 1980. The starting point was a population census taken in 1959 in conjunction with demographic data on birth and death rates in each of the major regions of the country, separate calculations being made for urban and rural districts. Expected population totals were then calculated for the target years, showing not only a regional distribution but also an age distribution into four groups, children of pre-school age, children of school age, the working population, and the retired population. The results indicated considerable differences in the regional rates of natural growth of population. As the next step, inter-regional migration was projected on the basis of planned capital formation and regional development.

4.123 Information which had been gathered from household budget surveys conducted over a number of years was then used to establish relationships in both physical and monetary terms between household type and consumption. In this model of consumer behaviour, the consumption level of various products and services, expressed both in physical units (e.g. living space in square metres, volumes of electricity, gas, and water) and in value, was related to the size and composition of the household and the level of family income. The data obtained from the surveys made it possible to take account of local and national consumption patterns.

4.124 The use of household income-expenditure relationships to project consumption implies a projection of the total wage bill (and in this case of its regional distribution). This, in turn, imposes certain restrictions upon the regional distribution of industry and the industrial distribution of wages. In practice, consistency between regional household incomes and expenditures can always be attained by revising each projection until they converge.

4.125 The element of uncertainty in planning should not be overlooked. Apart from possible unforeseen occurrences, such as unexpected technical changes, price and income elasticity of consumer demand introduce flexibility into the most rigorously specified plans. It is conceivable, although unlikely, that the planned quantity and composition of production may be realized: consumption must be projected with much less certainty.

4.126 Projections of primary input requirements of the economy of the United Arab Republic were made for 1960/61 based upon a 1954 input-output table. Having computed, on the basis of this table, the primary input content of each component of final demand, (as illustrated in table 4.1), projections of the value of these components were used to estimate future requirements for primary inputs. It was found that of a total increase of £E181 million in final demand, imports would absorb as much as £E84 million. And, whereas household consumption expenditures were projected to increase by £E42 million, the increase in household incomes, (wages, salaries, and distributed profits), generated by all components of final demand would be as much as £E77 million. If the assumptions upon which the projection was based were correct, this would suggest that certain measures, such as taxation to reduce disposable household income, or increases in the production of consumer goods, are necessary to diminish the discrepancy between the projected level of household incomes and the projected level of household expenditures. In India, an application of input-output analysis brought out the fact that 40% of the inputs required to improve agricultural productivity must be of industrial origin. The results of this analysis were useful in clarifying the ideas of planners, for there had been a tendency at first to stress agriculture at the expense of industry.

IV. Statistical Uses

(a) General

4.127 The statistical uses of an input-output table can be described as all those functions it serves as a record of information. Since each element in any table is both an input and an output the table can be regarded in a sense as a system of double-entry book-keeping in which the production account of each sector of the economy is linked. The method may be used to form an accounting system within each sector, and the outputs or values added which are recorded for each sector may be used as weights in adding detailed price, employment, or quantity data to form more aggregative indexes of economic activity. Finally, statistical and analytical uses of the table may be combined to check simultaneously the accuracy of the coefficient matrix and independently observed statistical series.

4.128 Preparation of an input-output table for purely statistical purposes need not be governed by the methodological restrictions imposed by analytical uses of the table. Data can be classified in sectors without regard to the question of homogeneity, for example, and for statistical purposes it is more useful as well as easier to record transactions in purchaser's prices rather than producer's prices. The preparation of tables for different purposes is not a choice between mutually exclusive alternatives. A set of auxiliary tables makes possible the translation from one table to the other.

4.129 Perhaps more than any other country, the Netherlands has used its input-output table for statistical purposes. A questionnaire is sent annually to all enterprises: a separate form is completed for each establishment within the enterprise where the principal economic activity is different from that of the enterprise. If any establishment carries on secondary production at a significant level, this activity within the establishment is also recorded separately. When the resulting table is compiled, the consistency of all available socio-economic data with the information recorded in the table is tested as far as this is possible. A consequence has been the improvement of the existing data on stocks and capital formation. More importantly, quantity indexes of final output are used to compile preliminary national accounts. Five to six months after each accounting period new final expenditure data become available, and this is used in conjunction with the existing coefficients to estimate output and value added. In this way, the statistical and forecasting uses of input-output analysis overlap. In the past it took about two and a half years for a completely new table to be compiled.

4.130 In the Netherlands, the input-output table and the national accounts are related by auxiliary tables which make possible the translation from the accounting conventions of one to the other. In Norway, however, the two are completely integrated, so that the only difference is that in the input-output table own-account construction and machinery repair are re-grouped. The table is prepared both in current and in constant prices and in purchaser's and producer's prices for 134 production sectors. In the case of Norway, the analytical requirements of the input-output table have determined the specification not only of the national accounts but also of the primary statistical sources. The input-output table and the national accounts are also integrated in the United States.

By contrast, in those countries where the commodity flow method is not used in estimation of the national accounts, the input-output table has no direct relation with the national accounts. A detailed survey of more than 3,000 commodities forms the basis for the construction of the input-output table in Japan.

4.131 The Swedish input-output table, too, is based upon commodity groups, rather than upon establishments. However, the original data is obtained from establishments, and is then redefined by assuming that the input structure of commodity groups is the same in all establishments. In 1968 it is planned to incorporate a commodity flow system, from which an input-output table can be derived, as part of the official statistical programme integrated with the national accounts.

4.132 The Polish experience in constructing input-output tables suggested that the detailed balancing of sector outputs helped to reduce the discrepancy between national income measured on the product side and national income measured on the income side. Furthermore, as a result of compiling the 1962 table, a new classification of economic activity will be introduced in 1970.

4.133 The preparation of the input-output table in Finland helped to integrate foreign trade with industrial statistics, and made clear the need for improvement in statistics relating to the inputs of agriculture, construction, and services.

4.134 In Yugoslavia, the table was used to check the consistency of various partial accounts which had been prepared for different sectors of the economy. In trying to reconcile input-output aggregates with the national accounts, it was found that consistency depended upon the complete unity of the primary sources of data themselves. Another interesting use of the tables was in deriving price indexes for economic activities which are difficult to value because of the length of the period of production (e.g. Construction and Shipbuilding).

4.135 The preparation of an input-output table in Czechoslovakia prompted a unified classification of economic activity in place of the various classifications which had existed in the fields of production, trade, and taxation. Since the table was derived from data in the system of balances it was expressed in purchaser's price, thus limiting its analytical uses. However, another input-output table is contemplated for 1966 in several hundred commodity detail, implying a change in the sources of primary data - the accounts of enterprises.

4.136 One of the uses of the input-output coefficient matrix in Israel was to check the consistency of final expenditure estimates with independently-derived estimates of outputs and imports.

4.137 All of the foregoing uses have related to the economy as a whole, but there are many cases in which input-output tables have been prepared for particular divisions of the economy. It is a common practice, for example, to distinguish exports by country (or region) of destination and imports by region of origin. This is not only appropriate where a multi-regional table - such as that for the six countries of the European Economic Community - is being prepared, but also in the cases where foreign exchange or political considerations are relevant in distinguishing the trading regions.

4.138 In Poland, tables have been prepared for four divisions of the economy distinguished by the prevailing form of ownership, viz. the socialized economy, the state-owned sector, the co-operatively owned sector and the privately owned sector. The distinction was considered to be useful because of the different methods of planning used in each sector.

4.139 In centrally planned economies, it is common to distinguish the branches according to which the economy is administered and the tables prepared for these branches are used in planning. The grouping of industries in branches or blocs is discussed in the next section. Examples of special tables prepared for particular industries, such as the chemical, electricity, or petroleum industries are often analysed using linear programming methods, since such analyses frequently take account of production alternatives and call for optimization. In this section, however, it is appropriate to describe a detailed set of tables for the transactions of the Administration in the economy of France. Since, unlike households or enterprises, there is no theoretical framework for analysing the transactions of the Administration, they can be regarded as purely "statistical" tables.

4.140 According to Lequeret, a set of tables was prepared showing, for the year 1958, the material transactions of all non-profit institutions in France, including such organizations as church, schools and ex-servicemen's associations as well as all branches of government. The tables were composed of 65 rows each representing a product or product group and a number of columns which varied according to whether the type of transaction or type of institution was identified. Government purchases, which accounted for the largest part of the table, were divided into three major groups, Military Consumption, Civil Consumption and Gross Fixed Capital Formation. Each of these was in turn subdivided into a number of branches, such as "Education", "Roads", etc. Altogether 35 categories of administrative institutions were shown, but separate types of transactions, like transfers-in-kind, were also shown as branches.

4.141 These historical tables were used as a base to estimate the demand for goods and services up to 1965, the end of the third French planning period. It was found, that with certain exceptions, such as road-building and educational services, that it was difficult to obtain any systematic basis for making the projections. However, it was felt that, apart from yielding an inventory of statistical shortcomings, the tables helped to dispel illusions about the possibilities of constantly reducing the expenditures of the administrative sector.

(b) Relationship to National Accounts and Balances

4.142 Under the national accounting system employed in most market economies, consistency is to be expected between the aggregate values of the principal components of expenditure, consumption, exports, gross domestic fixed capital formation etc. which appear in the national accounts and in the final demand column totals of the input-output table. Conversely, the row totals of the primary input categories, wages, taxes, imports, etc. should be equal in value to the corresponding gross domestic product entries. (For details, see chapter II.) This is true of the Netherlands tables and the United States table, 1958. In Norway, the input-output table and the national accounts system are integrated at the primary data sources. This, however, is exceptional, and in most countries the two sets of accounts are prepared according to different conventions (for example, transactions are valued in purchaser's prices in the expenditures accounts versus producer's prices in input-output tables). Accordingly, in order to reconcile transactions at the more detailed sector level, it is necessary to have several auxiliary tables.

4.143 Under the net material balance system employed in centrally planned economies there should be likewise consistency between the principal components of expenditure on the net material product, and the major aggregates of final demand in the input-output table. It is also important to note the similarity between the rows of the input-output table in physical terms and the system of commodity balances which is used in most centrally planned economies.

4.144 The unification of input-output tables, national accounts and balances, and financial flows in a larger comprehensive social accounting matrix has been shown to be conceptually feasible. So far as empirical implementation is concerned, however, the statistical programmes of most countries appear to favour the reconciliation rather than the synthesis of input-output tables and national accounts and balances. So long as each fulfils a different function, the arrangement of the basic information will continue to be different.

4.145 The following major adjustments are usually necessary to transform a disaggregated product account, or a commodity balance, into a typical input-output transaction table.

1. Transformation from purchaser's to producer's prices.
2. Transfer or redefinition of secondary products.

4.146 For the widest use of an input-output table the following supporting tables are desirable:

1. Table of trade margins
2. Table of transport costs
3. Table of indirect taxes
4. Table of imports

4.147 Amongst countries with market economies, Japan, Norway, and the Netherlands reconcile their national accounts and input-output tables in the greatest detail. The importance of the four supporting tables illustrated above is not confined to their statistical uses however: in fact, their principal function is to allow a much greater flexibility and improved accuracy in the analytical uses of the table. Amongst countries with centrally planned economies, Hungary and Poland reconcile their net material product and gross social product accounts with the input-output table.

4.148 National accounts, when disaggregated on the production side, are usually classified by industry, whereas for an input-output table an activity or commodity group classification is desirable. This is recognized by the practice in most countries of re-defining the industrial classification for input-output purposes to include at least the most significant cases of secondary production.

V. The Analysis of Economic Structure

(a) General

4.149 The structure of an input-output table generally refers to the composition of the input coefficient matrix. Comparisons of the structure of input-output tables, pertaining to different years or to different countries, have been made with the hope of finding some systematic pattern of structural change. In principle, there is no difference between international and intertemporal comparisons: in both cases flow tables are the product of technical input relations, the set of prices, and final demand, including exports and imports, all of which reflect the tastes, the available technology, and the resources peculiar to the particular country or time period. In practice, however, international comparisons are handicapped by differences in the conventions adopted in compiling the table, including differences in aggregation. For the same reasons, it is much easier to construct price indexes for tables of one country than it is to express the sector outputs of one country in the relative prices of another. In international comparisons, therefore, differences in prices are usually not eliminated, but the influence of final demand is diminished by comparing the input coefficient matrixes rather than the flow tables.

4.150 Despite such obvious difficulties, a rather careful comparison has been made of the input-output tables of four countries, Japan, Norway, Italy, and the United States, (Chenery and Watanabe, Econometrica, Vol. 26, No. 4, October 1958). Having aggregated the tables of each country to a common classification, a comparison of individual coefficients showed that the inputs into the Manufacturing sectors were much more similar than coefficients of other sectors. This conclusion is hardly surprising, bearing in mind the greater similarity which is apparent in manufacturing technology (as opposed, for instance, to agriculture), and the fact that the data for this sector are likely to be more accurate. More interesting is the fact that intertemporal comparisons reach the same conclusion.

Further important similarities were found in the tables of the four countries, but these can best be prefaced by a brief account of the methods of structural analysis.

4.151 There are two basic concepts in structural analysis, the notion of independence in inter-sectoral relations and the notion of hierarchy. These concepts are embodied respectively in the attempts to arrange the sectors in blocs such that there are no coefficients related with sectors outside the blocs; and in the attempts to arrange sectors in a triangular order, such that each sector receives inputs only from sectors below it in order and delivers inputs only to sectors above it in order. Two points may be made at once. First, in the absence of an absolutely decomposable and/or an absolutely triangular table no unique criterion for the ordering of industries can be derived: from this it follows that the attempt to impose a particular ordering requires the specification of some criterion for the arrangement of sectors. It is frequently proposed that all input-output tables should be arranged in a triangular order, even although the idea of "triangulation" for its own sake is as pointless as classification for its own sake. Just as economic activities are grouped in different ways for different purposes, so sectors can be arranged in different orders for different purposes. There is nothing conclusive about the order which is the result of minimizing the weighted or unweighted sum of the above-diagonal coefficients in a matrix. When this computation was performed for the coefficient matrixes of the four countries, however, it was found that the order of industries in each table was reasonably similar, as measured by a coefficient of rank correlation.

4.152 Perhaps the principal reason for arranging industries in a triangular order is because it facilitates a computational solution in input-output analysis. If a matrix is completely triangular - or if the above-diagonal elements are small enough to be ignored - then output estimates can be obtained from a bill-of-goods without inverting the matrix. Computing costs have diminished to the point where this is hardly a great economy except in those cases where frequent iterations are called for. This may happen where estimates of final demand or of the coefficients themselves are constantly being revised in the search for a consistent solution.

4.153 It seldom happens that the matrix of coefficients of a modern economy can be completely triangularized. (Although it is common in a very under-developed economy where there are few interindustry relations.) The degree of sector detail and the method of classification determine the extent to which a triangular order can be approximated. Generally, however, a triangular arrangement can be made of groups of sectors, rather than of all sectors as a whole.

4.154 If sectors of a matrix can be arranged in such a way that they form one or more blocs, which are entirely independent of sectors in other blocs, then the matrix is said to be decomposable. The decomposable matrix, in reality, is as elusive as the triangular matrix; however, there are certain purposes for which it becomes important to distinguish groups of industries.

4.155 In countries with centrally planned economies, responsibility for the performance of the economy is divided amongst various branches of the administration which correspond to groups of industries. The function of the ministries to plan the performance of each bloc must be reconciled with the need for consistency with the over-all plan. Accordingly, it is useful to arrange the industries in groups corresponding to the nearly independent groups suggested by the relations in the input-output table. In this way, revisions may constantly be made in plans for any sector in the bloc disregarding the effect outside the bloc and disregarding the demand by industries outside the bloc for the output of industries within the bloc. Furthermore, if the industries within the bloc can be arranged in a triangular or nearly triangular order, this facilitates the revision of plans.

4.156 If an input-output table can be arranged in a number of blocs which are substantially independent, and at the same time the blocs stand in a triangular relation to one another then the arrangement can be described as bloc-triangular. Nine or ten such blocs are distinguished for planning purposes in Poland and Yugoslavia. Generally speaking, such an arrangement can be approximated, if necessary, in the input-output tables of most advanced economies.

4.157 It must be pointed out that the possibility of triangularity and bloc-independence rests upon the exclusion of the household and investment sectors from the endogenous quadrant of the table. The introduction of consumption and labour coefficients into the input coefficient matrix destroys most of the independence and hierarchy existing in the matrix in its usual form. Therefore, these concepts must be applied circumspectly: they are appropriate, for example, in the analysis of purely technological relations, but not in the analysis of income-multiplier reactions.

4.158 An increasingly common application of the concept of bloc independence in input-output analysis is in the detailed analyses of particular sectors. For instance, a partial analysis of an industrial complex may be made using programming methods, disregarding in the computation relations with industries outside the complex.

(b) The Structure of Under-developed Economies

4.159 It has frequently been objected that input-output analysis has little use in under-developed economies, because of the high opportunity cost of collecting and processing the necessary data, and because the value of the table is limited by the lack of interdependence between sectors. So far as data is concerned, the under-developed economy has several advantages. First, if the economy is small, there are fewer figures to be recorded; secondly, the level of foreign trade in relation to gross output is likely to be high, and statistics of exports and imports are easily collected by customs officials in their normal duties. Finally, the input-output table, quite apart from the merits of its analytical uses, forms a useful framework for the compilation of every kind of economic statistic. As section IV made clear, it can not only be used as a measure of national income but serves as a check on the consistency of data independently estimated in different branches of the economy.

4.160 In the extreme case in which an economy is so under-developed that the value of total output in most of its sectors scarcely exceeds the value of final demand, something useful about the future path of its development may still be learned from a comparative examination of the structure of a more developed economy.

4.161 A table prepared for a small region in the Congo (Dem. Rep.) for the year 1957 may be used to illustrate this point. The table shows that aside from plantation and subsistence agriculture, housing construction and services, only two metal industries operated in the region. One was gold-mining, of which the entire output was exported, while the other was bicycle-assembling of which the entire input (bicycle parts) was imported. Gold-mining is an example of a regionally-specific industry depending upon a particular resource endowment:

no general statement can be made about such industries, which do disturb the general pattern of similarity of input-structures. In this case, too, it is clear that since gold is not processed further before its final disposition, further expansion of a related industry is unlikely. However, bicycle-assembling can be regarded as the nucleus of a group of industries at first assembling, later fabricating, metal goods. Instead of these goods being directly delivered to final consumers, like bicycles, they can, like tools, replace inputs to other industries which presently are imported.

4.162 At this point it may be asked, what evidence is there to suggest that a complex of industries will actually develop in the region corresponding to a bloc which has developed in a more advanced economy? There are several reasons.

4.163 First, despite dissimilarities of tastes, comparisons of the consumption patterns of different countries show, that as income levels rise, the proportions of food, clothing, and durable goods of different types consumed tend towards the proportions which obtained in more advanced countries which already had achieved that income level. Thus the development of consumer demand exerts a profoundly unifying effect upon the development of the structure of production. Secondly, the choice of technology is negligible. The process of development consists essentially in the installation of an approximation of the structure of the more advanced economies, modified by the existence of regional resource endowments and by the techniques available to exploit them.

4.164 Thirdly, industries appear to develop in blocs rather than in isolation; the industries to which they sell, and from which they buy tend to grow with them. The reasons are not to be found in the familiar locational factors of transport costs and economies of scale alone - although these are important, but also in the fact that, to use Leontief's words, "the incessant process of technological change derives strong stimulus from intimate contact between buyers and sellers of a new process or product".

4.165 Finally, foreign trade plays an important part in determining the structure of a developing economy. It is theoretically possible for an economy to enjoy a rising level of real income by specializing upon one export and depending upon imports to satisfy the growing demand of the population, but usually a scarcity of foreign exchange will eventually drive up the price of imports sufficiently to make profitable the domestic production of goods formerly imported. The existence of an input-output table for a developing economy is useful in illustrating the possibilities of import-substitution. In general, import-substitution begins at the top of the hierarchy. To revert to the example from the Congo, the next step is evidently a metal-fabricating plant rather than a blast-furnace.

4.166 Thus it seems useful to regard the structure of an under-developed economy as an image of an incomplete structure of a developed economy. Part of the incompleteness, in economies at an intermediate stage of development, is compensated for by imports from the advanced economies, which receive in exchange the exports of the developing economy. Thus a comparison of the foreign trade of the United States and the United Kingdom, on one hand, with those of Peru, the United Arab Republic, and Israel on the other, reveals that the advanced economies export machinery and transport equipment and import raw materials, while the developing economies import machinery and transport equipment and export raw materials.

4.167 Needless to say, there is no mechanical solution to be found to the question of projecting the structure of a developing economy. The careful use of input-output tables, including those of more advanced economies, combined with the judgement of the economist, can certainly help in projections of the future path of development. At present, much more information is necessary to supplement that contained in input-output tables - an inventory of technological changes by sector, accompanied by detailed descriptions, would be a valuable first step.

4.168 Of course, it should be emphasized that the mere existence of an elaborate projection of the economy will not bring about economic growth. In the last analysis, judgement, effort, and an appropriate social, political, and organizational framework are the decisive factors. The effective exercise of good judgement can be, however, greatly facilitated by the use of appropriate analytical techniques, among which the input-output method is certainly not the least important.

APPENDIX I. THE COMPARABILITY OF INPUT-OUTPUT TABLES

A.1 Differences among countries in the uses of input-output tables and in the resources available for their compilation makes it unwise to propose at this stage one uniform standard which should be universally adopted. But few could reasonably object to the suggestion that data should be collected at the worksheet level in such a way that any table can be converted into some standard form to permit comparison with the tables of other countries.

A.2 There are at least two advantages in international comparability. The number of observations of the structure of an economy are increased, making possible a more accurate analysis of this structure. Secondly, an integration of the two tables in some form of multi-regional analysis becomes feasible.

A.3 Comparability, i.e., the compilation of tables which are convertible into some standard form, escapes the criticisms which have been directed at standardization, viz. that it necessarily inhibits experimentation or that there is no single standard form which can be usefully imposed. For purposes of comparability, the nature of the standard form is less important than is standardization. Since it is unlikely that exact comparability in every detail can ever be established between the input-output tables of different countries, the importance of publishing complete information on the methodology of a table as well as auxiliary data must be emphasized. Goldman[1/] has proposed that each new table should be published with a "package", containing subsidiary tables, supporting material, and an account of the methodology, all in sufficient detail to provide flexibility in using the tables for various purposes.

A.4 Some standard form for comparability must be laid down, so that when a table differs from this form the appropriate auxiliary data can be prepared. In this respect some of the recommendations contained in the report of the Conference of European Statisticians' Working Group on Input-Output Statistics (Conf. Eur. Stat./WG. 19/5) should be borne in mind. The interested reader should also refer to the classification of economic activity contained in the proposals for a revised SNA.

1/ See Barna (ed.) Structural Interdependence and Economic Development London, 1963, chapter 17; also Shuntaro Shishido, "Problems in the International Standardisation of Interindustry Tables", Journal of the American Statistical Association, March 1964.

A.5 Input-output tables are generally compiled from data collected on an establishment basis. Adding to this the fact that industrial classification schemes in most countries can be aligned with the International Standard Industrial Classification, it is clear that the ISIC must form the basis for any common input-output sector classification. This is actually a second-best solution, since the ultimate goal for an input-output classification should be a technical unit (commodity group or activity) basis rather than an establishment basis. It should be observed, however, that the ISIC is not incompatible with a commodity grouping. The Japanese table for 1960, which was prepared from commodity data and published in 150 sector detail is reconcilable with the ISIC. But if the ISIC is to serve as the basis for an international standard input-output sector classification it must be adjusted to exclude secondary production and also disaggregated.

A.6 According to the ISIC, for example, independent coke ovens are classified in major group 329, whereas coke ovens in iron and steel works are in group 341 (iron and steel basic industries), while the production of coke in gasworks is in group 512 (gas manufacture and distribution). Furthermore, own-account construction is classified with the establishments in which it occurs, in the ISIC. In both cases, redefinition of the sectors concerned is obviously desirable. For these reasons, the classification scheme proposed in the report of the Working Group requires amendment. Furthermore, if a more detailed international input-output classification is to be established, (let us say, upwards of 100 sectors) then such ISIC groups as 011 (Agricultural and livestock production), 341 (Iron and Steel Basic Industries), and 231 (Spinning, Weaving, and Finishing Textiles) should be disaggregated to approximate a more homogeneous grouping.

A.7 So far as the establishment of uniform categories of final demand and primary inputs is concerned, there would seem to be little difficulty. For market economies the model is clearly the appropriate categories as defined in the System of National Accounts, while centrally-planned economies should define their categories to be consistent with the principal components of the Material Product System. Specifically, final demand should be divided into: private consumption, government consumption, fixed investment, net stock changes, and net exports (if competing imports are entered negatively), while the following categories of primary input should be distinguished: compensation of employees, other factor income including capital consumption, net indirect taxes, and non-competing imports. In accordance, with the principle of comparability, any table can be prepared with a more or less detailed classification scheme than the one proposed, so long as the necessary information is made available to convert the table into the Standard Format. This principle applies equally to the reconciliation of the tables of centrally-planned and market economy countries. Thus, if the former would record, in addition to the information ordinarily published in their tables, the consumption of enterprises and institutions engaged in non-material activities and the expenditure on non-material services by units engaged in material production, then it would be possible to prepare tables for centrally-planned economies according to the format used in market economy countries. Conversely, the latter countries should distinguish in their tables non-material services from goods and material services, so that these tables may be converted to a format consistent with the Material Product System of accounting.

A.8 It should be possible for all countries to prepare tables in producer's prices including net indirect taxes. Even better would be two tables, one showing transactions valued in producer's prices proper and the other showing the indirect taxes on each transaction.

A.9 The output distributed along each row should include (i) commodities shipped by establishments in the industry; (ii) primary products of the industry produced elsewhere; (iii) competing imports at domestic port value; (iv) reductions in inventories of finished products of the industry. The row total, gross domestic output, is obtained by subtracting inventory reductions and competing imports. The gross output measure means that transactions between establishments within the sector should be included in output. The entries in each cell of the transactions table should represent as far as possible the actual inputs rather than the purchases of the sector.

A.10 Among the various alternatives which exist for treating imports the solution to be most highly recommended is that in which competing imports are entered as a final demand column (with negative signs) and non-competing imports are entered as a row. At the same time, if possible, an auxiliary table should be prepared, showing the distribution of competing imports. Although such a table is statistically demanding, it would permit full convertibility to any other convention.

A.11 If the unallocated sector contains a significant proportion of transactions which cannot be allocated even using the judgement of those compiling the table, then it is probably better not to distribute the unallocated elements in any mechanical fashion. To do so would be only to diminish the accuracy of some of the recorded transactions.

APPENDIX II. INPUT-OUTPUT TABLES OF SELECTED COUNTRIES*/

Table 1

National input-output tables compiled

Country	Starting year of input-output work	Number of tables compiled	The years to which the tables refer	Prepared by the national statistical office or not
Australia		5 1/	1946-47, 1953-54, 1955-56, 1958-59	Partly 14/
Austria	1963	-	1961	Partly 11/
Belgium	1956	2	1953, 1959	No 3/
Bulgaria	1960	1	1960	Yes
Canada	1955	1	1949	Yes
Cyprus	1960	2	1954, 1957	No 4/
Czechoslovakia	1958	5	1956-59, 1962	Yes
Denmark	During the 1930's	14	1930-39, 1947, 1949, 1953, 1958	Yes
Finland	1958	1	1956	Yes
France	1953	2	1956, 1959	Partly 5/
Germany, Eastern	1959	5	1959-62	Yes
Germany, Fed. Rep. of	1962	-	-	Yes
Greece	1963	-	-	Yes
Hungary	1955	3	1957, 1959, 1961	Yes
India		3	1951-52, 1953-54, 1955-56	Yes
Ireland	1958	2	1956, 1960	Yes
Israel	1960	1	1958	No 16/
Italy	1951	1	1950	Partly 6/
Japan	1958	3 15/	1951, 1955, 1960	Yes
Mexico		1	1950	No 12/
Netherlands	1948	20 1/	1938, 1947-61 For some years more than one table prepared	Yes
New Zealand		2	1952-53, 1954-55	Yes
Norway	1952	16	1947-62	Yes

* A complete list of tables published in all countries is to be found in the Input-Output Bibliographies, (see Page 1, footnote 2).

Table 1 (continued)

Country	Starting year of input-output work	Number of tables compiled	The years to which the tables refer	Prepared by the national statistical office or not
Poland	1957	6	1956-61[2]	Yes
Portugal		1	1959	
Spain	1954	2	1954, 1958	No[10]
Sweden	1957	1	1957	No[7]
United Arab Republic		3	1959, 1960, 1961	No[13]
United Kingdom	1949	4	1935, 1948, 1954,	Partly[8]
United States	1936	4	1919, 1929, 1939, 1947	Partly[9]
USSR	1924, 1959	2	1923/24, 1959	Yes
Yugoslavia	1955	3	1955, 1958, 1960	Yes

Remarks:

(a) This table should be studied in conjunction with table 2 which gives information on current and intended input-output work in the various countries.

(b) This table refers only to input-output tables in value terms compiled for the country as a whole. Up-dated tables, planned matrices or forecasts for inter-industry relations in future years, regional tables, etc. are not listed.

(c) The starting year of input-output work was not always specified in the national replies. Where no information was given, it is assumed that the work started some two years before the publication of the first tables.

Table 1 (continued)

Notes

1/ For 1953-54, two tables were prepared using alternative classifications and registration methods.

2/ The tables for 1958-1961 consist of only seven sectors.

3/ 1953: l'Université Libre de Bruxelles, 1959 Bureau de Programmation économique.

4/ Private study by A.J. Meyer and S. Vasiliou.

5/ Together with the Ministry of Finance.

6/ 1950: Mutual Security Agency, Instituto Nazionale per lo Studio della Congiuntura, Central Statistical Institute. Derived Tables: 1953 Instituto - Congiuntura; 1956 Ente Nazionale Idrocarburi.

7/ University of Stockholm.

8/ 1935: by T. Barna. 1948 and 1960: Department of Applied Economics, Cambridge. 1954: Central Statistical Office together with the Board of Trade.

9/ 1919, 1929, and 1939: Private study by W.W. Leontief. 1947: Bureau of Labour Statistics.

10/ 1954: Instituto de Estudios Politicos; 1958: Organizacion Sindical Española.

11/ Institute of advanced studies and Scientific Research at the University of Vienna, Institute of Economic Research, Central Statistical Office, other national agencies.

12/ Banco de Mexico compiled this table.

13/ Tables were compiled by the National Planning Institute.

14/ 1946-47, 1953-54, 1955-56: Tables were compiled by Professor B. Cameron of the Australian National University.

15/ Three tables were compiled for 1951 by Ministry of International Trade and Industry, Ministry of Agriculture and Forestry and Economic Planning Agency.

16/ Compiled by Bank of Israel.

Table 2

Current and planned input-output work

Country	Tables under constr-uction (for the years)	Tables planned (for the years)	Planned frequency of compi-lation of input-output tables	Whether or not incor-porated in general statistical programmes	Notes
Australia	-	1962-63	-	Yes	
Austria	1961		3-4 years	Yes	Committee set up on 5 December 1963.
Belgium	1959	-	3-4 years	Yes	Forecast prepared for 1965.
Bulgaria	1963		2-3 years	Yes	-
Canada	1961	-	10 years	Yes	-
Cyprus	-	-	-	-	-
Czechoslovakia		1966	-	Yes	From 1966 onwards it is intended to compile very large tables.
Denmark	-	-	-	-	Presumably the practice of frequent compila-tions will be upheld.
Finland	1959	1964	At least every 5 years	No	-
France	1959	-	-	Yes	-
Germany, Eastern	Annually	Annually	Annually	Yes	-
Germany, Fed. Rep. of	1954, 1958 1960	1962	-	Yes	-
Greece	-	1958 or 1963	4-5 years	No	Special working team set up in 1963.

Table 2 (continued)

Country	Tables under constr-uction	Tables planned	Planned frequency of compi-lation of input-output tables	Whether or not incor-porated in general statistical programmes	Notes
	for the years				
India	1959	-	-	No	
Ireland	-	-	Every 5 to 8 years	Yes	
Israel	-	-	-		
Italy	1959	1963 or 1964	5-10 years	Yes	
Japan	1963	Annually	Annually	Yes	
Mexico	1960	-	10 years	Yes 1/	
Netherlands	Annually	Annually	Annually	Yes	
New Zealand	1959-60		3 years	Yes	
Norway	Annually	Annually	Annually	Yes	-
Poland	1962	- Annually small tables - 1960 or 67 large table.	- Annually small tables - every 3-4 years large table.	Yes	-
Spain	1962	-	4 years	No	-
Sweden	-	1959, 68.		No	-
United Arab Republic	1962	Annually	Annually	Yes	
United Kingdom	-	1963	5 years	-	-
United States	1958	1963	5 years	Yes	It is planned to up-date the 1958 table for 1961.
USSR	-	-	3-4 years	-	-
Yugoslavia	1962	1964	2 years	Yes	Updated tables planned for every second year.

Notes:

1/ Incorporated in the statistical programme of the Bank of Mexico.

Table 3

Number of Production Sectors. Relation to National Accounts and balances

Country	Year	Number of production sectors 1/	Relation to National Accounts/Balances
Australia	1958-59	35	Fully integrated with NA.
Austria	1961	42	Generally corresponding to NA.
Belgium	1959	85	Does not conform.
Bulgaria	1960	68	Incorporated into the system of national economic balances.
Canada	1949 1961	42 60-70	Extension of the NA framework.
Czechoslovakia	1962	96	Conforms.
Denmark	1953	33x19 and 19x19	Part of NA.
Finland	1959	118	Generally corresponding to NA.
France	1959	77	Generally corresponding to NA.
Germany, Eastern	Annually	27	
Germany, Fed. Rep. of	1954-58 1960	20 34	Corresponding to NA.
Hungary	1961	54	Linked to NA.
India	1951-56 1959	36 29	Corresponding to NA.
Ireland	1956 1960	36 36	Generally corresponding to NA. Corresponding to NA.
Israel	1958	297x164 164x164 77x77 42x25	
Italy	1959	76	Generally corresponding to NA.
Japan	1960	450x350 153x153 56x56	Corresponding to NA. 2/
Mexico	1950	32	Corresponding to NA.
Netherlands	Annually	35	Completely integrated into the system of NA.

Table 3 (continued)

Country	Year	Number of production sectors 1/	Relation to National Accounts/Balances
New Zealand	1952-53 1945-55	12	Corresponding to NA.
Norway	1949-1960 1959-1962	87 134	Completely integrated into the system of NA.
Poland	1956-1961 1962	7-27 145	Corresponding to NA.
Portugal	1959	42	
Spain	1954 1958 1962	28 207 86	Corresponding to NA.
Sweden	1957	127	No strict comparison has been made.
United Arab Republic	1959-61	10	
United Kingdom	1954	46	The table is presented within the framework of NA.
United States	1958	85	Fully integrated with the NA.
USSR	1959	83	Completely conforms with the system of national economic balances.
Yugoslavia	1958	78	Conforms for the main aggregates.

Notes:

1/ The number is the same for rows and columns unless otherwise indicated.

2/ National Accounts Statistics are now being studied for improvement. The Table for 1960 is generally integrated into the NA.

Table 4

The Statistical Unit. Treatment of unallocated inputs and outputs

Country	Year	Stat. unit	Treatment of: Secondary activities	Own account construction	Unallocated elements
Australia	1958-1959	Act.	Data refer to commodity groups. No attempt to reallocate input incomes and general costs common to all industries (wages, repair, etc.)	Generally transferred to the construction industry	Separate row
Austria	1961	Est.	Not yet decided.		
Belgium	1960	Est.	Problems with separation of inputs for these activities		
Bulgaria	1960	Ent.	Transfer attempted	Transferred	Separate sector
Canada	1961	Est.	Transfer attempted; proportionality of input structures assumed.	Transferred to the construction industry	Separate sector
Czechoslovakia	1962	Est.	Transfer attempted.	Transferred	
Denmark	1953	Est.	Transfer attempted as far as possible.		
Finland	1959	Ent.	Transfer attempted so far as possible.	Transferred	Separate sectors
France	1959	Ent.	Transfer attempted so far as possible.	Separately shown.	-
Germany, Eastern	Annually	Ent.			Separate sector
Germany, Fed. Rep. of	1958	Ent.	Secondary activities contained in the figures of the sector.	Separately shown.	Eliminated
Hungary	1959	Ent.	Some transfer performed	Transferred	Eliminated

Table 4 (continued)

Country	Year	Stat. unit	Treatment of: Secondary activities	Own account construction	Unallocated elements
India	1951-1956	Est.	Transfer attempted as far as possible.	Transferred	Separate sector
Ireland	1960	Est.	Transfer attempted as far as possible.	Transferred to the construction industry	Separate row
Israel	1958	Est.	Treated as in USA.		Eliminated
Italy	1959	Est.	Transfer attempted as far as possible.	Transferred	Eliminated
Japan	1960	Act.[1/]	By-products and scrap are treated as negative inputs.		Separate sector
Mexico					
Netherlands	1963	Est.	Transferred if possible and if important.	Part of the output of the industry	Separate sector
New Zealand	1959-1960	Est.	Secondary production is not distinguished.		Eliminated
Norway	1961	Est.	Secondary production is not distinguished.	Transferred	Separate sectors
Poland	1962	Ent.	Some transfers attempted.	Transferred	2 variants: (1) Separate sectors; (2) Eliminated
Spain	1958	Est.	Transfers attempted as far as possible.	Transferred to the construction industry.	
Sweden	1957	Est.	Data refer to commodity groups; with certain assumptions secondary production problems are bypassed.	-	Separate sector
United Arab Republic	1959-1961	Est.	Transfer attempted.		Eliminated

Table 4 (continued)

Country	Year	Stat. unit	Treatment of:		
			Secondary activities	Own account construction	Unallocated elements
United Kingdom	1954	Est.	Transfers not attempted but magnitude and location of secondary activities assessed in auxiliary tables.	Partly transferred	Eliminated
United States	1958	Est.	Treated as sales to primary industries and distributed to consuming industries from the primary industries.	Transferred	Eliminated
USSR	1959	Ent.	Secondary outputs and inputs transferred to appropriate primary industries.	Transferred	Eliminated
Yugoslavia	1958	Est.	Since data largely relate to technical units, the secondary activities are deemed insignificant.	-	Eliminated

Abbreviations:

Est. = Establishment
Ent. = Enterprise
Act. = Activity

Notes: Transfer means that the secondary products and their inputs are transferred from the producing industries to the primary producing sectors.

1/ Almost all sectors are set on activity basis except service industries.

Table 5

Correspondence between national sector classifications and the ISIC

Countries \ ISIC major (two-digit) groups	01 Agriculture	02 Forestry and logging	03 Hunting, trapping and game propagation	04 Fishing	11 Coal mining	12 Metal mining	13 Crude petroleum and natural gas	14 Stone quarrying, clay and sand pits	19 Other non-metallic mining and quarrying	20 Food manufacturing industries except beverage industries	21 Beverage industries	22 Tobacco manufactures	23 Manufacture of textiles	24 Manufacture of footwear, other wearing apparel and made-up textile goods	25 Manufacture of wood and cork except manufacture of furniture	26 Manufacture of furniture and fixtures	27 Manufacture of paper and paper products	28 Printing, publishing and allied industries	29 Manufacture of leather and leather and fur products, except footwear and other wearing apparel
AUSTRALIA												X							
AUSTRIA	X'	X					X	X	X				X	X			X'		X
BULGARIA	X'	X'			X	X'	X'	X'	X'	X'	X'	X'	X'	X'	X		X	X	X'
CANADA	X	X									X	X				X			
CYPRUS	X'					X		X		X'	X'	X	X	X'	X	X	X	X	X
CZECHOSLOVAKIA		X			X							X					X	X	
DENMARK		X		X									X	X					
FINLAND	X'	X				X'		X'		X'	X'	X	X'				X'	X'	
FRANCE				X	X		X'			X'	X	X	X'				X	X	
GERMANY, FED. REP. OF																			
HUNGARY	X	X	X	X	X'	X'	X	X'	X'	X'	X'	X'	X'	X	X	X	X	X'	X
INDIA																			
IRELAND										X'	X	X	X	X					X
ITALY		X		X	X	X	X			X'		X	X'	X'			X		X
JAPAN	X'	X'		X'	X'	X'	X'	X'	X'	X'	X'	X	X'	X'	X'	X'	X'	X'	X'
NETHERLANDS					X					X'			X	X			X	X	
NEW ZEALAND	X	X								X'	X	X	X'	X'	X	X	X	X	X
NORWAY	X'	X'	X	X'	X	X				X'	X'	X	X'	X'	X'	X'	X'	X'	X
POLAND					X'	X'	X					X	X'				X'		
SPAIN	X'	X'		X'	X'	X'		X'	X'	X'	X'	X	X'	X'	X'		X'	X	X'
SWEDEN	X'			X						X'		X				X	X'	X'	
UNITED KINGDOM					X					X'	X	X			X	X	X'	X	X
UNITED STATES					X'	X	X'	X				X				X'	X'	X	
USSR					X		X'						X		X	X	X		
YUGOSLAVIA					X	X'	X			X'		X'	X'	X'			X'		

Countries \ ISIC major (two-digit) groups	30 Manufacture of rubber products	31 Manufacture of chemicals and chemical products	32 Manufacture or products of petro. and coal	33 Manufacture of non-metallic mineral products, except products of petroleum and coal	34 Basic metal industries	35 Manufacture of metal products, except machinery and transport equipment	36 Manufacture of machinery, except electrical machinery	37 Manufacture of electrical machinery apparatus, appliances and supplies	38 Manufacture of transport equipment	39 Miscellaneous manuf. industries	40 Construction	51 Electricity, gas and steam	52 Water and sanitary services	61 Wholesale and retail trade	62 Banks and other financial institutions	63 Insurance	64 Real Estate	71 Transport	72 Storage and warehousing	73 Communication	81 Government services	82 Community services	83 Business services	84 Recreation services	85 Personal services	86 Activities not adequately described
AUSTRALIA											X	X'	X													
AUSTRIA				X	X	X	X	X	X	X	X	X'		X				X'		X	X	X		X		X
BULGARIA	X	X'		X			X'	X	X	X'	X'	X		X				X		X						
CANADA	X								X		X									X						
CYPRUS	X	X				X	X	X	X'		X			X				X								
CZECHOSLOVAKIA									X'																	
DENMARK									X		X			X				X		X						
FINLAND	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'		X	X	X	X	X'		X			X	X		
FRANCE	X	X'			X		X'	X	X'		X			X				X'		X						
GERMANY, FED. REP. OF												X		X												
HUNGARY	X	X'	X'	X'	X'	X'	X	X	X	X'	X'	X'		X				X		X						
INDIA		X'									X	X					X									X
IRELAND									X		X										X					
ITALY	X		X'								X'	X'					X	X'		X						
JAPAN	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'	X'	
NETHERLANDS				X	X			X	X	X	X			X'	X	X	X			X	X			X		
NEW ZEALAND	X			X			X'	X	X'	X'	X	X	X	X				X'		X						
NORWAY	X	X'	X	X'	X'	X'	X'	X'	X'	X'	X'	X'	X		X'	X'	X'	X	X	X	X'	X'		X		
POLAND	X'	X'	X'		X'			X'	X'		X'			X				X'		X'						
SPAIN	X'	X		X'	X'	X'		X	X'		X'	X'		X'	X	X	X	X'		X						
SWEDEN								X'	X'		X'			X				X'		X'						
UNITED KINGDOM	X				X'		X	X'	X'		X	X'		X												
UNITED STATES									X'											X'						
USSR	X	X'	X'		X'	X'	X'	X'	X'		X															
YUGOSLAVIA	X						X	X'	X'		X			X'				X'								

X: The ISIC major group in question is shown in the National Classification of country concerned.

X': The National Classification is more detailed, but the ISIC major group in question can be derived from it.

Table 6

Treatment of imports

Country	Year	Variant A	Variant B	Variant C	Variant D	Notes
Australia	1958-59, 1962-63	Yes	Yes			
Austria	1961					Negative exports.
Belgium	1959	-	-	Yes	-	
Bulgaria	1960	Yes	Yes	-	Yes	
Canada	1949	Yes	-	-	-	Planned as supplementary study for 1961 table.
Czechoslovakia	1962	-	Yes	-	-	
Denmark	1953	Yes	-	-	-	
Finland	1956	Yes	-	-	-	
	1959	-	-	-	Yes	
France	1959	-	Yes	-	-	
Germany, Fed. Rep. of	1958	Yes	-	-	-	
Hungary	1961	Yes	Yes	-	Yes	
India	1951-56	-	Yes	-	-	
	1959			Yes	-	
Ireland	1956	-	-	Yes	-	
	1960	Yes	-	-		
Israel	1958				Yes	
Italy	1959	-	-	-	Yes	
Japan	1951			Yes		
	1955			Yes	Yes	
	1960		Yes		Yes	
Mexico	1950	Yes				
Netherlands	Annually	Yes	-	-	-	It is planned to make matrices D also for following years.
	1958	-	-	Yes	Yes	
New Zealand				Yes		
Norway	Annually	Yes	-	-	Yes	For some domestic sectors imports specified in more detail; for other domestic sectors, there are no corresponding imports.

Table 6 (continued)

Country	Year	Variant A	Variant B	Variant C	Variant D	Notes
Poland	1956-62	Yes	Yes	Yes 1/	Yes	In course of preparation for 1962
Spain	1958	Yes	-	-	-	Matrices D are computed for 1962
Sweden	1957	-	-	-	Yes	
United Arab Republic	1959-61		Yes 2/			
United Kingdom	1954	Yes	-	-	-	
	1960	-	-	Yes	-	
United States	1958	-	-	Yes	-	
USSR	1959	-	Yes	-	-	
Yugoslavia	1958	-	Yes	-	-	

Note: The treatment of imports shown as variants A to D is as follows:

Variant A: Imports figure in the import rows of the sector columns which effectively absorb the given import.

Variant B: The cells of the imports row contain only imports of the product which constitutes the output resulting from the sector in question.
In this case imported products are distributed via the domestic sectors producing the same or similar products.

Variant C: This treatment takes account of the well-known distinction between competitive and non-competitive imports; non-competitive imports are treated as imports direct to the consuming industry and competitive imports figure in the import cells of the producer sectors.

Variant D: Every input element consists of two parts: home produced inputs and imported inputs. In this case imports are debited to the actual users and do not appear as transfer flows between the sectors.

1/ For 1962 only.

2/ The imports are balanced against the corresponding exports giving either a positive or a negative value.

Table 7

Kind of prices used

Country	Producers' prices	Purchasers' prices	Other price concepts
Australia	X	X	
Austria	X		
Belgium	X		
Bulgaria	X		
Canada	X		
Czechoslovakia	X	X	
Denmark	X		
Finland	X		
France			Producers' prices for intermediate transactions; purchasers' prices for final deliveries.
Germany, Eastern	X	X	
Germany, Fed. Rep. of	X		Producers' prices, including transport cost paid by the producing sector.
Hungary	X		
India	X		
Ireland	X		
Israel	X		
Italy	X		
Japan	X	X	
Mexico	X		
Netherlands	X		
New Zealand	X		
Norway	X	X	
Poland	X		
Spain	X		

Table 7 (continued)

Country	Producers' prices	Purchasers' prices	Other price concepts
Sweden	X	X	
United Arab Republic	X		
United Kingdom	X		Producers' prices, including, in certain cases, transport cost paid by the producing sector.
United States	X		
USSR		X	
Yugoslavia	X		

Table 8

Treatment of final demand sectors

Abbreviations used: Cp = Private consumption; Cg = Government consumption;
I = Capital formation; E = Export;
S = Changes in stocks;

Country	Year	Sectors of final demand	
		Number	Specification
Australia	1958-1959	5	Cp; Cg; I; S.; Exports of goods; Other Exports.
Austria	1961	7	Cp; Cg; Ig; S; E; (EEC, EFTA, Total).
Belgium	1959	7	Cp; Cg; S; E; I in Housing; I in Transport Vehicles; I in Equipment and Materials.
Bulgaria	1960	5	Cp; Cg; I; S; E.
Canada	1949	5	Cp; Cg; S; E; Business Gross Fixed Capital Formation.
Czechoslovakia	1962	5	Cp; I and General repairs; S; E; Cg.
Denmark	1953	5	Cp; Cg; I; S; E.
Finland	1959	4	I; E; Consumption; Changes in Stocks plus errors and omissions.
France	1959	5	Cp, Cg together; I; S; E; correction of exports.
Germany, Eastern	Annually	5	Cp (subdivided into 2 branches); I; S; E; Capital Repair.
Germany, Fed. Rep. of	1958	7	Cp; Cg; I; E; Own-account Construction; Changes of Input Stocks; Changes in Output Stocks.
Hungary	1961	5	Cp; Cg; I; S; E.
India	1959	3	Cp; Cg; I.
Ireland	1960	5	Cp; Cg; I; S; E (Goods; Invisible).
Israel	1958	5	Cp; Cg; I; E; S.
Italy	1959	4	Cp; Cg together; I; S; E.
Japan	1960	6	Business Consumption Expenditure;[1/] Cp; Cg; I; S; E.
Mexico	1950	4	Cp; Cg; I (divided into private and public Investment); E.
Netherlands	Annually	6	Cp; Cg; Ig; Ip; E; S.
New Zealand	1959-1960	5	Cp; Cg; I; S; E.
Norway	1961	7	Cp; E; S; Central Military Consumption; Central Government Non-military Consumption; Local Government Consumption (two sectors); I (if necessary according to 22 sectors).

Table 8 (cont'd)

Treatment of final demand sectors

Abbreviations used: Cp = Private consumption; Cg = Government consumption;
I = Capital formation; E = Export;
S = Changes in stocks;

Country	Year	Sectors of final demand	
		Number	Specification
Poland	1962	5	Cp; Cg (subdivided into 9 branches); I (subdivided for 3 spheres); S (Subdivided for 2 spheres); E.
Spain	1958	5	Cp; Cg (includes Government Investment); I (minus Government Investment); Increases in stocks; E.
Sweden	1957	13	2/
United Arab Republic	1959-1961	1	Final Demand.
United Kingdom	1954	5	Cp; Cg; I; S; E.
United States	1958	4	Cp; Cg (subdivided for Federal, State and Local governments); I (broken down between producers durable equipment, construction and inventories = S).
USSR	1959	13	Cp; Cg (subdivided for 6 branches); I (subdivided into fixed capital formation and the formation of reserves non-fixed funds and inventories, i.e. including S); Capital repairs; Other uses; Replacement of Losses in Fixed and non-fixed Capital E.
Yugoslavia	1958	5	Cp; Cg; I; S; E.

Notes:

1/ Business consumption expenditure consists of three components:

(1) The cost of welfare for employees (2) Social expenses on business
(3) Travel expenses excluding traffic fares.

2/ Exports, Private consumption, State: national defence, Civil state activities; consumption, Civil state activities: investments excl. Railways and Telegraph, Railways: investments, Telegraph and telephone: investments, Cities and urban districts: total, Rural districts: total, County councils: Total, Agriculture: investments, Industry - trade etc.: investments, Inventory changes.

Table 9

Treatment of the "primary" inputs

Abbreviations used: W = Wages and Salaries; P = Profits; D = Depreciation; S = Changes in Stocks.

Country	Year	Rows for primary inputs: Number	Rows for primary inputs: Specified
Australia	1958-1959	4	W;P; Custom duty; other indirect taxes less subsidies.
Austria	1961	5	W;P;D; Indirect Taxes and Subsidies; Employment; Contribution to Social Insurance
Belgium	1959	6	W; Income of Independents; Income from Property; from Enterprises and Amortization; Taxes and subsidies (3 sectors).
Bulgaria	1960	4	Original Revenues of Population; Original Revenues of Enterprises; D.
Canada	1949	6	W;D; Corporate Profits and Other Investment Income; Net Income of Unincorporated Business, Indirect taxes on imported goods and services; Indirect taxes minus subsidies on domestic goods and services.
Czechoslovakia	1962	8	W;P;D;S; Payments outside the Wage Fund. Health Insurance Benefits. Turnover tax; Net Income of Collective Farms and Co-operatives and other income elements.
Denmark	1953	3	W; Other Factor Income; Indirect taxes less subsidies.
Finland	1959	5	W;P;D; Indirect taxes; Subsidies
France	1959	3	W;D; taxes.
Germany, Fed. Rep. of	1958	1	Contribution to the Gross Domestic Product (Sub-divided into 3 branches).
Germany, Eastern	Annually	3	P;D;S.
Hungary	1961	2	D; Wages, Incomes and Accumulation (the second item is further specified for internal use).
India	1959	2	W;P and D together.
Ireland	1960	4	W; P (including D); Indirect taxes; subsidies (-).
Israel	1958	5	W;P;S; Indirect Taxes; Subsidies (-).
Italy	1959	5	W; D; Compulsory social insurance contributions by employers; other income. Indirect taxes less subsidies
Japan	1960	6	Business consumption expenditure; W;P;D; Indirect Taxes; Subsidies.
Mexico	1950	4	W;P;D; Indirect taxes minus Subsidies (-).
Netherlands	Annually	6	W; Social security contribution; D;P; Indirect Taxes; Subsidies (-).
New Zealand	1959-1960	3	D; Indirect Taxes minus Subsidies; Net Domestic Output.

Table 9 (cont'd)

Treatment of the "primary" inputs

Abbreviations used: W = Wages and Salaries; P = Profits; D = Depreciation; S = Changes in Stocks.

Country	Year	Rows for primary inputs	
		Number	Specified
Norway	1961	5	W;P;D; Indirect Taxes; Subsidies received.
Poland	1962	8	W;D; Social Insurance; Net Income of Private Producers; Net Income of Co-operatives; Net Income of State Enterprises, Taxes and Budgetary differences; other non-material costs.
Spain	1958	7	W;P;D; Indirect Taxes; Direct Taxes; Social Insurance paid by enterprises; Social Insurance paid by workers.
Sweden	1957	7	Labour; carried out by administrative personnel, Labour; carried out by operative personnel, Labour; carried out by outworkers, Subsidies, Indirect Taxes, customs duties and import fees, Real capital services - Interests - profits etc.
United Arab Republic	1959-1961	1	W.
United Kingdom	1954	3	W; Gross profits and other Trading income (before depreciation and stock appreciation); taxes less subsidies.
United States	1947	1	Value added.
USSR	1959	9	W;D; Wage-type payments, income of collective farmers; Social Insurance; Profits of state enterprises; Indirect Taxes; Other Income elements; Net Income of Collective Farms and Co-operatives.
Yugoslavia	1958	4	W;P;D;S.

Note: The treatment of imports is treated separately in Table 6.

Table 10

Special input-output tables

Country	Inverse matrices	Tables in constant prices	Tables for certain product groups: In phys. qu.	Tables for certain product groups: In value	Investment matrices	Occupational (labour force) tables	Regional tables	Consumption tables 1/	Spec. tables for certain industries	Import matrices	Tax matrices	Other tables
Australia	X				X			X				Final demand at producers' and purchasers' prices.
Austria	X											
Belgium	X				X		X	X				
Bulgaria	X	X'	X	X				X	X			
Canada	X		X'	X'			X	X		X		Exports.
Czechoslovakia	X								X		X	
Denmark	X	X			X							
Finland	X				X							
France	X	X	X		X	X	X'					
Germany, Eastern			X'	X'		X'			X'			
Germany, Fed. Rep. of			X		X							Final demand at purchasers' prices.
Hungary	X		X	X	X				X	X	X	Changes in stocks.
India	X											
Ireland	X											
Israel	X					X						
Italy	X	X	X	X			X		X'	X	X'	Final demand at purchasers' prices.
Japan 2/	X		X	X		X	X			X		
Mexico	X											
Netherlands	X				X		X'			X	X	

Table 10 (cont'd)

Special input-output tables

Country	Inverse matrices	Tables in constant prices	Tables for certain product groups: In phys. qu.	Tables for certain product groups: In value	Investment matrices	Occupational (labour force) tables	Regional tables	Consumption tables 1/	Spec. tables for certain industries	Import matrices	Tax matrices	Other tables
New Zealand	X				X							
Norway	X	X			X	X		X		X		
Poland	X	X'	X		X	X'				X		(i) Breakdown of receiving sectors into: state; co-operative; and private. (ii) Reclassification of receiving sectors by economic organizations (ministries). (iii) changes in stocks.
Spain	X								X	X'	X'	
Sweden	X						X					Table in buyers' prices.
United Kingdom	X			X					X			
United States	X	X'			X	X	X					
USSR	X					X	X		X			
Yugoslavia	X											

X = Compiled.
X' = In course of preparation or intended.

1/ Matrix of consumers' expenditure by expenditure categories and sector of origin.

2/ The table for 1960.

Table 11

Time required for compilation; and whether results published

Country	Time required for the compilation of input-output tables	Whether published	Notes
Australia		Published	
Austria	2-3 years		Table under construction.
Belgium	-	Partly published	
Bulgaria	2 years	For internal use	
Canada	5 years	Published	
Czechoslovakia	1 1/2 years	-	
Denmark	-	Published	
Finland	3-4 years	Published	
France	-	Published	
Germany, Eastern		Partly published	
Germany, Fed. Rep. of	2-3 years		
Hungary	2 years	Published	
India		Published	
Ireland	1 1/2 - 2 yrs	Published	1960 Table published in aggregated form. 1956 Table is to be published.
Israel	2 years	Published	
Italy	2 years	Published	
Japan	2 years 1/	Published	
Mexico		Published	
Netherlands	2 1/2 years	Published	More detailed 1958 table unpublished.

Note:

1/ The tables for basic years which are to be compiled once in five years (1955, 1960, 1965 etc.) require two years to compile.

Table 11 (continued)

Time required for compilation; and whether results published

Country	Time required for the compilation of input-output tables	Whether published	Notes
New Zealand	3 years	Published	
Norway	-	Published	Preliminary annual tables available 4 months after the expiration of the year in question
Poland	2 years	Published	For small tables 1-1 1/2 years.
Spain	2-3 years	Published	
Sweden	7 years	Published	
United Arab Republic	1 year	Published	
United Kingdom	4 years	Published	The most detailed table was published in aggregated form (50 sectors).
United States	5 years	Published	The 1947 table was published in aggregated form (50 sectors).
USSR	2 years	Published	Inner matrix published.
Yugoslavia	1 1/2-2 years	Published	The 1960 table was not published.

Remarks:

(a) The time required for the compilation is of course affected by the size of the tables.

(b) In some cases the "time required" is the estimated time for tables in course of preparation.

(c) In many cases primary inputs are not shown in the published tables. Sometimes final demand is published in aggregate form, or not included in the published tables.

Table 12

Sources of data; relation of sector specification to national industrial classification

Country	Year	Sources of data			Relation of specification of sectors to national standard industrial classifications
		Statistics collected primarily for other purposes	Statistics specifically collected for input-output tables	Special sample surveys	
Australia	1958-1959	Yes	No	-	Based on Census Industrial Classification.
Austria	1961	Yes	No	For certain items	Based on National Industrial Classification.
Belgium	1959	Yes	No	For certain items	Specification based on C.S.T. and N.D.B.
Bulgaria	1960	Yes	Yes	For certain items	Based on National Industrial Classification.
Canada	1961	Yes	No	For certain items and branches	Based on National Industrial Classification.
Czechoslovakia	1962	Yes	Yes	For certain branches	Special classification worked out for the table.
Denmark	1953	Yes	-	-	Specification near to National Industrial Classification used in National Income Statistics.
Finland	1959	Yes	Yes	Yes	National Industrial Classification used.
France	1959	Yes	No	For certain branches	Conforms with National Industrial Classification.
Germany, Eastern	Annually	Yes	Yes		
Germany, Fed. Rep. of	1958	Yes	-	Yes	National Classification of economic branches used.

Table 12 (continued)

Sources of data; relation of sector specification to national industrial classification

Country	Year	Sources of data: Statistics collected primarily for other purposes	Statistics specifically collected for input-output tables	Special sample surveys	Relation of specification of sectors to national standard industrial classifications
Hungary	1961	Yes	Yes	Yes	Conforms with National Industrial Classification.
India	1951-56	Yes	No	No	Based on National Industrial Classification.
	1957	Yes	No	No	
Ireland	1960	Yes	No	-	Based on National Industrial Classification.
Israel	1958	Yes	Yes	No	
Italy	1959	Yes	For certain branches	For certain items and branches	Specification near to National Industrial Classification.
Japan	1960	Yes	Yes	No	Based on I.S.I.C.
Mexico	1950	Yes	No	No	Based on I.S.I.C.
Netherlands	Annually	Yes	Many statistics adjusted	-	Based on I.S.I.C.
New Zealand	1959-1960	Yes	Yes	Yes	Specifications close to National Industrial Classification.
Norway	Annually	Yes	Many statistics adjusted	-	Based on National Industrial Classification.
Poland	1962	Yes	Yes	Yes	Based on National Industrial Classification
Spain	1958	Yes	Yes	For certain items	Specification close to National Industrial Classification.
Sweden	1957	-	-	Extensive use of sample surveys	In industry generally the practice of the industrial statistics adopted. For other sectors various principles used.

Table 12 (continued)

Sources of data; relation of sector specification to national industrial classification

Country	Year	Sources of data: Statistics collected primarily for other purposes	Sources of data: Statistics specifically collected for input-output tables	Sources of data: Special sample surveys	Relation of specification of sectors to national standard industrial classifications
UAR	1959-1961	Yes	-	-	Classification is based on the classification of the Ministry of Industry.
United Kingdom	1954	Yes	No	No	National Industrial Classification used.
United States	1958	Yes	No	Yes	National Industrial Classification used.
USSR	1959	Yes	No	Sample surveys for 20% of industrial enterprises and construction sites carried out	Sectors established as commodity groups; national industrial classification used in aggregated form.
Yugoslavia	1958	Yes	No	No	Specification could not be harmonized with national industrial classification (in the latter arts and crafts are treated separately)

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