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SOCIAL ACCOUNTING MATRICES AND EXTENDED INPUT-OUTPUT TABLES

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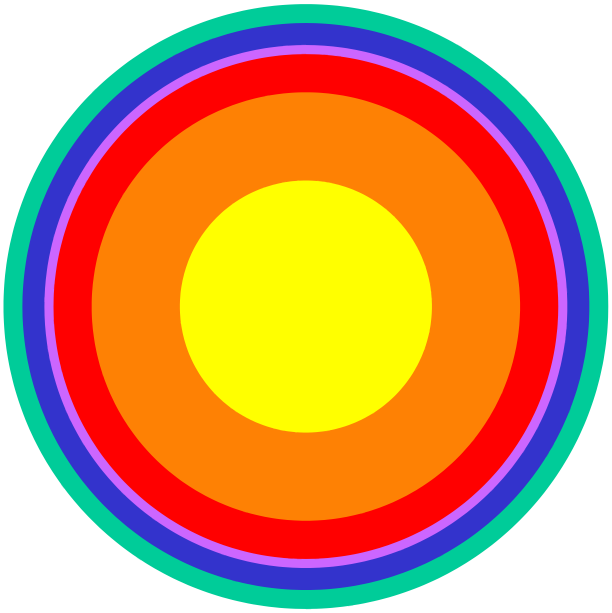

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This paper summarizes the historical development of Social Accounting Matrices (SAM) related to input-output tables and describes the linkages between SAM and the input-output framework in the European System of National Accounts. After these introductory remarks, an example of a SAM based on input-output analysis is given which might encourage cooperation projects of statisticians working in these two fields.

1. SAM and input-output framework

At the end of the forties and beginning of the fifties, Richard Stone already proposed a presentation of the results of national accounting not only in T-accounts but also in a matrix format.[1] He called such matrix a *Social Accounting Matrix* (SAM) and demonstrated that input-output tables could be interpreted as a special case of a SAM: „I propose to use the term input-output table to mean a statement in current money terms of the flow of goods and non-factor services between the operating accounts of the system and between these and all other accounts combined. All other transactions in the system are aggregated and appear as the elements in the final row of the matrix."[2]

In the sixties, Richard Stone and his team developed the Cambridge Growth Model.[3] In this context, he also published a first SAM for Great Britain 1960[4] and improved the conceptual framework of such matrix presentation. He especially stressed the importance of using different statistical units (e.g. commodities, establishments, institutional units) in the system for describing the variety of economic activities in a most suitable way. According to this concept, it is necessary to link the different parts of the accounting system by special transition matrices from one statistical unit to another.[5] These considerations were the starting point for the concepts of the *System of National Accounts (SNA)* 1968.[6] The supply and disposition tables of the input-output framework became an integral part of the national accounting matrix.[7]

In the seventies, the term social accounting matrix changed its meaning. It was now used for a type of national accounting matrix especially describing the interrelationships of income and transfer flows between the different institutional units: „The pattern of these transfers conditions the distribution of income in exactly the same way as the pattern of interindustry transactions conditions the structure of production."[8] Such special emphasis on socio-economic analysis was strongly supported by Richard Stone: „We already have a disaggregation of the productive system in input-output tables and, for a more restricted number of countries, a

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[1] See Stone 1949, Stone 1951-52, Stone 1955a and 1955b. Cf. also Stone 1961. Comments to this work were made by Hill 1995, p. 27. See also Stahmer 2002 with further references.
[2] Stone 1955b, p. 158 f.
[3] See the overview in Stone 1981a, pp. 77-96.
[4] Stone 1962b.
[5] Stone 1962a.
[6] United Nations 1968.
[7] United Nations 1968, Chapter II and Chapter III, cf. especially the famous table 2.1 of the complete system, p. 18 passim. See also later comments of Richard Stone in Stone 1979 and Stone 1981b.
[8] Pyatt 1999, p. 366.

disaggregation of the financial system in flow-of-funds tables. The missing peace is the disaggregation of income and outlay."[9]

In the seventies and eighties, these concepts were especially used in developing countries.[10] The promising experiences in these countries encouraged national accountants to propose socio-economic analysis as integral part of the revised concepts of national accounting.[11] This strategy has been successful: SNA 1993 as well as ESA 1995 contain chapters on SAM which show its usefulness and the great variety of its applications.[12] In the next section, the proposals of the international system of national accounts regarding the linkages between input-output and SAM are described in detail.

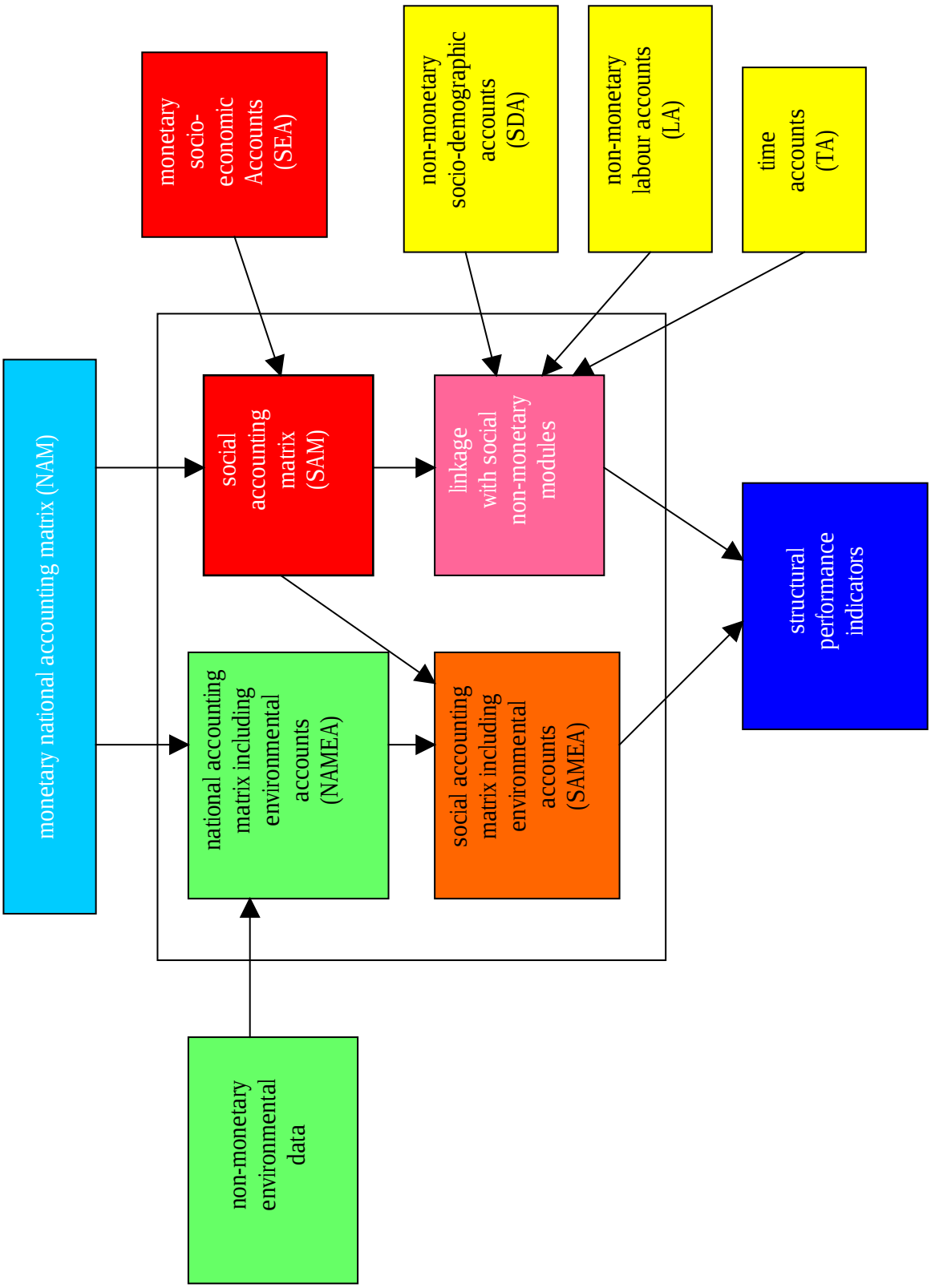
Great support for implementing the SAM concepts not only in developing but also in developed countries was given by the work done by Steven Keuning and his team at Statistics Netherlands. They presented the concepts and numerical examples of a *System of Economic and Social Accounting Matrices and Extensions* (SESAME) which comprises a whole family of SAM modules.[13] *Table 1* gives an overview on the different parts of the system which is able to describe economic, social and environmental aspects of human activities in an integrated framework. Eurostat together with several European countries is now preparing a handbook on the concepts of SAM especially based on these experiences.[14]

2. Linkages of SAM and input-output in the ESA

In the chapter on the sequence of accounts and balancing items (Chapter 8), the ESA also describes different types of matrix presentation of national accounts data (par. 8.100 - 8.155). In the introductory remarks, it is mentioned that the input-output table is a well-known example of such a presentation: „The input-output table is a widely used matrix framework to supply detailed and coherently arranged information on the flow of goods and services and on the structure of production costs (par. 8.101)."

[9] Stone 1985, p. 181.
[10] See Pyatt, Roe 1977 and Pyatt, Round 1985.
[11] Keuning, de Ruijter 1988, Keuning 1991, Pyatt 1985, 1991a and 1991b.
[12] Commission of the European Communities et al. 1993, pp. 461-488, Eurostat 1995, pp. 195-206.
[13] See the overview in Keuning 2000 and Timmerman, van de Ven 2000 with further references.
[14] Eurostat 2002.

Table 1: System of Economic and Social Accounting Matrices and Extensions (SESAME)



In the following paragraphs of ESA, it is shown how the full sequence of ESA accounts and balancing items could be presented in a matrix format (8.104 - 8.125 and table 8.19). Each entry in an aggregate matrix can be considered as the grand total of a submatrix which shows detailed information by different types of transactors or other groupings (par. 8.126). A more detailed matrix reveals the economic flows at a meso-level which allows an analysis of the interrelations between the different groups of economic actors. The SAM is described as a special type of matrix presentation which allows a further elaboration on the interrelations between the social and economic aspects of the system. Some information on the SAM is given in the last part of Chapter 8 of the ESA (par. 8.133 – 8.155 and tables 8.20, 8.21).

In the introductory paragraphs of the description of the SAM, the close linkages between SAM and input-output tables are stressed: „The supply and use tables opt for a classification of rows and columns which is most suitable to describe the economic processes under consideration, namely the processes of production and use of products. However, those matrices do not incorporate the interrelations between value added and final expenditure. By extending a supply and use table, or an input-output table, to show the entire circular flow of income at a meso-level, one captures an essential feature of a Social Accounting Matrix (SAM) (par. 8.133)."

According to these considerations, the SAM is defined as a presentation of ESA-accounts in a matrix which elaborates on the linkages between a supply and use table and sector accounts (par. 8.134). Special emphasis is laid on the role of people in the economy which implies a further breakdown of the household sector and a disaggregation of the persons employed. In this context, two parts of the use table of the input-output framework are especially disaggregated: the components of net value added, shown in the third quadrant of the table, and the final uses which are presented in the second quadrant.

Table 8.22 of the ESA gives an example of a detailed matrix of net value added. The compensation of employees is subdivided by resident and non-resident employees. Resident employees are further disaggregated by sex, category of occupation and place of residence. Net operating surplus is shown in a breakdown by the (sub) sector of the enterprises to which the establishment belongs, and net mixed income according to the location of the household enterprises (par. 8.153). Employees could further be subdivided by level of schooling, age and type of job contract (full-time/part-time, permanent/temporary) (par. 8.136). It is recommended that labour income is also decomposed into hours worked and average wage rates per hour (par. 8.138).

In the input-output framework, final uses are shown in a breakdown by product group. The SAM concepts recommend a further breakdown of final consumption expenditures by institutional sectors (e.g. types of households). Changes in inventories should be shown in a cross classification by product group and institutional sector, gross fixed capital formation by product group and investing industries. For socio-economic analysis, the proposed breakdown of final consumption expenditures by product group and household (sub) sectors would have higher priority than the disaggregation of capital formation.

3. Example of a SAM based on input-output analysis (SAMIO)

In this section, an example is given for using extended input-output tables and SAM modules to compile a SAM which is based on results of input-output analysis. This matrix is called SAMIO to stress the linkages between SAM and the I-O framework. The example shall encourage common research and analysis of input-output and SAM specialists. Such cooperation is urgently needed for improving the data base for developing strategies towards sustainable development.

By applying input-output models, the SAMIO gives a very condensed picture of the production and consumption activities of certain groupings of the population. The SAM data on value added and labour inputs by socio-economic group are directly linked with the SAM modules on final uses by socio-economic group. Such linkages of labour and consumption were already proposed by Utz-Peter Reich, Philipp Sonntag and Hans-Werner Holub twenty-five years ago.[15] They presented a Labour-Consumption Accounting which has several similarities with the approach presented in this section.

The SAMIO concepts allow a new type of operating surplus: Each socio-economic group is not only delivering results of their production activities to themselves or to other persons but also receiving such results from themselves or from others. The balancing items of these flows show for each socio-economic group who is the „net recipient“ or „net supplier“ of these interrelationships. The total amount of received production values could be treated as a variable of the welfare function of these persons.

Following the concepts of the „magic triangle“ of input-output tables, the SAMIO is compiled in time units, in monetary units and in physical term (tons).[16] Differing from traditional concepts, the concepts of SAMIO are derived from considerations on the time use of the population. In this context, the pioneering work of Gary Becker and Graham Pyatt was very stimulating for developing suitable concepts.[17] A broader approach which is also based on welfare considerations was proposed by Gerhard Scherhorn.[18] He also distinguishes welfare caused by goods and services, welfare connected with time use and welfare related to environmental conditions.

3.1 Data base for compiling SAMIO

An extended monetary input-output table - similar to the table described in the context of the „magic triangle“ - is the starting point for the computation.[19] *Table 2* shows this table based on 1990 data for Germany. The main

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[15] Reich et al. 1977, see also Horz, Reich 1982 and Reich 1986.
[16] See Stahmer 2000.
[17] See Becker 1965 and Pyatt 1990. Cf. also Kazemier, Exel 1992.
[18] Scherhorn 2002 with further references.
[19] See the detailed information in Stahmer et al. 2002 and Stahmer 2000.

differences refer to the treatment of education services, the concepts of household services and the disaggregation of the private consumption.

Education services (column/row 7) are treated in a more conventional way. The gross output does not become part of fixed capital formation but is treated as government consumption. This concept also implies that the consumption of fixed produced assets does not include the consumption of educational capital. Furthermore it is not necessary to introduce the margin of education as a balancing item.

The treatment of all household services as production activities has not changed.[20] According to this concept, consumer durables are investment goods which are depreciated. Differing from the monetary I-0 table of the „magic triangle", the labour inputs of household production (defined with the so-called third-person criterion) get no monetary value. Some changes have also been made with regard to the uses of household services. Household services related to employment (column/row 10) are not treated as intermediate consumption but as private consumption. According to this concept, the balancing item of the margin of labour was not necessary. Corresponding with the treatment of education services, the household services related to studying (column/row 11) are not treated as fixed capital formation but as private consumption. No changes have been made in the cases of the use of household production services (column/row 9) and other household services (column/row 12). Household production services are mainly intermediate inputs, other household services represent the main part of private consumption.

The column of private consumption is further subdivided by specific socio-economic groups of the population. The example in *table 2* only shows a disaggregation by young people (0 - 17 years old), adults except aged persons (18 - 64 years old) and aged persons (65 years and older). The detailed breakdown of private consumption compiled for Germany 1990 comprises 32 types of households with further subdivisions by the persons living in the households (2 to 5 groups of persons). The basic data only deliver monetary information on the households as a whole. The further breakdown by person could partly be estimated by applying specific weighting procedures and partly by using simplified weighting systems (e.g. equivalent scales). Following this two-stage procedure, the whole population was finally disaggregated by 120 groups of persons. Main emphasis has been laid on the situation of young people in different types of families. These data were compiled in the context of a research project sponsored by the „Deutscher Arbeitskreis für Familienhilfe (German Association for Supporting Families)", Kirchzarten.

As memorandum items, *table 2* also shows the direct time inputs of the different activities. In the case of employment (columns 1 – 8), the time inputs show the hours at the working place.

For socio-economic analysis, it is preferable to endogenize the consumption of fixed produced assets. Finally, the use of fixed assets has also an intermediate character.[21] Investment goods are directly or indirectly inputs for producing private or government consumption goods and services, other investment goods or exports.

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[20] See Becker 1964 and Lancaster 1966.
[21] See Stahmer, Strassert 2002.

Input-output models can reveal these linkages between inputs and final uses. As a necessary data base for input-output analysis, the depreciation items of the different industries (branches) are subdivided by the type of investment goods. For modelling purposes, these data are treated as additional intermediate inputs. In accordance with this concept, the primary inputs (third quadrant of the I-O table) will only comprise imports for intermediate uses and net value added. An additional correction has to be made in the second resp. fourth quadrant. The columns of fixed capital formation are reduced by the corresponding items of depreciation showing only net capital formation. Thus, the row sums of total uses of depreciation will become zero. *Table 3* shows such a matrix for the consumption of domestically produced assets and the corresponding corrections. Row 13 of *table 3* corresponds with row 19 of *table 2*.

Socio-economic activities are not only based on the use of domestic product but also directly or indirectly linked with imported goods and services. For analyzing the impacts of foreign trade in the countries of origin it is necessary to endogenize not only the consumption of fixed assets but also the intermediate inputs of imports. A thorough analysis of the production activities abroad would only be possible if input-output tables of all important countries delivering import goods would be available. For getting first estimates, it is possible to apply the domestic input structures also for describing foreign production activities. Of course, such assumption neglects the fact that many imported

Table 2: Extended monetary

Billion

Row No.	Uses / Supply	Input of: agri-culture, forestry, fishing	mining, water and energy supply	manu-facturing	con-struc-tion	market services	environ-mental protec-tion ser-vices	edu-cation services	non-market services	house-hold produc-tion
		1	2	3	4	5	6	7	8	9
	Product output by product group									
1	Products of agriculture, forestry, fishing	7.5	0.1	43.4	0.1	5.9	-	0.1	1.1	6.0
2	Prod.of mining,water and energy supply	1.8	30.8	45.0	0.5	20.7	0.7	1.6	5.7	15.4
3	Products of manufacturing	14.8	13.1	571.1	72.0	109.0	2.4	2.7	41.3	109.1
4	Construction work	0.7	3.9	7.1	4.2	23.4	1.8	1.3	7.2	1.0
5	Market services	8.2	15.9	288.6	39.6	424.5	1.7	7.8	109.1	127.9
6	Environmental protection services	0.1	0.9	5.2	2.0	1.8	4.9	0.5	1.1	2.5
7	Education services		-	-	-	-	-	-	-	-
8	Non-market services	0.4	0.5	5.8	0.7	4.9	1.3	0.1	66.5	2.8
9	Household production services	-	-	-	-	-	-	-	-	42.3
10	Househ. services related to employment	-	-	-	-	-	-	-	-	-
11	Household services related to education	-	-	-	-	-	-	-	-	-
12	Other household services	-	-	-	-	-	-	-	-	-
13	Domestic products, totals	33.5	65.1	966.0	119.1	590.1	12.9	14.1	232.1	307.0
14	Compensation of employees	7.0	35.4	486.3	85.4	405.7	6.2	77.8	211.6	-
15	Net operating surplus	21.9	12.3	94.9	34.6	388.1	- 0.7	0.4	-	-
	Revenues on products									
16	Non-deductible value added tax	-	-	-	-	11.6	1.0	1.3	14.3	23.3
17	Taxes less subsidies on products	- 4.5	- 2.6	54.5	2.3	23.3	-	0.2	0.3	-
18	Net value added	24.4	45.2	635.6	122.3	828.7	6.4	79.7	226.2	23.3
	Consumption of fixed produced assets[2)]									
19	Domestic investment goods	10.3	17.6	61.5	4.6	141.3	6.2	7.5	8.4	22.9
20	Imported investment goods	1.5	2.7	11.4	0.7	18.3	0.3	0.9	0.9	6.8
21	Non-deductible value added tax	-	-	-	-	11.2	-	-	2.6	3.6
	Imports from the rest of the world									
22	Goods	5.9	13.4	225.2	13.0	29.5	0.7	0.6	13.6	42.1
23	Services	0.4	0.7	8.6	1.0	22.9	0.0	0.9	5.7	4.8
24	Primary inputs, totals	42.6	79.6	942.3	141.7	1 051.8	13.6	89.5	257.5	103.6
25	Gross output, final uses	76.0	144.7	1 908.3	260.8	1 642.0	26.6	103.6	489.6	410.6
	Memorandum item:									
26	Time inputs (Mill.hours)	2 035	743	13 821	3 333	17 404	262	1 828	6 841	82 320

1) Including consumption of private non-profit organizations serving households (18,7 Bill. DM).
2) Including consumer durables.

input-output table - Germany 1990

Deutsche marks

branches				Final uses									
household services (except household production)				private consumption				fixed capital formation					
services related to employ-ment	services related to studying	other services	totals	young persons	adults (except aged persons)	aged persons	govern-ment con-sump-tion[1]	fixed assets (except consumer durables incl. change in stocks)	con-sumer durables	exports to the rest of the world	totals	Total uses	Row no.
10	11	12	13	14	15	16	17	18	19	20	21	22	
0.1	0.0	3.2	67.3	-	-	-	-	2.8	-	5.9	8.7	76.0	1
0.4	0.2	18.4	141.3	-	-	-	-	- 0.7	-	4.1	3.4	144.7	2
7.6	1.5	116.1	1 060.6	-	-	-	-	184.7	73.3	589.7	847.7	1 908.3	3
0.1	-	2.4	53.1	-	-	-	-	205.1	-	2.5	207.7	260.8	4
20.1	10.1	403.4	1 457.1	-	-	-	-	32.6	40.7	111.6	184.9	1 642.0	5
0.2	0.1	7.2	26.5	-	-	-	0.1	-	-	-	0.1	26.6	6
-	-	-	-	-	-	-	103.6	-	-	-	103.6	103.6	7
0.3	2.2	20.7	106.2				380.6	1.1	-	1.8	383.4	489.6	8
-	5.6	297.7	345.6	32.7	25.2	6.9	-	-	-	-	64.8	410.4	9
-	-	-	-	0.6	51.3	1.1	-	-	-	-	53.0	53.0	10
-	-	-	-	17.0	7.6	1.2	-	-	-	-	25.8	25.8	11
-	-	-	-	97.8	824.8	177.4	-	-	-	-	1 099.9	1 099.9	12
28.7	19.8	869.2	3 257.7	148.1	908.9	186.7	484.2	425.6	114.0	715.6	2 983.0	6 240.7	13
-	-	-	1 315.5								-	1 315.5	14
-	-	-	551.4								-	551.4	15
3.0	1.1	50.3	106.0	-	-	-	-	27.7	17.9	3.4	49.0	155.0	16
-	-	-	73.4								-	73.4	17
3.0	1.1	50.3	2 046.3								-	2 046.3	18
9.6	1.6	53.5	345.1	-	-	-	-	- 257.4	- 87.7	-	- 345.1	-	19
2.9	0.6	14.4	61.3	-	-	-	-	- 36.6	- 24.7	-	- 61.3	-	20
1.5	0.3	8.3	27.5	-	-	-	-	- 13.8	- 13.7	-	- 27.5	-	21
5.0	1.0	70.2	420.1					66.3	31.9	47.4	145.6	565.7	22
2.2	1.4	34.0	82.7					0.1	0.1	0.4	0.6	83.3	23
24.2	6.0	230.6	2 983.0	-	-	-	-	- 241.5	- 94.0	47.8	- 287.7	2 695.3	24
53.0	25.8	1 099.8	6 240.7	148.1	908.9	186.7	484.2	184.1	20.0	763,4	2 695,3		25
12 255	15 430	397 824	554 097										26

Table 3: Additional

Billion

Row No.	Uses / Supply	Input of: agri-culture, forestry, fishing	mining, water and energy supply	manu-facturing	con-struc-tion	market services	environ-mental protec-tion ser-vices	edu-cation services	non-market services	house-hold produc-tion
		1	2	3	4	5	6	7	8	9
		Consumption of fixed								
	Product group									
1	Products of agriculture, forestry, fishing	-	-	-	-	0.2	-	-	-	-
2	Prod.of mining,water and energy supply	-	-	-	-	-	-	-	-	-
3	Products of manufacturing	7.1	11.7	46.4	3.5	56.1	0.7	2.7	2.7	15.0
4	Construction work	2.3	4.9	9.5	0.6	71.7	5.4	4.2	5.2	-
5	Market services	0.9	1.0	5.5	0.5	12.8	0.1	0.5	0.5	7.9
6	Environmental protection services	-	-	-	-	-	-	-	-	-
7	Education services	-	-	-	-	-	-	-	-	-
8	Non-market services	-	-	0.1	-	0.4	-	-	-	-
9	Household production services	-	-	-	-	-	-	-	-	-
10	Househ. services related to employment	-	-	-	-	-	-	-	-	-
11	Household services related to education	-	-	-	-	-	-	-	-	-
12	Other household services	-	-	-	-	-	-	-	-	-
13	Totals	10.3	17.6	61.5	4.6	141.3	6.2	7.5	8.4	22.9
		Imports from the								
	Product group									
1	Products of agriculture, forestry, fishing	1.5	0.0	15.6	0.0	1.8	-	0.0	0.7	8.9
2	Prod.of mining,water and energy supply	0.1	9.0	25.6	0.0	0.2	0.0	0.0	0.1	0.2
3	Products of manufacturing	5.8	7.0	195.4	13.7	45.5	0.9	1.4	13.7	39.8
4	Construction work	0.0	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.0
5	Market services	0.4	0.7	8.7	1.0	22.9	0.0	0.7	4.0	4.6
6	Environmental protection services	-	-	-	-	-	-	-	-	-
7	Education services	-	-	-	-	-	-	-	-	-
8	Non-market services	-	-	-	-	-	-	0.1	1.7	0.2
9	Household production services	-	-	-	-	-	-	-	-	-
10	Househ. services related to employment	-	-	-	-	-	-	-	-	-
11	Household services related to education	-	-	-	-	-	-	-	-	-
12	Other household services	-	-	-	-	-	-	-	-	-
13	Totals	7.8	16.8	245.3	14.8	70.7	1.0	2.3	20.2	53.7
14	Goods	5.9	13.4	225.2	13.0	29.5	0.7	0.6	13.6	42.1
15	Services	0.4	0.7	8.6	1.0	22.9	0.0	0.9	5.7	4.8
16	Consumption of imported fixed produced assets 1)	1.5	2.7	11.4	0.7	18.3	0.3	0.9	0.9	6.8

1) Including consumer durables.

use tables 1990
Deutsche marks

branches				Final uses									
household services (except household production)				private consumption				fixed capital formation					
services related to employment	services related to studying	other services	totals	young persons	adults (except aged persons)	aged persons	government consumption[1]	fixed assets (except consumer durables incl. change in stocks)	consumer durables	exports to the rest of the world	totals	Total uses	Row no.
10	11	12	13	14	15	16	17	18	19	20	21	22	
domestic ally produced assets													
-	-	-	0.2	-	-	-	-	- 0.2	-	-	- 0.2	-	1
-	-	-	0.0	-	-	-	-	-	-	-	-	-	2
7.4	1.0	33.1	187.6	-	-	-	-	- 131.0	- 56.5	-	- 187.6	-	3
-	-	-	103.9	-	-	-	-	- 103.9	-	-	- 103.9	-	4
2.2	0.6	20.4	52.9	-	-	-	-	- 21.8	- 31.1	-	- 52.9	-	5
-	-	-	-	-	-	-	-	-	-	-	-	-	6
-	-	-	-	-	-	-	-	-	-	-	-	-	7
-	-	-	0.6	-	-	-	-	- 0.6	-	-	- 0.6	-	8
-	-	-	-	-	-	-	-	-	-	-	-	-	9
-	-	-	-	-	-	-	-	-	-	-	-	-	10
-	-	-	-	-	-	-	-	-	-	-	-	-	11
-	-	-	-	-	-	-	-	-	-	-	-	-	12
9.6	1.6	53.5	345.1	-	-	-	-	- 257.4	- 87.7	-	- 345.1	-	13
rest of the world													
0.1	0.0	4.1	32.8	-	-	-	-	0.8	-	1.1	1.9	34.7	1
0.0	0.0	0.2	35.3	-	-	-	-	- 0.1	-	0.0	0.0	35.3	2
7.8	1.6	80.1	412.7	-	-	-	-	28.6	7.3	46.4	82.4	495.0	3
0.0	-	0.0	0.5	-	-	-	-	0.4	-	0.0	0.4	0.9	4
2.2	1.2	32.8	79.3	-	-	-	-	0.0	0.0	0.2	0.2	79.5	5
-	-	-	-	-	-	-	-	-	-	-	-	-	6
-	-	-	-	-	-	-	-	-	-	-	-	-	7
0.0	0.2	1.4	3.6	-	-	-	-	-	-	-	-	3.6	8
-	-	-	-	-	-	-	-	-	-	-	-	-	9
-	-	-	-	-	-	-	-	-	-	-	-	-	10
-	-	-	-	-	-	-	-	-	-	-	-	-	11
-	-	-	-	-	-	-	-	-	-	-	-	-	12
10.1	3.0	118.6	564.2	-	-	-	-	29.8	7.4	47.8	84.9	649.1	13
5.0	1.0	70.2	420.1	-	-	-	-	66.3	31.9	47.4	145.6	565.7	14
2.2	1.4	34.0	82.7	-	-	-	-	0.1	0.1	0.4	0.6	83.3	15
2.9	0.6	14.4	61.3	-	-	-	-	- 36.6	- 24.7	-	- 61.3	-	16

products are not domestically produced. *Table 3* also shows an import matrix which is used for input-output analysis in the following sections. It should be mentioned that this import matrix also contains a depreciation matrix for the imported investment goods with corresponding corrections in the columns of fixed capital formation. The data on imports correspond with the figures in *table 2*, rows 20, 22 and 23.

For linking environmental aspects with the socio-economic data base of I-O tables, material balances are used which give a complete description of all physical inputs and outputs of the different industries (branches). The data used in the context of describing ecological aspects of the SAMIO in section 3.4 are shown in *table 4*.

In linking physical flows with the monetary data of the extended I-O table, only parts of the material balances are used. Physical flows which are not further taken into account, are indicated by italic letters. With regard to the *product flows*, all intermediate domestic products (rows 2 and 17) will be excluded. Remaining product flows are only the imports of intermediate products (row 3), exports of goods (row 19) and the physical flows of investment goods (row 18). In the case of *raw materials and residuals*, all throughput materials (rows 8 and 20) are excluded. These materials comprise cooling water or soil excavation for structures which are used as raw materials and which are given back to the nature as residuals without any further economic treatment. Furthermore, residuals which are still treated or re-used for economic purposes (rows 5 and 21), are excluded. The remaining residuals (rows 23 to 28) which are linked with socio-economic data in the model described in section 3.4, are stored in controlled landfills (like waste) or are disposed back into the nature (e.g. air pollution or treated waste water). In the case of natural resources, only those are taken into account in socio-economic modelling which are used as inputs of economic activities (rows 9 to 14).

3.2 SAMIO in time units

The social accounting matrix based on input-output analysis (SAMIO) focusses on the activities of the population disaggregated by socio-demographic or socio-economic groups of persons. A very simple disaggregation of the population is used as example in this chapter: The persons are only subdivided according to their age. The chosen three groupings of the population are young people (0 to 17 years old), adults except seniors (18 to 64 years old) and aged persons (65 years and older). In Germany 1990, 11.6 million persons belonged to the young people, 42.0 to the adults except seniors and 9.7 to the aged people. Other possible classifications could be types of households, education levels or sex.

Table 4: Material balances 1990

Million tons

Row. No.	Uses / Supply	Input of branches: agri-culture, forestry, fishing	mining, water and energy supply	manu-facturing	con-struc-tion	market services	environ-mental protec-tion services	education services	non-market services	house-hold produc-tion	services related to employ-ment	services related to studying	other services	Totals
		1	2	3	4	5	6	7	8	9	10	11	12	13
1	*Product inputs*	*199*	*2 141*	*2 202*	*618*	*148*	*17*	*52*	*333*	*802*	*75*	*37*	*2 201*	*8 825*
2	*Domestic origin*	*188*	*2 092*	*1 963*	*590*	*134*	*17*	*52*	*331*	*783*	*71*	*36*	*2 180*	*8 438*
3	*Imported*	*10*	*49*	*239*	*28*	*13*	*0*	*0*	*2*	*19*	*4*	*1*	*21*	*387*
4	*Residual inputs for economic treatment or re-use*	-	*1*	*13*	*9*	*104*	*4 461*	*0*	*0*	*1*	*0*	*0*	*2*	*4 591*
5	*Current production*	-	-	*3*	*0*	*104*	*4 461*	*0*	*0*	-	-	-	-	*4 569*
6	*Fixed produced assets*	-	*1*	*9*	*9*	*0*	-	*0*	*0*	*1*	*0*	*0*	*2*	*22*
7	*Natural resource inputs of throughput materials*	-	*32 386*	*5 346*	*113*	-	*3 500*	-	-	-	-	-	-	*41 345*
8	Other natural resource inputs	607	5 839	1 139	68	118	10	15	90	94	29	5	152	8 165
9	Energy carries	-	193	-	-	-	-	-	-	-	-	-	-	193
10	Other solid materials	1	25	591	56	-	-	-	1	-	-	-	-	673
11	Water raised	262	5 361	373	4	28	-	13	77	15	1	1	42	6 177
12	Oxygen	33	258	175	8	90	10	2	12	79	28	4	110	810
13	Carbon dioxide	311	-	-	-	-	-	-	-	-	-	-	-	311
14	Other air components	-	1	-	-	-	-	-	-	-	-	-	-	1
15	*Totals*	*806*	*40 367*	*8 699*	*808*	*370*	*7 988*	*67*	*423*	*897*	*105*	*42*	*2 354*	*62 926*
16	*Domestic product outputs*	*251*	*6 961*	*1 361*	*540*	*99*	*0*	-	*17*	*36*	-	-	-	*9 266*
17	*Intermediate products*	*194*	*6 935*	*1 187*	*6*	*80*	*0*	-	*0*	*36*	-	-	-	*8 438*
18	*Gross capital formation*	*47*	-	*18*	*534*	*7*	-	-	*17*	-	-	-	-	*622*
19	*Exports*	*10*	*27*	*156*	*0*	*13*	-	-	-	-	-	-	-	*206*
20	*Residual outputs of throughput materials*	-	*32 386*	*5 346*	*113*	-	*3 500*	-	-	-	-	-	-	*41 345*
21	*Residual outputs for economic treatment or re-use*	*27*	*102*	*1 237*	*80*	*114*	*13*	*49*	*299*	*660*	*60*	*32*	*1 896*	*4 569*
22	Other residual outputs	527	918	755	75	157	4 475	18	107	201	45	10	459	7 746
23	Waste	253	18	116	58	20	44	0	2	3	0	0	27	541
24	Waste water	-	18	184	-	-	4 395	-	-	1	0	0	3	4 600
25	Water vaporised	13	606	283	8	54	22	15	93	126	20	6	321	1 567
26	Oxygen	226	-	-	-	-	-	-	-	-	-	-	-	226
27	Carbon dioxide	34	274	161	7	80	12	2	12	68	24	4	99	778
28	Other air emissions	2	2	11	1	4	1	0	0	3	1	0	9	34
29	*Totals*	*806*	*40 367*	*8 700*	*808*	*370*	*7 988*	*67*	*423*	*897*	*105*	*42*	*2 354*	*62 926*

Starting point for constructing a SAMIO is the total amount of hours available in one year to the different groups of population. It is easy to compile these data because the yearly time budget is fixed (8 760 hours per person, in leap years 8 736 hours). In row 14 and columns 1 to 3 of *table 5*, the available time of the three groups of population is recorded. These figures could be interpreted as the total supply of time.

The use of the time budget of the age groups is shown in the first three rows of *table 5*. Three different types of time use are distinguished:

- personal activities which are undertaken for own purposes only (columns 1 to 3),
- unpaid household production activities done not only for own purposes but also for other members of the same household or for members of other households (columns 4 to 6) and
- paid employment activities which aim at producing marketed or non-marketed products.

The figures of the first two mentioned categories were estimated using the data of the time budget survey 1991/92. In the case of employment, the totals are also recorded in the time budget survey. The disaggregation of hours worked according to the different types of final uses and the age groups can only be made by input-output analysis. The directly and indirectly necessary labour hours of the different socio-economic groups of the population to produce the different types of final uses can be estimated by the following equations:

(1) $T^{P}_{dom} = T_{SAM}\, B_{dom}\, Y_{dom}$ with

(2) $$T_{SAM} = \begin{pmatrix} t_1 \\ . \\ . \\ . \\ t_n \end{pmatrix} \qquad i = 1,\ldots,n$$

(3) $B_{dom} = (I - A_{dom} - D_{dom})^{-1}$

t_i	row vector of labour hour coefficients (including travelling time to the working place) of the socio-economic group i related to the monetary gross output by branch[22]
A_{dom}	coefficient matrix of (monetary) intermediate inputs of domestic products related to (monetary) gross output by product group and branch
D_{dom}	coefficient matrix of (monetary) consumption of fixed produced assets (domestic production) related to (monetary) gross output by investment good and branch
Y_{dom}	matrix of (monetary) final uses of domestic products by product group and category of final uses

[22] The time inputs of private activities are not taken into account. The row vector contains zeros for these branches.

Table 5: Social accounting matrix in time units based on input-outut analysis (SAMIO - T) 1990

Billions hours

Row No.	Uses / Supply	Employment			Personal activities Household production		Final consumption					Net fixed capital formation	Exports of products	Total uses
		Young persons	Adults (except aged persons)	Aged persons	Services within house-holds	Services between house-holds	Private con-sump-tion	Services of NPISH[1]	Edu-cation services	Health services	Other govern-ment services			
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	Young persons (until 17 years old)	97.7			2.5	0.1	0.7				0.1		0.1	101.2
2	Adults (excl. aged persons) (18 to 64 years old)		249.4		57.9	4.1	21.2	0.7	3.0	3.9	6.9	4.9	16.0	368.0
3	Aged persons (65 years and older)			66.1	16.7	1.0	0.9			0.1	0.1			84.9
4	Unpaid services within households	15.2	45.2	16.7										77.1
5	Unpaid services between households	1.3	2.1	1.8										5.2
6	Private consumption	2.7	16.7	3.4										22.8
7	Services of NPISH[1]	0.1	0.5	0.1										0.7
8	Education services	1.8	1.1	0.1										3.0
9	Health services	0.4	2.2	1.4										4.0
10	Other government services	1.3	4.7	1.1										7.1
11	Net fixed capital formation													0.0
12	Imports of products	1.4	8.2	1.8								1.9	5.6	18.9
13	Balances	- 20.7	37.9	- 7.6								- 6.8	- 2.8	0.0
14	*Total Supply*	101.2	368.0	84.9	77.1	5.2	22.8	0.7	3.0	4.0	7.1	0.0	18.9	
	Memorandum item: Population (1 000 persons)	11 551	42 006	9 693										63 250

It has to be mentioned that the labour hours necessary to produce investment goods are shown in *table 5* for net investment only. Labour hours directly and indirectly necessary for reproducing depreciated investment goods are associated with the other final uses (private consumption, government consumption, exports).

The breakdown of labour hours by age group and branch is part of a SAM module describing the paid working hours disaggregated according to different socio-demographic and socio-economic criteria (see the module time accounts (TA) in *table 1*). In the case of the chosen age groups, it was only necessary to distribute a few labour hours of young and aged persons among the different branches because their participation in paid employment is low. *Table 5* reveals the expected result that most of the hours spent for paid employment are associated with persons aged from 18 to 65 years.

The first three columns of *table 5* show the beneficiaries of the time spent. The three age groups of the population receive

- hours of personal activities from themselves (rows 1 to 3),
- hours of household production from themselves, from other members of the same household or from members of other households (rows 4 and 5) and
- hours of paid employment activities as far as they consume products which are directly or indirectly produced by these labour hours.

The distribution among the beneficiaries of the hours of household production activities could partly be compiled by the results of specific questions of the time budget survey. In several cases, the distribution could only be roughly estimated using suitable ratios of distribution (e.g. number of persons in the different types of household).

The distribution of the labour hours directly and indirectly necessary for producing consumption goods and services (row 6) for the different age groups of population could be estimated by using equation (4):

(4) $t^{u}_{dom} = t\ B_{dom}\ Y_{SAM}$ with

(5) $Y_{SAM} = (C_1 \ldots C_m\ inv'\ ex')$ and

$i = 1, \ldots, n$

(6) $t = \sum_{i=1}^{n} t_i$

Y_{dom} and Y_{SAM} are related in the following way:

(7) $Y_{dom} = (C\ inv'\ ex')$ with

$$(8)\ C = \sum_{i=1}^{n} C_i$$

C_i	matrix of (monetary) final consumption of the socio-economic group i by product group and category of final consumption
inv'	column vector of net fixed capital formation by product group
ex'	column vector of exports of goods and services by product group

According to equation (5), the disaggregation of final uses by socio-demographic/economic groups not only contains a breakdown of private consumption (as it is done in *table 2*) but is also extended to the consumption of non-profit institutions serving households (NPISH) and government consumption. For a comprehensive socio-economic analysis, the beneficiaries of non-market services should be identified. These services comprise parts of individual consumption which could be associated with specific groups of persons without greater difficulties and collective consumption which are provided simultaneously to all members of the community (see ESA, par. 3.83).

In our numerical example, private consumption (row 7) can be subdivided by 120 groups of persons in 32 types of households. For calculating *table 5*, the socio-economic classification was aggregated to the three age groups. The distribution of education services (row 8) among the age groups of pupils was relatively easy. In the input-output table used as data base, ten different types of institutions delivering education services were distinguished (from „kindergarten“ up to university)[23]. The distribution of the other services of government and of the non-profit institutions serving households among the age groups of population was estimated based on quota which were derived from different sources. In the case of health services (row 9), detailed data of the health insurance companies could be used. It should be mentioned that the health services only comprise the non-marketed part. Services directly paid by households are recorded as private consumption. As far as no special key was available, the final consumption items were distributed according to the number of persons in each age group.

The population is not only consuming domestic products but also imported goods and services. Thus, labour hours abroad are necessary to produce directly or indirectly the products which are delivered to the importing country. If no information on the input-output relations in countries producing import products were available, it seems acceptable to use the assumption of same input coefficients for producing domestic and imported products. The results could be interpreted as the opportunity costs of producing in the own country instead of importing these products.

The calculation of the labour hours directly and indirectly necessary to produce imported products abroad follows the following equation:

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[23] See Ewerhart 2001.

$$(9)\quad t_{imp} = t\ B\ A_{imp}\ B_{dom}\ Y_{SAM} + t\ B\ Y_{imp}$$

with

$$(10)\quad B = (I - A_{dom} - D_{dom} - A_{imp})^{-1}$$

A_{imp}	coefficient matrix of (monetary) intermediate inputs of imported products (including consumption of imported investment goods) related to (monetary) gross output by product group and branch
Y_{imp}	matrix of (monetary) final uses of imported products by product group and category of final uses

In equation (9) the first term on the right side comprises the labour hours directly and indirectly necessary to produce imported intermediate products (including also imported products for private consumption). The second term denotes the labour hours necessary for producing directly imported products for final uses which comprise investment goods and directly re-exported import products.

The indirectly imported labour hours which are associated with the three age groups of population (row 12 of *table 5*) only comprise hours necessary for producing imported intermediate inputs which are directly or indirectly used for the production of final consumption. Differing from the domestic production (see rows 6 to 10 of *table 5*), no breakdown by type of final consumption is shown in the table.

The data for (net) capital formation and exports (row 12, columns 11 and 12 of *table 5*) are an addition of the labour hours of intermediate imports indirectly necessary for producing these types of final uses and the labour hours necessary for the directly imported products of final uses.

The totals of all hours received by the different socio-economic groups could be interpreted as inputs of their welfare function. Young people benefitted from 122 billion hours, adults (except seniors) from 330 billion hours and aged people from 93 billion hours (rows 1 to 12, columns 1 to 3 of *table 5*). In comparison with the number of persons belonging to the age groups, young people receive 10 550 hours per head, adults (except aged persons) only 7860 and aged people 9540 hours per head. These figures could be compared with the annual hours of each person (8760).

In row 13 of *table 5*, the time delivered and the time received are balanced. This balancing procedure is shown for the different age groups of the population, for the foreign trade and for fixed capital formation.

In the case of the socio-economic groups, the balancing items reveal the social position of the respective group. Because of the great amount of their employment work and their unpaid household production, the adults (younger than 65 years) are delivering much more time than they are receiving. Apart from their personal time of 250 billion hours, they are spending 118 billion hours for work others are also benefitting from. On the other hand, they are only receiving 80 billion hours from others. Thus, they have a net spending of 38 billion hours.

In our highly aggregated example, the other two age groups are the beneficiaries. Young people are only spending less than 4 billion hours for others but are receiving nearly 25 billion hours: They have a „deficit“ of about 21 billion hours. This amount represents the investment of the society in the young generation.

In the case of aged persons, their „time account“ has also a negative balancing item (8 billion hours). Apart from their private time (66 billion hours), the time of their own social work amounts to 19 billion hours which especially contains hours of household work. On the other hand, they are receiving 27 billion hours which also contain the hours necessary for producing goods and services consumed by aged persons.

The society is not only investing in the young generation but also in extended production facilities. In our example, net capital formation has a positive amount (7 billion hours). This amount is balanced in row 13 of *table 5* by the corresponding negative item.

In the case of Germany, the foreign trade with products shows a surplus of exports in comparison with the imports (exports: 22 billion hours, imports: 19 billion hours). This surplus (3 billion hours) is balanced by the corresponding negative item in row 13 of *table 5* which is lastly delivered by the age group actively involved in economic production (18 to 65 years old).

3.3 SAMIO in monetary units

The SAMIO in time units also delivers the basic scheme for the SAMIO in monetary units. For socio-economic analysis, it seems to be preferable to apply specific concepts which do not automatically accept the dominance of economic monetary thinking. The time use data of the population could be used as a suitable starting point.

Starting point of the monetary SAMIO which is presented in *table 6* are the figures for net value added (including the value of household work) which are distributed among the three age groups of population according to their participation in the different production activities (row 14, columns 1 to 3). Differing from the SAMIO in time units, these values could only be determined by firstly estimating the uses of the monetary values (rows 1 to 3 in *table 6*).

The time used for personal activities (rows 1 to 3, columns 1 to 3) does not get a monetary value. The values of household work (rows 1 to 3, columns 4 and 5) are easily compiled by multiplying the figures of time use by a suitable wage rate. In the German case, the wage rate of a domestic servant (the so-called generalist) has been used. Of course, other types of valuation (e.g. the wage rates of specialists) could easily be introduced.

Similar to the procedure in the case of time units, the monetary values of the different final uses associated with the socio-economic groups as employed persons (rows 1 to 3, columns 6 to 12 of *table 6*) are estimated by linking net value added and final uses within an input-output model:

(11) $M^{P}_{dom} = NVA_{SAM}\, B_{dom}\, Y_{dom}$ with

(12) $NVA_{SAM} = \begin{pmatrix} nva_1 \\ \vdots \\ nva_n \end{pmatrix}$ $i = 1,...n$

nva_i	row coefficient vector of net value added produced by the employed persons of socio-economic group i related to the monetary gross output by branch (with zeros in the case of the branches of private activities)

Table 6: Social accounting matrix in monetary units based on input-outut analysis (SAMIO - M) 1990

Billions Deutsche Marks

Row No.	Uses / Supply	Employment			Final consumption							Net fixed capital formation	Exports of products	Total uses
		Young persons	Adults (except aged persons)	Aged persons	Services within households	Services between households	Private consumption	Services of NPISH[1]	Education services	Health services	Other government services			
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	Young persons (until 17 years old)	0			25.4	1.3	28.1				2.9		3.5	61.2
2	Adults (excl. aged persons) (18 to 64 years old)		0		598.8	46.0	846.9	17.1	97.8	117.6	195.2	164.5	556.3	2 640.2
3	Aged persons (65 years and older)			0	170.7	10.9	37.2			3.9	2.8			225.5
4	Unpaid services within households	158.8	465.4	170.7										794.9
5	Unpaid services between households	14.5	23.8	19.9										58.2
6	Private consumption	108.5	666.0	137.7										912.2
7	Services of NPISH[1]	3.1	11.4	2.6										17.1
8	Education services	61.8	35.0	1.0										97.8
9	Health services	11.8	67.5	42.2										121.5
10	Other government services	36.7	133.4	30.8										200.9
11	Net fixed capital formation													0.0
12	Imports of products	49.2	270.8	58.3								67.1	203.6	649.0
13	Balances	- 383.2	966.9	- 237.7								- 231.6	- 114.4	0.0
14	*Total Supply*	61.2	2 640.2	225.5	794.9	58.2	912.2	17.1	97.8	121.5	200.9	0.0	649.0	
	Memorandum item: Population (1 000 persons)	11 551	42 006	9 693										63 250

In our example, the contribution of the employed persons of the different socio-economic groups to the production of the branch where they are employed is estimated using the ratios of distribution of the labour hours of the employed persons. Of course, other quota could also be applied.

In the rows 4 and 5 of *table 6* the valued hours of household production are distributed among the age groups benefitting from these services. Because of the unique type of monetarization (only „generalists“), the quota of the age groups are very similar to those of *table 5*.

In the rows 6 to 10 of *table 6*, the net value added associated with the final uses is distributed among the beneficiaries of these products. The compilation method corresponds with the procedure already described in equation (4):

(13) $m^{u}_{dom} = nva\ B_{dom}\ Y_{SAM}$ with

(14) $nva = \sum_{i=1}^{n} nva_i$

The monetary values of imported products are linked with the final consumption of the age groups of population, with net capital formation and with exports in row 12 of *table 6*. In this case, it is not necessary to take into account the production facilities abroad. The imported values are directly associated with the final uses by the following equation (15):

(15) $m^{u}_{imp} = (1...1)\,(A_{imp}\ B_{dom}\ Y_{SAM} + Y_{imp})$

The total monetary values received by the different socio-economic groups (rows 1 to 12, columns 1 to 3 of *table 6*) could be interpreted as a monetary contribution to their welfare functions. The young persons receive 444 billion Deutsche Mark (38 480 DM per head), the adults (except seniors) 1 673 billion Deutsche Mark (39 830 DM per head) and the aged persons 464 billion Deutsche Mark (47 790 DM per head). In the case of young people, the high costs of education within and outside the households are strongly influencing the result. In the case of aged persons, the high amount of care within the households and the high health expenditures are determining the level of total costs.

The balancing items shown in row 13 of *table 6* could be interpreted in the same way as already done in the case of time units. The adults (with age from 18 to 65 years) deliver values of 967 billion Deutsche Mark to the other two age groups (383 and 238 billion Deutsche Mark respectively), to future economic activities (net investment: 232 billion Deutsche Mark) and to other countries (export surplus: 114 billion Deutsche Mark).
The description of the compilation methods may have revealed already the close linkages between the SAMIOs in time and monetary units. Apart from the time used for personal activities (rows 1 to 3, columns 1 to 3), monetary and time data could also be interpreted simultaneously: The time data represent the direct and

indirect time inputs to produce the monetary values. On the other side, the monetary data can be interpreted as the values given to the time received or spent by the different groups of population.

3.4 SAMIO in physical units

Comprehensive studies on possibilities to achieve paths of sustainable development imply an integrated social, economic and environmental analysis. Very similar to the concepts applied in SESAME, data on natural resources and residuals could be linked with the social and economic information given in SAMIO.

These linkages are based on the complete material balances which have already been described (see *table 4*) and the consistent presentation of physical flows in physical input-output tables presented in the context of the „magic triangle".[24] Differing from the approach chosen in these tables, only specific physical flows which belong either to the primary inputs or to the final uses, are chosen for further analysis. These physical flows comprise natural resources which are used as intermediate inputs of economic activities and residuals which are leaving the economic circuit and are stored in controlled landfills (e.g. waste) or disposed again into the nature (e.g. air emissions or treated waste water). In *table 4*, these physical flows have already been indicated.

Apart from the mentioned flows of natural resources and residuals, specific physical product inputs and outputs could be taken into account: Imported intermediate inputs are part of the primary inputs, investment goods and exports of goods are part of the final uses in physical accounting. Nevertheless, these physical flows were excluded because they are represented in the SAMIO by the natural resources directly or indirectly necessary to produce them. This treatment does not exclude a supplementary analysis of these flows in the context of balancing transboundary flows or accounting the changes of physical assets. For such studies, the figures of *table 4* deliver a suitable data base.

The physical flows are associated with the activities of the different age groups of population in the *tables 7a and 7b*. *Table 7a* shows the use of natural resources, *table 7b* the mentioned residuals flows.

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[24] See Stahmer 2000, pp. 145 - 147.

Table 7: Social accounting matrix in physical units based on input-outut analysis (SAMIO - P) 1990

a) Natural resource inputs - Million tons

Row No.	Uses / Supply	Employment			Final consumption								Net fixed capital formation	Exports of products	Total uses
		Young persons	Adults (except aged persons)	Aged persons	Services within households	Services between households	Private consumption	Services of NPISH[1]	Education services	Health services	Other government services				
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)		(11)	(12)	(13)
1	Young persons (until 17 years old)	17			3	0	137				7			12	176
2	Adults (excl. aged persons) (18 to 64 years old)		143		66	6	4 119	37	175	240	496		535	1 930	7 747
3	Aged persons (65 years and older)			26	20	0	181			8	7				242
4	Unpaid services within households	18	57	14											89
5	Unpaid services between households	1	2	3											6
6	Private consumption	537	3 222	678											4 437
7	Services of NPISH[1]	7	24	6											37
8	Education services	108	64	3											175
9	Health services	24	138	86											248
10	Other government services	93	339	78											510
11	Net fixed capital formation														
12	Imports of products	264	1 464	314									280	1 033	3 355
13	Balances	- 893	2 294	- 966									- 815	380	0
14	*Total Supply*	176	7 747	242	89	6	4 437	37	175	248	510		0	3 344	
	Memorandum item: Population (1 000 persons)	11 551	42 006	9 693											63 250

Table 7: Social accounting matrix in physical units based on input-outut analysis (SAMIO - P) 1990

b) Residual outputs - Million tons

Row No.	Uses / Supply	Employment			Final consumption							Net fixed capital formation	Exports of products	Total uses
		Young persons	Adults (except aged persons)	Aged persons	Services within households	Services between households	Private consumption	Services of NPISH[1]	Education services	Health services	Other government services			
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	Young persons (until 17 years old)	48			38	1	140				6		9	242
2	Adults (excl. aged persons) (18 to 64 years old)		390		124	3	4 226	18	159	155	391	267	1 463	7 196
3	Aged persons (65 years and older)			76	28	7	186			5	6			308
4	Unpaid services within households	38	124	28										190
5	Unpaid services between households	1	3	7										11
6	Private consumption	554	3 303	695										4 552
7	Services of NPISH[1]	3	12	3										18
8	Education services	99	58	2										159
9	Health services	15	89	56										160
10	Other government services	73	268	62										403
11	Net fixed capital formation													
12	Imports of products	184	1 020	222								198	771	2 395
13	Balances	- 773	1 929	- 843								- 465	152	0
14	*Total Supply*	242	7 196	308	190	11	4 552	18	159	160	403	0	2 395	
	Memorandum item: Population (1 000 persons)	11 551	42 006	9 693										63 250

The input-output models used for estimating these linkages correspond with the models already described in section 3.2 (SAMIO in time units). For calculating the physical flows connected with the groups of population as producers, the following equation can be used:

$$(16) \quad P^{p}_{dom} = \begin{pmatrix} NR_{SAM} \\ RS_{SAM} \end{pmatrix} B_{dom}\ Y_{dom}$$

with

$$(17) \quad NR_{SAM} = \begin{pmatrix} NR_1 \\ \vdots \\ NR_n \end{pmatrix} \qquad i = 1,...,n$$

and

$$(18) \quad RS_{SAM} = \begin{pmatrix} RS_1 \\ \vdots \\ RS_n \end{pmatrix} \qquad i = 1,...,n$$

NR_i	coefficient matrix of physical inputs of domestic natural resources used by the socio economic group i related to (monetary) gross output by type of natural resources and branch
RS_i	coefficient matrix of residuals produced by the socio-economic group i related to (monetary) gross output by type of residuals and branch

Differing from the distribution of time units among the different socio-economic groups, complete matrices of natural resource inputs and residual outputs have to be estimated for each socio-economic group. In our numerical example, the calculation of the distribution of the physical flows among the socio-economic groups as producers is based on very simple assumptions (e.g. quota of labour hours by branch). In the case of private activities, two types of environmental impacts have to be distinguished: Impacts of producing the intermediate inputs of private activities and impacts of the production processes of the private activities themselves. In the first case, households are only indirectly responsible for, in the second case they are immediately producing residuals and using natural resources. In *table 7a/b*, the direct environmental impacts are shown in the rows 1 to 3 of the columns 1 to 5, the indirect impacts which are connected with employment work, are recorded in the rows 1 to 3 of column 6. For achieving this breakdown, submatrices of NR_{SAM} and RS_{SAM} were used which only contain data on the activities which are intended to be shown separately.

A similar procedure was necessary in the case of identifying the environmental impacts of the socio-economic groups as users. The basic equation has been

$$(19) \quad M^{U}_{dom} = \begin{pmatrix} NR \\ RS \end{pmatrix} B_{dom}\ Y_{SAM}$$

with

$$(20) \quad NR = \sum_{i-1}^{n} NR_i \quad \text{and}$$

$$(21) \quad RS = \sum_{i-1}^{n} RS_i$$

For separating the direct from the indirect environmental impacts of private activities, submatrices of NR and RS were necessary. The rows 1 to 5 of columns 1 to 3 of *table 7a/b* show the direct impacts connected with private activities, row 6 of columns 1 to 3 the indirect impacts of private consumption. The rows 7 to 10 of columns 1 to 3 show the environmental impacts of the other final consumption distributed among the age groups of the population as users.

The SAMIO in physical units not only describes the domestic physical flows but also the use of natural resources and the production of residuals abroad which is connected with the production of imported goods and services. In studies of the Wuppertal Institute, these flows are indicated as „rucksacks“ of the domestic production. Detailed analysis is necessary for estimating these rucksacks in a suitable manner. For simplifying the compilation procedure, the presented example is based on the assumption that the production processes in the own country and abroad are identical. Following this simple approach, equation (22) could be applied:

$$(22) \quad M_{imp}^{U} = \begin{pmatrix} NR \\ RS \end{pmatrix} B\, A_{imp}\, B_{dom}\, Y_{SAM} + \begin{pmatrix} NR \\ RS \end{pmatrix} B\, Y_{imp}$$

The results of this calculation of the uses of natural resources are shown in row 12 of *table 7a*. The data on the production of residuals linked with the socio-economic groups, the net investment and the exports are presented in row 12 of *table 7b*.

In the *tables 8a* and *b*, the information on natural resources and residuals is shown in a breakdown by different types of materials using a simplified version of the *tables 7a* and *7b*. Such differentiation is especially necessary to separate the huge amounts of water raised and waste water from the other flows. Furthermore, detailed information on specific natural resources and emissions is necessary for further analysis of environmental themes as it is proposed in the NAMEA framework mentioned.

The flows of natural resources and residuals are recorded as flows between the domestic economy and the natural environment of the own country and of the rest of the world. The totals of the rows 9 and 11 of the columns 1 to 3 in *table 8a* correspond with the totals of the rows 1 to 10 and 12 respectively of the columns 1 to 3 in *table 7a*. In the same way, the totals of the rows 10 and 12 of the columns 1 to 3 in *table 8b* could be found as totals of the rows 1 to 10 and 12 respectively of the columns 1 to 3 in *table 7b*.

The balances of natural resources and residuals are shown in row 13 of the *tables 7a* and *table 7b* respectively. In the case of physical flows, the imports play a more important role than the exports. Thus, the balance of exports and imports shows a surplus of foreign natural resources (380 million tons) and of foreign residuals (152 million tons).

3.5 Outlook

The concepts of SAMIO presented could only provide a starting point for further discussions. One field of research could be the integration of such data with econometric and general equilibrium models.[25] Furthermore, it could be analysed to which extent such tables could be applied for welfare analysis.

Nevertheless, future work has to focus on an improvement of the data base available. The implementation of the SESAME concepts in an increasing number of countries is an important and encouraging step towards this aim. A closer cooperation of the „input-output people“ with the statisticians calculating SAM modules will be a further precondition for future progress.

[25] See Frohn 2001 and 2002.

Table 8: Social accounting matrix in physical units based on input-outut analysis (SAMIO - P) 1990

a) Natural resource inputs by type of resource - Million tones

Row No.	Uses / Supply	Personal activities	Household production	Employment		Demostic environment	Exports of								Total uses
		Young persons	Adults (except aged persons)	Aged persons	Services within house-holds	Services between house-holds	Final con-sump-tion	Net fixed capital forma-tion	Exports of products	Natural re-sources	Resid-uals	Natural re-sources	Resid-uals	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	Young persons									176				176
2	Adults (excl. aged persons)									7 747				7 747
3	Aged persons									242				242
4	Services within households													
5	Services between househ.													
6	Final consumption													
7	Net fixed cpaital formation													
8	Exports of products													
9	Domestic natural resources	805	3 989	894				535				1 942		8 165
	Energy carriers	*15*	*73*	*16*				*3*				*87*		*194*
	Other solid materials	*43*	*195*	*44*				*214*				*176*		*672*
	Water raised	*641*	*3 170*	*714*				*272*				*1 380*		*6 177*
	Oxygen	*77*	*396*	*86*				*37*				*212*		*808*
	Carbon dioxide	*29*	*154*	*34*				*9*				*86*		*312*
	Other air components	*0*	*1*	*0*				*0*				*1*		*2*
10	Domestic residuals													
11	Foreign natural resources	264	1 464	314				280				1 033		3 355
	Energy carriers	*27*	*145*	*30*				*20*				*102*		*324*
	Other solid materials	*20*	*102*	*22*				*50*				*135*		*329*
	Water raised	*163*	*922*	*199*				*172*				*632*		*2 088*
	Oxygen	*24*	*130*	*28*				*29*				*109*		*320*
	Carbon dioxide	*30*	*164*	*35*				*9*				*54*		*292*
	Other air components	*0*	*1*	*0*				*0*				*1*		*2*
12	Foreign residuals													
13	Balances	- 893	2 294	- 966				- 815				380		0
14	Total supply	176	7 747	242				0		8 165		3 355		

Table 8: Social accounting matrix in physical units based on input-outut analysis (SAMIO - P) 1990

b) Residual outputs by typ of residuals - Million tones

Row No.	Uses / Personal activities / Household production / Employment / Demostic environment / Exports of / Supply	Young persons	Adults (except aged persons)	Aged persons	Services within house-holds	Services between house-holds	Final con-sump-tion	Net fixed capital forma-tion	Exports of products	Natural re-sources	Resid-uals	Natural re-sources	Resid-uals	Total uses
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	Young persons										242			242
2	Adults (excl. aged persons)										7 196			7 196
3	Aged persons										308			308
4	Services within households													
5	Services between househ.													
6	Final consumption													
7	Net fixed cpaital formation													
8	Exports of products													
9	Domestic natural resources													
10	Domestic residuals	831	4 247	929				267					1 472	7 746
	Waste	*46*	*243*	*53*				*48*					*152*	*542*
	Waste water	*523*	*2 677*	*583*				*115*					*702*	*4 600*
	Water vaporized	*164*	*821*	*184*				*59*					*338*	*1 566*
	Oxygen	*21*	*112*	*24*				*6*					*62*	*225*
	Carbon dioxide	*74*	*378*	*82*				*37*					*208*	*779*
	Other air emissions	3	16	3				2					10	*34*
11	Foreign natural resources													
12	Foreign residuals	184	1 020	222				198					771	2 395
	Waste	*33*	*183*	*40*				*20*					*90*	*366*
	Waste water	*69*	*388*	*85*				*90*					*345*	*977*
	Water vaporized	*37*	*201*	*44*				*51*					*187*	*520*
	Oxygen	*21*	*119*	*26*				*7*					*40*	*213*
	Carbon dioxide	*23*	*123*	*26*				*29*					*104*	*305*
	Other air emissions	1	6	1				1					5	*14*
13	Balances	- 773	1 929	- 843				- 465					152	0
14	Total supply	242	7 196	308							7 746		2 395	

References

Becker, Gary S. (1964): *Human Capital*, Columbia University Press: New York, London

Becker, Gary S. (1965): A Theory of the Allocation of Time, in *Economic Journal*, Vol. 75, pp. 493 – 517

Commission of the European Communities - Eurostat, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations, World Bank (1993): *System of National Accounts 1993*, Brussels/Luxemburg/ New York/Paris/Washington, D.C.

Eurostat (1995): *European System of Accounts - ESA 1995*, Luxembourg

Eurostat (2002): Draft Handbook on Social Accounting Matrices and Labour Accounts, preliminary version presented at the Voorburg Seminar, 17 - 18 June, Luxemburg

Ewerhart, Georg (2001): *Humankapital in Deutschland - Bildungsinvestitionen, Bildungsvermögen und Abschreibungen auf Bildung*, Beiträge zur Arbeitsmarkt- und Berufsforschung, No. 247, Bundesanstalt für Arbeit: Nürnberg

Frohn, Joachim (2001): Ökonometrische Modelle zur Analyse von Umweltstrategien, in Susanne Hartard, Carsten Stahmer (eds.), *Bewertung von Nachhaltigkeitsstrategien*, Metropolis: Marburg, pp. 139 – 158

Frohn, Joachim (2002): Zur Erweiterung von ökonometrischen Umweltmodellen um soziale Komponenten, in Susanne Hartard, Carsten Stahmer (eds.), *Magische Dreiecke - Berichte für eine nachhaltige Gesellschaft*, Band 3: *Sozio-ökonomische Berichtssysteme*, Metropolis: Marburg

Horz, Kurt, Utz-Peter Reich (1982): Dividing Government Product between Intermediate and Final Uses, in *Review of Income and Wealth*, Series 28, No. 3, pp. 325 – 343

Hill, Peter (1995): Richard Stone's Contribution to National Accounting, in Annali di Statistica, Series X, vol. 6: *Social Statistics, National Accounts and Economic Analysis*, International Conference in Memory of Sir Richard Stone, Certosa di Pontignano, Siena, October 1993, pp. 23 – 30

Kazemier, Brugt and Jeanet Exel (1992): *The Allocation of Time in the Netherlands in the Context of the SNA; A Module*, Netherlands Central Bureau of Statistics, National accounts, occasional paper, NA-052

Keuning, Steven J. (1991): Proposal for a Social Accounting Matrix which fits into the Next System of National Accounts, in *Economic Systems Research*, Volume 3, Number 3, pp. 233 – 248

Keuning, Steven J. (2000): Accounting for Welfare with SESAME, in: United Nations, *Handbook of National Accounting, Household Accounting: Experience in Concepts and Compilation, Volume 2: Household Satellite Extensions*, Studies in Methods, Series F, No. 75, New York, pp. 273 – 307

Keuning, Steven J. and Willem A. de Ruijter (1988): Guidelines to the Construction of a Social Accounting Matrix, in *Review of Income and Wealth*, Series 34, Number 1, March, pp. 71 – 100

Lancaster, Kelvin (1966): A New Approach to Consumer Theory, in *Journal of Political Economy*, Vol. 74, pp. 132 – 157

Lützel, Heinrich (1989): Household Production and National Accounts, in *Statistical Journal of the United Nations ECE*, Vol. 6, No. 4, pp. 337 – 348

Pyatt, Graham (1985): Commodity Balances and National Accounts - A SAM Perspective, in *Review of Income and Wealth*, Series 31, No. 2, pp. 155 – 169

Pyatt, Graham (1990): Accounting for Time Use, in *Review of Income and Wealth*, Series 36, No. 1, pp. 33 – 52

Pyatt, Graham (1991a): Fundamentals of Social Accounting, in *Economic Systems Research*, Volume 3, Number 3, pp. 315 – 341

Pyatt, Graham (1991b): SAMs, the SNA and National Accounting Capabilities, in *Review of Income and Wealth*, Series 37, No. 2, June, pp. 177 – 198

Pyatt, Graham (1999): Some Relationships between T-Accounts, Input-Output Tables and Social Accounting Matrices, in *Economic Systems Research*, Vol. 11, Number 4, December, pp. 365 – 389

Pyatt, Graham, Alan R. Roe and associates (1977): *Social Accounting Matrices for Development Planning: With Special Reference to Sri Lanka*, Cambridge University Press: Cambridge

Pyatt, Graham and Jeffery I. Round (eds.) (1985): *Social Accounting Matrices, A Basis for Planning*, A World Bank Symposium, Washington, D.C.

Reich, Utz-Peter (1986): Treatment of Government Activity on the Production Account, in *Review of Income and Wealth*, Series 32, No. 1, pp. 69 – 85

Reich, Utz-Peter, Philipp Sonntag and Hans-Werner Holub (1977): Arbeit - Konsum -Rechnung, Axiomatische Kritik und Erweiterung der Volkswirtschaftlichen Gesamtrechnung, Bund: Köln

Schäfer, Dieter and Norbert Schwarz (1995): *The Value of Household Production in the Federal Republic of Germany 1992*, 30 pages, unpublished paper

Scherhorn, Gerhard (2002): Zur Messung des Wohlstands, in Susanne Hartard, Carsten Stahmer (eds.), *Magische Dreiecke - Berichte für eine nachhaltige Gesellschaft*, Band 3: *Sozio-ökonomische Berichtssysteme*, Metropolis: Marburg

Stahmer, Carsten (2000): The Magic Triangle of Input-Output Tables, in: Sandrine Simon and John Proops (eds.), *Greening the Accounts*, Edward Elgar: Cheltenham, UK, Northampton, MA, USA, pp. 123 - 154

Stahmer, Carsten (2002): Das Unbekannte Meisterwerk – Sir Richard Stone und sein System of Social and Demographic Statistics, in Susanne Hartard, Carsten Stahmer (eds.), *Magische Dreiecke - Berichte für eine nachhaltige Gesellschaft*, Band 3: *Sozio-ökonomische Berichtssysteme*, Metropolis: Marburg

Stahmer, Carsten, Georg Ewerhart, Inge Herrchen (2002): Monetäre, Physische und Zeit-Input-Output-Tabellen 1990, Metzler-Poeschel: Stuttgart

Stone, Richard (1949): Social Accounting, Aggregation and Invariance, in *Cahiers du Congrès International de Comptabilité, 1948*, French translation: Economie Appliquée, vol. II, no. 1, pp. 26 – 54

Stone, Richard (1951-52): Simple Transaction Models, Information and Computing, paper presented at a conference on Automatic Control, Cranfield, 1951, in *The Review of Economic Studies*, Vol. XIX, no. 2, pp. 67 – 84

Stone, Richard (1955a): Model-Building and the Social Accounts: A Survey, in International Association for Research in Income and Wealth (ed.), *Income and Wealth*, Series IV, Bowes and Bowes: Cambridge

Stone, Richard (1955b): Input-Output and the Social Accounts, in University of Pisa (ed.), *The Structural Interdependence of the Economy, Proceedings of an International Conference on Input-Output Analysis*, Varenna, J. Wiley: New York, Giuffre: Milan, pp. 155 – 172

Stone, Richard (1961): *Input-Output and National Accounts*, OEEC, Paris

Stone, Richard (1962a): Multiple Classifications in Social Accounting, in *Bulletin of the International Statistical Institute*, Volume XXXIX, No. 3, pp. 215 - 233, reprint: University of Cambridge, Department of Applied Economics, Reprint Series, No. 220, 1964

Stone, Richard (1962b): A Social Accounting Matrix for 1960 (with Alan Brown and others), in *A Programme for Growth*, No. 2, Chapman and Hall: London

Stone, Richard (1979): *Where are we now? A Short Account of the Development of Input-Output Studies and their Present Trends*, paper presented at the 7th International Conference on Input-Output Techniques, Innsbruck, April

Stone, Richard (1981a): *Aspects of Economic and Social Modelling*, Librairie Droz: Genève

Stone, Richard (1981b): Input-Output-Analysis and Economic Planning: A Survey, presented June 1978, in *Mathematical Programming and its Applications*, Angeli: Milan

Stone, Richard (1985): The disaggregation of the Household Sector in the National Accounts, in Graham Pyatt and Jeffery I. Round (eds.), *Social Accounting Matrices, A Basis for Planning*, The World Bank, Washington, D.C., pp. 145 - 185

Stone, Richard and Giovanna Croft-Murray (1959): *Social Accounting and Economic Models*, Bowes & Bowes: London

Strassert, Günther, Carsten Stahmer (2002): Sachkapital und Physische Input-Output-Rechnung, in Susanne Hartard, Carsten Stahmer (eds.), *Magische Dreiecke - Berichte für eine nachhaltige Gesellschaft*, Band 3: *Sozio-ökonomische Berichtssysteme*, Metropolis: Marburg

Timmerman, Jolanda and Peter van de Ven (2000): The SAM and SESAME in the Netherlands. A Modular Approach, in: *United Nations, Handbook of National Accounting. Experience in Concepts and Compilation, Volume 2: Household Satellite Extensions*, Studies in Methods, Series F, No. 75, New York, pp. 309 - 354

United Nations (1968): *A System of National Accounts*, Studies in Methods, Series F, No. 2, Rev. 3, New York