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THE MAGIC TRIANGLE OF I-O TABLES

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CONTENTS

1. INTRODUCTION

The discussion on sustainable development has focussed on three dimensions of the problem: A successful strategy has to integrate social, environmental as well as economic aspects of sustainability. Such an approach can be symbolized by a triangle with the three dimensions of sustainability as corners. The meeting point of economists, environmentalists and social scientists has to be found in a process of stepwise bargaining and compromising in the central area of this triangle. Each specialist has to leave his corner to consider other opinions and to find a common strategy for achieving sustainability. It was Wassily Leontief who demanded such attitude and whose work represents an excellent example of life-long crossing scientific borderlines (see Polenske 1999 and Kurz et al. 1998).

Input-output tables (I-O tables) can play an important role in delivering a suitable data base for studying sustainable development. Wassily Leontief gave many examples how I-O tables can be used not only for economic analysis, but also for ecological and social studies (cf. Leontief 1928, 1951, 1973 and 1982). Experience during the last years has shown that it might be useful to use input-output tables with differing units of presentation to facilitate special studies on different aspects of sustainability:

- I-O tables in monetary units are especially useful for analysing economic problems,
- I-O tables in physical units (tonnes etc.) could be used for ecological studies,
- I-O tables in time units might serve as a data base for social studies.

From my point of view, a comprehensive analysis of sustainability can only be successful if all three types of I-O tables are used separately as well as in combination. In the following, a detailed description of the advantages and disadvantages of the three types of units for presenting I-O data will be given. As an example, comparable I-O tables using the above mentioned different types of units are shown describing the German economy in the year 1990.

2. GENERAL CONCEPTUAL CONSIDERATIONS

Two concepts of the production boundary of an economy are distinguished in the System of National Accounts (SNA): the traditional approach which mainly includes production for other economic units and a broader concept, also taking into account that part of household production which could be done by third parties (SNA, 1993; par. 6.14 - 6.36).

2.1 Beyond the Narrow Concept of Production

These concepts seem to be too narrow for analyzing social, economic and environmental problems in a comprehensive way. For describing the social dimension of sustainability, all activities of the population have to be considered. On the average of the whole population including all ages from babies up to retired persons, employment activities comprise only two of the twenty-four hours per day, whereas all other activities are normally neglected in traditional economic analysis.

It was shown in the sixties that a useful general activity analysis can be introduced which interprets all household activities as the production of services (Becker, 1964; Lancaster, 1966). Such a concept is useful for social as well as for environmental studies. Households are producing not only goods (services) but also ‘bads’, such as wastes and air pollutants.

According to such a comprehensive activity concept, the production boundary as well as the corresponding concept of capital, have to be extended. All purchases of consumer durables become part of capital formation, and the depreciation of these goods is part of household costs.

2.2 Beyond the Economic Concept of Transactions

In national accounting, the description of transactions focusses on transactions which are actually carried out in monetary units. In special cases such as barter transactions, non-monetary transactions are valued using comparable market values (SNA, 1993; par. 3.34 - 3.49).

Such an approach cannot be sufficient if a comprehensive activity analysis is aimed at. The physical flows of materials from nature to the economy have to be described, as well as all transformation processes within the economy and the material flows back to nature. In the traditional framework, only about a twelfth of the material flows are valued in monetary units, while all other transactions are neglected.

Furthermore, even all service flows within the household sector are not taken into account. The following paragraphs will discuss the possibility of extending this narrow economic concept of transactions, to achieve a comprehensive database for sustainability studies.

2.3 Limits of Monetarization

In the nineteen sixties and seventies, many economists hoped to describe economic activities in a comprehensive way using the concept of economic welfare (Nordhaus and Tobin, 1972; NNW Measurement Committee, 1973; Uno, 1995; Diefenbacher, 1995; Reich and Stahmer, 1993). The measure of economic welfare not only included the traditional economic transactions, but also a comprehensive valuation of all household activities, as well as of the environmental costs of economic activities.

Further stimulation for comprehensive monetarization was given in the nineteen eighties by the discussions on environmentally adjusted gross domestic product. The aim of these approaches was to calculate a sustainable level of economic activity. Different versions of this measure were presented in the System for Integrating Environmental and Economic Accounting (SEEA) of the United Nations (United Nations, 1993; van Dieren, 1995) The concepts discussed revealed fundamental differences in comparison to the welfare measures presented in the seventies. The aim of economic activities cannot only be defined as the maximization of present welfare of the own population but rather as a path of development which takes into account the welfare in other countries and the needs of future generations too. It was *A Long Goodbye* (Raymond Chandler) to the dream of overall welfare measurement (Radermacher and Stahmer, 1996).

The debate on possibilities of calculating a sustainable level of economic activities has also shown that an approach dealing with sustainability in a national accounting framework has severe drawbacks. Sustainability paths could often be only reached after a longer period of adjusting economic processes. Thus, modelling of future scenarios seems to be unavoidable, which cannot be adequately reflected in the backward-oriented national accounting system. Furthermore, the international interrelationships, especially the global impacts of economic activities and the indirect environmental impacts of imported goods and services abroad, have to be taken into account (Ewerhart and Stahmer, 1998; Radermacher, 1999). Proops (1991) made a good point in his comments to the World Bank on the SEEA when he proposed the used of the term ‘global modelling’ instead of ‘national accounting’.

Considering this discussion, national accountants may arrive at a more modest approach of additional monetarization. In any case, it seems to be useful to value those non-monetary flows which might have similarities to market transactions and, thus, could be monetarized by using comparable market values. Examples of such imputations are estimates at market values for the flows of natural resources from nature to the economy, and for the services provided by households as far as they could also be delivered by

third persons. This concept is described as version V.1 in the SEEA (United Nations, 1993, pp. 124 - 128;. Stahmer, 1995).

Of course, such a limited concept of imputed monetary values cannot be sufficient for an extensive description of the social, environmental and economic dimensions of human activities. Household activities not following the third-person criterion, as well as the impacts of economic activities on the natural environment (like climatic changes), cannot adequately be analyzed. In the following paragraphs, some other types of input-output tables are discussed which might play a complementary role.

2.4 Uses of Physical Accounting

A complete description of the interactions between nature and human beings can only be given by using physical units, such as tonnes, joules, etc. Such physical accounting can show the material flows from nature to the economy, the different steps of transformation within the economy and, finally, the material flows back to nature. Physical accounting also allows consistent balancing of all metabolic processes of living beings, such as plants, animals and human beings. A concept for treating human beings as an integral part of nature seems to be urgently needed (Ayres and Simonis, 1994; Strassert, 1993, 1998; de Boer et al. 1996).

These considerations have already led to physical accounting as an integral part of the SEEA (United Nations, 1993, part III). Similar concepts have been used to compile physical input-output tables in Germany, Denmark and Italy (Stahmer et al., 1997; Gravgard, 1998; Nebbia, 1999; de Boer et al., 1996). In the case of the German physical input-output tables, units of weight (tonnes) have been used supplemented by a description of energy flows in thermal values (joule).

The physical I-O tables also shows physical changes connected with household activities. Of course, these physical processes are mainly transformations of goods into residuals which are stored, treated or disposed of into nature.

The difficulty of taking into account qualitative aspects of material flows is a severe disadvantage of physical accounting. Poisonous and innocuous materials are ‘valued’ only by their weights, but not according to their impacts, e.g. on living beings. Such analysis has to be made in a second step, using suitable weighting schemes. Nevertheless, consistent material balances of all metabolic processes in units of weight are indispensable as a database for all further studies of the physical world.

Another shortcoming of physical accounting is the insufficient description of the production of services. These activities have an increasing importance in all countries. Hence, additional information on services has to be given by I-O tables in other units, e.g. in monetary units or units of time.

2.5 Uses of Time Accounting

It is an old dream of economic science to describe economic activities by using non-monetary units. It has been discussed over and over again whether it is possible to break through the appearance of revealed monetary values and to discover the hidden mystery of the substance of economic production (Reich, 1981, 1989).

In classical economic science, such analysis was carried out by using the necessary labour time for producing goods and services as indicator of their true values (cf. Wolfstetter 1973, Fleissner 1991, 1993). Unfortunately, this approach again raises problems. In which way should skilled labour be weighted in comparison to simple work? Could the contribution of machines, buildings, etc., for producing goods and services be neglected?

These problems could only be solved by introducing the concept of the ‘frozen’ labour time used for producing education services as well as investment goods in the past. Such labour time ‘melts’ in the described present when skilled labour or fixed capital goods are used. Following this concept, depreciation of both education (human) capital and fixed assets can be calculated in time units [cf. Austrian capital theory: Böhm-Bawerk (1889/91), Faber and Proops (1990, especially Chapter 3)]. In this case, the time of skilled labour is composed of both the actual working hours and the depreciation of the accumulated hours of educational services necessary to achieve the respective level of labour (cf. Schultz 1961, 1962; Becker 1964; Bos 1996; Keuning 1998 and OECD 1998).

The transformation of monetary values into time values has to take into account not only direct inputs of working time, but also the labour inputs on preceding stages of production. Such analysis can only be done by using input-output models (cf. Staeglin/Pischler 1976, Flaschel 1980, Engelbrecht 1996). The time directly and indirectly necessary to produce goods and services can be calculated in the following way (Ewerhart and Stahmer, 1999):

(1) $\mathbf{p} = \mathbf{s}(\mathbf{I} - \mathbf{A} - \mathbf{D})^{-1}$

Here:

p - total labour 'cost' of production (vector)

s - coefficients of direct labour inputs (related to gross output) (vector)

A - coefficients of intermediate inputs including imported intermediate products (related to gross output) (matrix)

D - coefficients of depreciation by investment good and branch (related to gross output) (matrix)

The Leontief-inverse coefficients in formula (1) also include the coefficients of depreciation **D**. This extension of the normally used inverse coefficients allows an endogenization of the use of capital goods (including the depreciation of human capital). Thus, the time values of products comprise both current and capital costs. [For an extensive introduction to input-output analysis, see Miller and Blair (1985)].

As already discussed in Section 2.1, a suitable concept of economic activities would comprise all human activities (cf. Pyatt 1990, Aulin-Ahmavaara 1991, Kazemier/Exel 1992, Fontela 1994, Stahmer 1995, Franz 1998. Cf. also Becker 1965, Lancaster 1966 and Brody 1970). According to this approach, the inputs of time contain not only the labour hours of occupied persons but also the 24 hours day of the whole population. Such comprehensive description of all activities in an input-output framework has been completed for Germany in spring 1999 (Ewerhart and Stahmer, 1999; Aslaksen et al., 1995). For facilitating comparisons with the physical I-O Table 1990, the same reporting year has been chosen. The time I-O table is especially based on the results of a time budget study which has been conducted for the years 1991/92 (Blanke et al., 1996; Franz, 1998; Schäfer and Schwarz, 1994). Special emphasis has been laid on a detailed description of teaching and studying activities, which improve the educational level of the population.

The values of products according to an I-O table in units of time cannot reflect an ideal concept of true values even if the depreciation of human capital and produced fixed assets are taken into account. It seems to be impossible to include all important factors of production. As an example, the infrastructure of organisation and knowledge documented in books and other media cannot be adequately represented in units of time. The present situation is determined by activities which reach back to the preceding decades and even centuries. It seems impossible to transform this influence into data on time use. Furthermore, all environmental problems connected with human activities are neglected in a time I-O table.

Nevertheless, the comprehensive valuation of human activities in units of time has huge advantages. While physical I-O tables can give a complete description of all

interrelationships between human activities and their natural environment, the time I-O tables can present a complete picture of all human activities. Furthermore, it allows linkages to quantitative as well as qualitative data on the whole population. Such linked analysis of economic, environmental and demographic aspects of the society has been widely neglected in the past.

This brief presentation of the advantages and disadvantages of the three types of units within an I-O framework has shown the necessity of combining their advantages for achieving a comprehensive description of human activities. The old debate on suitable units of presenting economic activities might be closed by admitting that no approach can be regarded as loser or winner. Instead of fighting against each other, cooperation seems to have a higher priority. The next part of my contribution will discuss similarities and differences between the three types of I-O tables for describing primary and intermediate inputs, gross output and final uses of the economy in the different quadrants of the tables. 1990 data of Germany are taken as numerical example. For comparing the extended versions of I-O tables with the traditional concept, the original monetary I-O Table 1990 is additionally presented (Statistisches Bundesamt, 1994).

3. COMPARISON OF THE CONCEPTS OF THE THREE TYPES OF I-O TABLES

As preparation for a thorough description of the three types of table it is first necessary to discuss the concepts used in their preparation.

3.1 Classification of Activities

A common activity classification has been used for facilitating a comparison between the three types of I-O tables. This classification comprises the breakdown of activities by 58 branches and 30 additional branches normally applied in I-O tables. The activities shown in addition are two branches of environmental protection services (waste water treatment, waste disposal), ten branches of education services (from the level of kindergarten up to university level) and eighteen branches of household services containing ten activities related to studying (corresponding with the ten branches of education services).

In the traditional 1990 classification, the environmental protection services and the education services were not separate, but included in the respective branches of enterprises, non-profit institutions serving households and government. The classification used in this chapter is already similar to NACE rev. 1 (see code no. 80: Education

services, code no. 90: Sewage and refuse disposal services, sanitation and similar services). The activities of environmental protection and education have been separated from their institutional background and shown in branches comprising all activities of the same kind.

The branches of household services are additional branches. In the traditional context, purchases of households are only shown as part of private consumption. It should be stressed that all activities are included comprising the household production activities (following the third-person criterion) as well as other activities, such as services related to employment (e.g. driving to the work place), study activities, activities of media consumption, social contacts and physiological regeneration.

The I-O tables presented in Section 4 of this paper are aggregated to 12 branches: agriculture, forestry, fishing; mining, water and energy supply; manufacturing; construction; market services (except environmental and education services); household production services; household services related to employment; household services related to studying; other household services.

3.2 Primary inputs

Table 1 gives an overview of the different types of primary inputs presented in the monetary, physical and time I-O tables. In the case of monetary I-O tables, the traditional one is shown in addition to the extended version.

Primary inputs represent a fresh impetus given to economic circulation. In this sense, primary inputs are treated as external factors whereas intermediate inputs already contain primary inputs of preceding production stages. Thus, they are shown as endogenous part of the economic circulation. In the I-O tables, primary inputs are presented in the third quadrant of the table, whereas intermediate inputs are items of the first quadrant.

In the traditional monetary I-O tables (*Table 1*, column 1), three types of primary inputs play prominent roles:

the production factor of labour measured with its income flows,
the production factor of fixed capital measured with its depreciation,
the flow of imports of goods and services used for domestic production.

In addition, the government revenues on products (like non-deductible value added tax and production taxes) are treated as primary inputs.

Table 1: Primary inputs in the German monetary, physical and time input-output tables (IOT) 1990

Ser. No.	description	Monetary IOT		Physical IOT	Time IOT
		traditional	extended		
		million DM		1 000 tons	million hours
		(1)	(2)	(3)	(4)
1	**1. Labour inputs**	**1 868 800**	**2 584 225**		**554 096**
2	employment	1 868 800	1 866 887		46 268
3	margin of labour and education		- 135 814		
4	household activities		853 152		507 828
5	*household production*		*853 152*		*82 312*
6	*activites related to employment*				*12 255*
7	*activites related to education*				*15 430*
8	*other household activities*				*397 831*
9	**2. Revenues on products**	**101 680**	**179 391**		
10	non-deductible value added tax	28 240	105 951		
11	taxes less subsidies on products	73 440	73 440		
12	**3. Consumption of fixed produced capital**	**303 010**	**572 542**	**42 216**	**36 012**
13	fixed assets (except consumer durables)	303 010	307 874	38 106	9 451
14	consumer durables		126 030	4 110	3 907
15	education (human) capital		138 638		22 654
16	**4. Withdrawal from the non-produced natural capital**			**49 510 759**	
17	water			46 427 665	
18	other raw material			3 083 094	
19	*oxygen*			*810 171*	
20	*carbon dioxide, other air emissions*			*311 838*	
21	*soil excavation*			*1 151 818*	
22	*energy carriers*			*193 347*	
23	*other solid materials*			*615 920*	
24	**5. Imports from the rest of the world**	**342 179**	**502 842**	**387 100**	**16 741**
25	goods (without private consumption goods)	301 892	301 892	342 904	9 441
26	services (without private consumption services)	40 287	40 287	46	1 268
27	private consumption goods and services		160 662	44 150	6 032
28	**Total primary inputs**	**2 615 669**	**3 839 000**	**49 940 075**	**606 849**

In the extended monetary I-O tables (*Table 1*, column 2) the same types of primary inputs are used, but the contents of the different items are substantially extended.

In the case of labour inputs, imputed values of time spent on household production, according to the third-person criterion, are included. Furthermore, a margin of labour and education is included which balances the depreciation of education (human) capital, as well as additional intermediate inputs regarding household services related to employment. It is assumed that labour income includes components corresponding to the depreciation of education capital, recorded as part of the consumption of fixed produced assets and with the additional costs of households related to employment. To avoiding double counting, the income flow has to be corrected by using the mentioned margin.

The extension of the production boundary also influences the other primary inputs of the extended monetary I-O table. Purchases of private consumption products are now treated as intermediate inputs. This concept implies that the non-deductible value-added tax on private consumption products, as well as the imported part of private consumption, are now treated as primary inputs and therefore they are increasing the respective items.

The purchase of consumer durables is part of capital formation in the extended monetary I-O tables. According to this concept, depreciation of consumer durables is treated as a primary input.

Monetary data on economic uses of the natural environment are missing in the extended monetary I-O table of 1990. This compilation work will hopefully be done by the Wuppertal Institute for Climate, Environment and Energy.

Market valuation of the raw materials extracted from nature could be used as a starting point for such an estimation. Estimates of the use of nature as a sink for economic residuals are much more difficult to obtain, because the impacts of present activities are normally only observable in the future. Furthermore, such impacts could be international, even global.

Primary inputs of physical I-O tables (see *Table 1*, column 3) can only comprise data which could be measured in physical terms. Such information is especially available in the case of raw materials which are withdrawn from nature. These materials comprise water flows, air components, such as oxygen (inputs of animals) or carbon dioxide (inputs of plants), as well as solid materials, such as sub-soil assets. Other physical flows recorded as primary inputs are imported goods from the rest of the world which are used as intermediate inputs.

In physical I-O tables, a presentation of the uses of fixed assets creates difficulties. The concept of depreciation cannot be applied, because decreasing monetary values do not necessarily correspond with decreasing physical stocks. Hence, the so-called gross concept of fixed assets has to be preferred. According to this concept, fixed assets are recorded in two different periods: in the reporting period of investment and in the period when the respective asset is leaving the production process. In this period, a physical flow is shown from final uses back to the branch which had used the asset. Such a flow is treated as a primary input, substituting for the depreciation value of the monetary tables. It increases gross output and is distributed according to the destination of the asset (e.g. being re-used, being treated as waste, or being discharged on controlled landfills).

Such a concept cannot be considered an ideal approach. From my point of view, it would be preferable to treat fixed assets at the beginning of the respective period as intermediate inputs of production processes, and assets at the end of the period as additional inputs of production [cf. the growth model of von Neumann (1945), Lancaster (1971, pp. 164 ff)]. Such a procedure would allow an endogeneous treatment of assets in activity analysis and would also facilitate a description of physical flows connected with fixed assets. Further discussion is necessary to clarify the concepts which should be aimed at.

A comprehensive description of human activities as a primary factor of production can only be given by using an I-O table based on time as the unit of presentation. According to the concepts of time I-O tables (see *Table 1*, column 4), primary inputs of labour are not limited to the working hours of employed persons, or to the time spent for household production (following the third-person criterion), but comprises the complete time budget of the whole population.

The labour inputs of time (1990: 554.1 billion hours) representing the whole time spent by the population can only reflect quantitative, but not qualitative, aspects of labour. This disadvantage of time accounting can be reduced by introducing a concept of education (human) capital and calculating the depreciation of such capital stock in time units. Such an estimate could be based on information about the accumulated use of time spent for teaching and studying. In a second step, the education capital can be depreciated according to the length of life time persons are using the knowledge accumulated.

A similar procedure has been used to calculate the direct and indirect time inputs which had been necessary to produce fixed produced assets (e.g. machinery, equipment, buildings and consumer durables) used for production purposes. The monetary depreciation of fixed assets could be completely transformed into time units. Furthermore, the imported intermediate inputs are calculated in direct and indirect labour

inputs, by assuming that the structures of production (input coefficients related to outputs) are the same for both domestic production and production in foreign countries.

The concept of time used in these I-O tables cannot be sufficient in the field of environmental studies; raw materials withdrawn from nature are normally not produced by human beings. Therefore, they cannot be transformed into production time of human activities. Supplementary data in physical units are necessary to give a more comprehensive picture of the economic-environmental interrelationships.

3.3 Intermediate Inputs

The intermediate inputs of economic activities in the different types of I-O tables are presented in ***Table 2***, rows 1 to 11. The intermediate inputs shown in the first quadrant comprise only domestic goods and services used in production processes. Imported intermediate products are treated as primary inputs and recorded in the third quadrant of the I-O tables (see Section 3.2).

The extended monetary I-O table (*Table 2*, column 2) differs from the traditional version (*Table 2*, column 1) with regard to the treatment of environmental protection services and household activities. Environmental protection services for housing (e.g. payments of households for waste water and waste treatment) are not recorded as intermediate inputs of the housing sector (as a part of the rent), but as direct inputs of household activities. The purchases of household consumption goods and services are (except for consumer durables) intermediate inputs of household activities. An additional increase of intermediate inputs of household activities is caused by internal flows of household services which are used as intermediate inputs of other household activities.

In physical I-O tables (*Table 2*, column 3), intermediate inputs consist of domestic products and of residuals of domestic production which are recycled or treated in environmental protection facilities. Intermediate flows of services are not recorded in the physical table (exceptions are e.g. some equipment for defense purposes or meals prepared in restaurants).

In time I-O tables, the product flows of the extended monetary I-O tables are transformed into the hours directly and indirectly necessary to produce the respective products. In contrast to the physical version, both goods and service flows can be valued in time units (see *Table 2*, column 4).

Table 2: Intermediate inputs and gross outputs in the German monetary, physical and time input-output tables (IOT) 1990

Ser. No.	description	Monetary IOT		Physical IOT	Time IOT
		traditional	extended		
		million DM		1 000 tons	million hours
		(1)	(2)	(3)	(4)
		Intermediate Inputs			
1	**1. Product inputs**	**2 041 341**	**4 040 240**	**8 437 839**	**203 487**
2	goods (except water and private consumption goods)	1 031 867	1 031 867	1 565 100	33 915
3	water	8 953	8 953	6 654 051	220
4	services (incl. re-used products, without private consumption services)	1 000 521	992 090	73 872	40 166
5	private consumption goods and services (except water)		879 173	109 279	27 262
6	services related to employment		58 372		14 685
7	intermediate uses of household production services		1 069 784	35 537	87 239
8	**2. Residual inputs**			**4 536 634**	
9	wastes for economic re-use and treatment			140 468	
10	waste water for treatment			4 396 166	
11	**Total intermediate inputs**	**2 041 341**	**4 040 240**	**12 974 473**	**203 487**
		+ Primary inputs			
12	**Total primary inputs**	**2 615 669**	**3 839 000**	**49 940 075**	**606 849**
		= Gross outputs			
13	**1. Product outputs**	**4 657 010**	**7 879 240**	**9 266 130**	**810 336**
14	goods (except water)	2 380 859	2 380 859	2 452 146	77 769
15	water	8 972	8 972	6 661 841	220
16	services (incl. re-used products, except household services)	2 267 179	2 261 702	116 606	83 011
17	household services		3 227 707	35 537	649 336
18	*household production services*		*1 351 755*	*35 537*	*111 302*
19	*services related to employment*		*58 372*		*14 685*
20	*services related to education*		*42 215*		*18 255*
21	*other household services*		*1 775 365*		*505 094*
22	**2. Residual outputs**			**53 648 418**	
23	waste water			49 246 503	
24	water vaporized			1 566 597	
25	other residuals			2 835 318	
26	*oxygen*			*226 052*	
27	*carbon dioxide, other air emissions*			*811 944*	
28	*soil disposal, other solid materials*			*1 507 635*	
29	*wastes*			*289 687*	
30	**Total outputs**	**4 657 010**	**7 879 240**	**62 914 548**	**810 336**

3.4 Outputs

The outputs of the different activities (see *Table 2*, rows 13 to 30) are identical with the totals of intermediate and primary inputs.

In traditional monetary I-O tables (*Table 2*, column 1), outputs comprise products sold, increases of stocks of own products and products used in the same unit for own purposes (e.g. own-account production of assets). In the case of non-market production, market values of the products are not available. Consequently, gross outputs are calculated as totals of intermediate and primary inputs.

In the extended monetary I-O tables (*Table 2*, column 2), additional outputs of household activities are shown. These outputs are compiled in the same way as non-market services in the traditional framework, by adding all intermediate and primary inputs of the respective activity. These inputs comprise private consumption goods, depreciation of both consumer durables and education (human) capital and, in the case of household production services (following the third-person criterion), monetary values of the time spent on these activities.

In physical I-O tables (*Table 2*, column 3), outputs consist of products and residuals of production processes. The outputs of service activities (also including all household activities) normally comprise only residuals. Thus, the importance of the service sector for the whole economy cannot be adequately reflected in a physical framework.

In time I-O tables (*Table 2*, column 4), outputs are valued by the hours directly or indirectly being necessary to produce the respective goods and services. Such a concept also allows an adequate treatment of all household activities; labour inputs of these activities are valued by the hours spent. As far as imported products are used for domestic production, the time values of these products are calculated by using the assumption that the production processes of both domestic production and production abroad have the same input structures. Furthermore, it has already been mentioned that the depreciation of fixed assets, including consumer durables and education capital, is calculated by the time necessary to produce the respective investment goods and services in the period of investment.

3.5 Final Uses

Final uses are outputs of economic activities which leave the economic circulation. They are described in the second quadrant of I-O tables. An overview of the final uses presented in the different types of tables is given in ***Table 3***.

In the traditional monetary I-O tables (*Table 3*, column 1), four types of final uses are distinguished:

- private consumption,
- government consumption,
- fixed capital formation (including change in stocks),
- exports of goods and services.

Private consumption comprises purchases of private consumption products and the consumption of non-profit institutions serving households. The products purchased disappear into a ‘black hole’, because their further uses in household activities are not described. Furthermore, it is assumed that consumer durables are consumed in one period. This concept reveals the low priority household activities are given in traditional national accounting.

Government consumption comprises all government services which are provided for the whole community, without payment of specific users.

Fixed capital formation contains only investment goods which are used for production purposes. Thus, consumer durables are not taken into account because household activities are not treated as production in the conventional framework. Furthermore, changes of non-produced natural capital are not recorded.

The flows between the home country and the rest of the world only comprise goods and services. Flows of residuals (e.g. air emissions) which might affect the natural environment of other countries are not taken into account.

Substantial changes can be observed in the extended version of monetary I-O tables (*Table 3*, column 2).

Private consumption is now defined as the final uses of household services produced in the different branches of household activities. The aggregates could be interpreted as consumption for own use, similar to government consumption. Similar to government consumption and consumption of non-profit institutions serving private households,

Table 3: Final uses in the German monetary, physical and time input-output tables (IOT) 1990

Ser. No	description	Monetary IOT		Physical IOT	Time IOT
		traditional	extended		
		million DM		1 000 tons	million hours
		(1)	(2)	(3)	(4)
1	**1. Privat consumption**	**1 085 325**	**2 076 030**		**529 997**
2	consumption products	940 548	2 057 337		529 157
3	*goods*	*306 052*			
4	*services*	*634 496*			
5	*household services*		*2 057 337*		*529 157*
6	consumer durables	114 047			
7	consumption of nonprofit institutions serving households	30 730	18 693		840
8	**2. Government consumption**	**444 070**	**361 944**		**13 761**
9	except education services	358 994	361 944		13 761
10	education services	85 076			
11	**3. Fixed capital formation**	**425 577**	**685 408**	**733 007**	**40 041**
12	produced natural assets			28 699	
13	machinery and equipment	176 928	176 928	8 554	5 605
14	buildings	248 248	248 248	553 052	8 339
15	consumer durables		114 047	4 403	4 040
16	education (human) capital		145 784	20 949	22 006
17	change in stocks	401	401	117 350	51
18	controlled landfills				
19	**4. Disposal into the non-produced natural capital**			**48 994 384**	
20	waste water			44 846 589	
21	water vaporized			1 565 925	
22	other residuals			2 581 870	
23	*oxygen*			*226 052*	
24	*carbon dioxide, other air emissions*			*811 655*	
25	*soil disposal, other solid materials*			*1 507 577*	
26	*wastes*			*36 586*	
27	**5. Exports to the rest of the world**	**660 697**	**715 618**	**212 684**	**23 051**
28	goods	577 696	602 226	192 591	19 119
29	services	83 001	113 392	17 950	3 932
30	wastes for treatment			2 143	
31	**Total final uses**	**2 615 669**	**3 839 000**	**49 940 075**	**606 850**

private consumption is valued by the costs of household activities (intermediate consumption, depreciation, value of time spent for household activities).

The concept of government consumption has not been substantially modified. The treatment of education services as investment is the only conceptual change.

The concept of fixed capital formation shows more important changes in the extended monetary I-O tables. Apart from the treatment of consumer durables as investment goods, the education services and the household services related to studying are treated as fixed capital formation which increases the education (human) capital. The household services related to studying comprise all costs of pupils and students directly associated with their studies (e.g. travelling costs, costs of teaching aids, part of dwelling costs). Further changes of fixed capital formation would be necessary if changes of natural capital were taken into account.

The final uses of physical I-O tables (*Table 3*, column 3) do not comprise private and government consumption, because all physical inputs of government and private activities are treated as intermediate inputs. The outputs of these activities are services without material counterpart, as well as residuals which partly increase the flows back into the nature. Fixed capital formation and disposal into non-produced natural capital are the most important aggregates of final uses in the physical I-O tables. As far as exports comprise physical goods, physical flows to the rest of the world are shown.

The concept of final uses in the time I-O tables (*Table 3*, column 4) is very similar to that of the extended monetary I-O tables. The value of private consumption, also comprising most of the time spent for household activities, dominates all other aggregates. In the context of fixed capital formation, the increase of education (human) capital also contains the time of pupils and students for studying.

4 DESCRIPTION OF THE THREE TYPES OF I-O TABLES

We now move to the three types of tables discussed above, and offer a description of each in turn.

4.1 General Comments

In the following paragraphs, there is a brief description of the three types of I-O tables showing German economic activities in the year 1990 (see ***Tables 4*** to ***6***). Comments will

focus on the twelve activities which are presented in the highly aggregated tables. It has already been mentioned that the I-O tables have been compiled from 91 activities (see Section 3.1). It is planned to publish the tables in this detailed classification to allow special studies, e.g. on household activities or on education services.

It is not possible to describe all supplementary tables which have been compiled in the context of the three extended I-O tables. It should be mentioned that import matrices are available for all types of I-O tables, showing the imports in a breakdown by product group as well as by using branch and final use, respectively. In *Tables 4 to 6,* the column totals of the import matrices are only presented as primary inputs of the respective using branches.

Several additional tables are available in the case of physical I-O tables. The data comprise detailed information on the material inputs and outputs of economic activities, which can be further subdivided into complete material balances of energy uses, water uses and other materials. Furthermore, special balances of biological metabolism of animals plants and human beings are estimated.

In the case of physical I-O tables, it might be useful to reduce material flows for some specific analyses. There are throughput materials which do not enter economic circulation, but are only treated as primary inputs (withdrawal from non-produced natural assets) and final uses (disposal into the non-produced natural assets). Most important examples are water flows, like cooling water, which enter the natural sphere again without any further treatment. Other examples are soil materials only moved in the context of construction activities. In *Table 5,* throughput materials are shown in row 20. They comprise about three quarters of all material flows without having an important economic or ecological influence. Thus, it could be considered to remove them before analysing the physical flows of economic activities in the context of physical I-O tables.

In the case of time I-O tables, additional information on the qualification structures of employed persons by branch are available. Furthermore, data on the qualification levels of the whole population can be combined with the complete range of household activities.

4.2 Extended Monetary I-O table

The activities shown in columns 1 to 5 and 8 of ***Table 4*** represent the traditional classification of production activities. Special emphasis is given to environmental protection activities which are explicitly presented in column/row 6. The environmental

protection activities only comprise services which are delivered to third parties (external protection activities) whereas internal protection activities, like water treatment plants for own purposes, are not taken into account (Schäfer and Stahmer, 1989; Kuhn, 1990). It might be possible to ‘externalise’ their costs by establishing separate production units, but it would be very difficult to estimate the corresponding physical flows, e.g. of waste and air pollution.

In column/row 7, there is a description of education services of government institutions, enterprises and nonprofit institutions serving households. The gross output of these activities is treated as fixed capital formation and increases the stock of education (human) capital (row 7, column 18). The consumption of education capital is associated with those activities which use the accumulated knowledge of people (row 19). As far as labour inputs have monetary values (row 14), it is assumed that the value of depreciation of education capital is part of these revenues. To avoid double counting, a (negative) margin of labour and education has been introduced (row 15) which also counterbalances the intermediate inputs of household services related to employment (row 10).

It is assumed that all household activities are productive. Nevertheless, the use of the term ‘household production’ is limited to the case of household activities which meet the third-person criterion (column/row 9). The gross output of household production is compiled as the total of the value of intermediate consumption products, depreciation of consumer durables and the value of the time spent for household production. The depreciation of education capital is counterbalanced by the mentioned margin (row 15, column 9). Household production services are partly used as intermediate inputs of other household activities (row 9, columns 9, 11 and 12). The remaining values leave the economic circulation and are treated as private consumption (row 9, column 14).

The household services (except household production) (columns/rows 10 to 12) represent household activities for own purposes which cannot be carried out by third persons. Thus, a suitable valuation of the time spent for these activities seems to be impossible. The gross output of these services comprise only intermediate inputs and consumption of fixed produced assets, including the depreciation of education capital which has not to be counterbalanced in this case. Household services related to employment (column/row 10) are used by the branches employing the respective persons. Household services related to studying (column/row 11) comprise learning activities of pupils and students. The costs of these activities are treated as investment in education capital (row 11, column 18). All other household services (column/row 12) are used for consumption purposes only (row 12, column 14). These activities comprise e.g. social activities and activities for physiological regeneration (eating, sleeping etc.).

Table 4: Extended monetary
Billion

Row No.	Uses / Supply	Input of								
		agri-culture, forestry, fishing	mining, water and energy supply	manu-facturing	construc-tion	market services	environ-mental protec-tion services	educa-tion 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	Products 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	-	-	-	-	-	-	-	-	130,3
10	Household services related to employment	0,5	1,0	17,5	4,0	22,7	-	3,0	9,6	-
11	Household services related to education	-	-	-	-	-	-	-	-	-
12	Other household services	-	-	-	-	-	-	-	-	-
13	**Product and residual inputs, totals**	**34,0**	**66,1**	**983,5**	**123,1**	**612,8**	**12,9**	**17,1**	**241,8**	**395,0**
14	Labour inputs	28,9	47,8	581,1	120,0	793,8	5,4	78,2	211,6	853,2
15	Margin of labour and education	- 1,8	- 1,5	- 27,8	- 6,4	- 37,0	- 0,2	- 6,1	- 15,4	- 39,5
	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	-
	Consumption of fixed produced assets									
18	Assets incl. consumer durables	11,8	20,3	72,9	5,4	170,7	6,5	8,3	12,0	33,3
19	Education (human)capital	1,3	0,6	10,3	2,4	14,3	0,2	3,1	5,7	39,5
	Withdrawal from the non-prod. natural capital									
20	Throughput materials	x	x	x	x	x	x	x	x	x
21	Other materials	x	x	x	x	x	x	x	x	x
	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**	**42,0**	**78,6**	**924,8**	**137,7**	**1 029,1**	**13,6**	**86,5**	**247,8**	**956,7**
25	**Gross output, balancing items**	**76,0**	**144,7**	**1 908,3**	**260,8**	**1 642,0**	**26,6**	**103,6**	**489,6**	**1 351,8**

input-output table - Germany 1990
Deutsche marks

branches				Final uses									
household services (except household production)						fixed capital formation			disposal nto the non-produced natural capital	exports to the rest of the world	totals	Total uses	Row No.
services related to employ-ment	services related to studying	other services	totals	private con-sump-tion	govern-ment con-sump-tion	fixed assets (except consumer durables incl. change in stocks)	con-sumer durables	edu-cation capital					
10	11	12	13	14	15	16	17	18	19	20	21	22	
0,1	0,0	3,2	**67,3**	-	-	2,8	-	-	x	5,9	**8,7**	**76,0**	1
0,4	0,2	18,4	**141,3**	-	-	- 0,7	-	-	x	4,1	**3,4**	**144,7**	2
7,6	1,5	116,1	**1 060,6**	-	-	184,7	73,3	-	x	589,7	**847,7**	**1 908,3**	3
0,1	-	2,4	**53,1**	-	-	205,1	-	-	x	2,5	**207,7**	**260,8**	4
20,1	10,1	403,4	**1 457,1**	-	-	32,6	40,7	-	x	111,6	**184,9**	**1 642,0**	5
0,2	0,1	7,2	**26,5**	-	0,1	-	-	-	x	-	**0,1**	**26,6**	6
-	-	-	**-**	-	-	-	-	103,6	x	-	**103,6**	**103,6**	7
0,3	2,2	20,7	**106,2**	18,7	361,9	1,1	-	-	x	1,8	**383,4**	**489,6**	8
-	17,4	922,1	**1 069,8**	282,0	-	-	-	-	x	-	**282,0**	**1 351,8**	9
-	-	-	**58,4**	-	-	-	-	-	x	-	**-**	**58,4**	10
-	-	-	**-**	-	-	-	-	42,2	x	-	**42,2**	**42,2**	11
-	-	-	-	1 775,4	-	-	-	-	x	-	**1 775,4**	**1 775,4**	12
28,7	**31,6**	**1 493,6**	**4 040,2**	**2 076,0**	**361,9**	**425,6**	**114,0**	**145,8**	**x**	**715,6**	**3 839,0**	**7 879,2**	13
-	-	-	**2 720,0**	- 2 720,0	-	-	-	-	x	-	**- 2 720,0**	**-**	14
-	-	-	**- 135,8**	135,8	-	-	-	-	x	-	**135,8**	**-**	15
3,0	1,1	50,3	**106,0**	-	- 155,0	27,7	17,9	-	x	3,4	**- 106,0**	**-**	16
-	-	-	**73,4**	-	- 73,4	-	-	-	x	-	**- 73,4**	**-**	17
14,0	2,5	76,1	**433,9**	-	-	- 307,9	- 126,0	-	x	-	**- 433,9**	**-**	18
5,4	4,7	51,1	**138,6**	-	-	-	-	- 138,6	x	-	**- 138,6**	**-**	19
x	x	x	x	x	x	x	x	x	x	x	x	x	20
x	x	x	x	x	x	x	x	x	x	x	x	x	21
5,0	1,0	70,2	**420,1**	-	-	66,3	31,9	-	x	- 518,3	**- 420,1**	**-**	22
2,2	1,4	34,0	**82,7**	-	-	0,1	0,1	-	x	- 82,9	**- 82,7**	**-**	23
29,6	**10,7**	**281,7**	**3 839,0**	**- 2 584,2**	**- 228,4**	**- 213,7**	**- 76,1**	**- 138,6**	x	**- 597,8**	**- 3 839,0**	**-**	24
58,4	**42,2**	**1 775,4**	**7 879,2**	**- 508,2**	**133,5**	**211,8**	**37,9**	**7,1**	x	**117,8**	**-**	**7 879,2**	25

4.3 Physical I-O Table

The physical I-O table (***Table 5***, shows a completely different picture of the economy. The activities producing material goods play a much more important role, while service branches, with their immaterial outputs, have a relatively low importance.

The production activities of agriculture, forestry and fishing (column/row 1) also comprise balances of plants and animals as far as they belong to the controlled economy. Thus, an analysis of the biological metabolism of living beings is possible.

The production activities of mining, water and energy supply (column/row 2) especially contain the withdrawal of raw materials from nature and their transformation into marketable goods. In comparison to the other flows of materials, water inputs and outputs dominate the description of these activities. As mentioned already, it seems to be preferable to allow a suitable reduction of these flows to facilitate the analysis of material flows. In row 20/column 2, most of the water flows are shown as throughput materials (e.g. cooling water) which represents about a half of all material flows of the economy.

In manufacturing and construction (columns/rows 3 and 4), the transformation of material goods into other material goods is described. Of course, these transformation processes require further inputs of raw materials withdrawn from nature, and they produce not only goods but also residuals. As far as soil is only moved but not used as material input of buildings etc., the respective material flow (row 20, column 4) is shown as throughput material.

In the case of market services (column/row 5), education services (column/row 7) and non-market services (column/row 8), material product inputs are normally transformed into residuals only. Apart from some exceptions (e.g. preparing meals in restaurants), the product output of services is immaterial.

Important material flows can be observed in environmental protection activities (column/row 6). Wastes and waste-water of other branches are treated and transformed into other types of residuals, which could be safely stored in controlled landfills, or which could be disposed of into nature without severe damages to ecosystems.

The material balances of household activities (columns/rows 9 to 12) are similar to those of the other service branches. Apart from preparing meals, no material product output is shown. The output of household services normally consists of residuals only. Some raw materials (e.g. oxygen and water) are taken into account in the case of the biological metabolism of human beings.

4.4 Time I-O Table

The comments given to the extended monetary I-O table (Section 4.2) could be applied for the interpretation of the time I-O table (***Table 6***) to a great extent. All values of the monetary table have been transformed into time values by the labour inputs directly or indirectly necessary to produce the respective products.

The additional primary inputs of household services (except household production) (columns/rows 10 to 12) cause the only major difference between the time and the monetary I-O table. In the extended monetary tables, the direct inputs of time of these activities have not been valued. Thus, the output is compiled only as the sum of intermediate inputs and depreciation. In the time I-O table, the direct inputs of time of all household services are taken into account. These amount to more than half of the value of time of all outputs of the whole economy (425 billion hours in comparison to 810 billion hours).

In the case of services related to employment (column/row 10), the additional inputs of time are linked with the traditional branches of the economy. The time spent travelling to the work place is now an additional intermediate input of the branches where the commuting persons are employed. These additional inputs are not counterbalanced, but are treated as part of the gross output of the traditional branches.

According to the extended concept of inputs of time, the hours spent by pupils and students for studying are now an important part of the outputs of the household services related to studying (column/row 11). In comparison to the outputs of education services (column 7), the household activities have now a substantially increased importance as part of the investment in education capital (see column 18: 18 billion hours in comparison to 4 billion hours of education services).

The other household services (column/row 12) have a higher value of gross output than all other activities shown in the time I-O table (505 billion hours in comparison to 305 billion hours). This output (e.g. social and leisure activities, physiological regeneration) can be interpreted as a final goal of all activities. The outputs are treated as private consumption (row 12, column 14) amounting to five-sixths of all final use.

Table 5: Physical input-
Million

Row No.	Uses / Supply	Input of								
		agri-culture, forestry, fishing	mining, water and energy supply	manu-facturing	construc-tion	market services	environ-mental protec-tion services	educa-tion 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	98,3	0,2	80,3	0,8	0,8	27,3	0,0	0,1	8,5
2	Products of mining, water and energy supply	64,5	2 084,7	1 343,9		109,9	111,4	51,2	310,5	741,5
3	Products of manufacturing	20,7	6,7	494,5	550,8	84,5	1 180,2	0,5	14,2	32,7
4	Construction work	-	-	-	0,0	28,5	21,7	0,0	6,0	-
5	Market services	4,7	-	47,8	20,7	1,8	112,1	0,0	0,1	0,5
6	Environmental protection services	-	0,4	-	-	6,0	4,7	-	-	-
7	Education services	-	-	-	-	0,1	49,1	-	-	-
8	Non-market services	-	-	-	-	0,5	298,6	-	-	-
9	Household production services	-	-	-	-	2,6	652,2	-	-	-
10	Household services related to employment	-	-	-	-	0,3	59,8	-	-	-
11	Household services related to education	-	-	-	-	0,1	32,0	-	-	-
12	Other household services	-	-	-	-	3,6	1 897,0	-	-	-
13	**Product and residual inputs, totals**	**188,2**	**2 091,9**	**1 966,5**	**589,7**	**238,7**	**4 446,0**	**51,8**	**330,9**	**783,2**
14	Labour inputs	x	x	x	x	x	x	x	x	x
15	Margin of labour and education	x	x	x	x	x	x	x	x	x
	Revenues on products									
16	Non-deductible value added tax	x	x	x	x	x	x	x	x	x
17	Taxes less subsidies on products	x	x	x	x	x	x	x	x	x
	Consumption of fixed produced assets									
18	Assets incl. consumer durables	-	1,9	15,1	21,0	0,0	-	0,0	0,0	1,1
19	Education (human)capital	x	x	x	x	x	x	x	x	x
	Withdrawal from the non-prod. natural capital									
20	Throughput materials	-	31 428,0	5 346,1	113,2	-	3 500,0	-	-	-
21	Other materials	606,9	6 797,1	1 138,5	67,9	118,0	9,8	14,8	89,7	62,3
	Imports from the rest of the world									
22	Goods	10,4	49,2	238,9	28,1	13,3	0,2	0,3	2,4	18,5
23	Services	-	-	0,0	0,0	0,0	-	0,0	0,0	0,3
24	**Primary inputs, totals**	**617,4**	**38 276,2**	**6 738,6**	**230,2**	**131,4**	**3 510,0**	**15,1**	**92,1**	**82,2**
25	**Gross output, balancing items**	**805,6**	**40 368,1**	**8 705,1**	**819,9**	**370,1**	**7 956,0**	**66,9**	**423,0**	**865,3**
	Supplementary information:									
26	Product outputs	251,4	6 961,0	1 361,4	540,3	99,4	0,4	-	16,8	35,5
27	Residual outputs	554,2	33 407,2	7 343,7	279,6	270,7	7 955,6	66,9	406,3	829,8

output table – Germany 1990
tons

branches				Final uses									
household services (except household production)						fixed capital formation							
services related to employment	services related to studying	other services	totals	private consumption	government consumption	fixed assets (except consumer durables incl. change in stocks)	consumer durables	education capital	disposal nto the non-produced natural capital	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	4,8	**221,3**	x	x	47,1	-	x	526,9	10,2	**584,3**	**805,6**	1
66,7	35,7	2 099,0	**7 036,3**	x	x	- 0,3	-	x	33 305,6	26,5	**33 331,8**	**40 368,1**	2
													3
4,5	0,7	34,6	**2 424,5**	x	x	13,9	4,4	x	6 106,4	155,9	**6 280,6**	**8 705,1**	
-	-	-	**56,3**	x	x	534,2	-	x	229,4	0,0	**763,6**	**819,9**	4
0,0	0,0	5,7	**193,5**	x	x	- 0,3	-	x	163,8	13,2	**176,7**	**370,1**	5
-	-	-	**11,1**	x	x	-	-	x	7 942,8	2,1	**7 945,0**	**7 956,0**	6
-	-	-	**49,1**	x	x	-	-	x	17,7	-	**17,7**	**66,9**	7
-	0,0	0,2	**299,3**	x	x	16,6	-	x	107,1	-	**123,7**	**423,0**	8
-	-	35,5	**690,3**	x	x	-	-	x	173,2	1,8	**175,0**	**865,3**	9
-	-	-	**60,1**	x	x	-	-	x	22,5	0,1	**22,6**	**82,7**	10
-	-	-	**32,0**	x	x	-	-	x	8,4	0,0	**8,5**	**40,5**	11
-	-	-	**1 900,6**	x	x	-	-	x	507,9	2,8	**5 10,7**	**2 411,3**	12
71,4	**36,4**	**2 179,8**	**12 974,5**	**x**	**x**	**611,3**	**4,4**	**x**	**49 111,7**	**212,7**	**49 940,1**	**62 914,5**	13
x	x	x	x	x	x	x	x	x	x	x	x	x	14
x	x	x	x	x	x	x	x	x	x	x	x	x	15
x	x	x	x	x	x	x	x	x	x	x	x	x	16
x	x	x	x	x	x	x	x	x	x	x	x	x	17
0,5	0,1	2,5	**42,2**	x	x	- 40,8	- 4,1	x	2,7	-	**- 42,2**	**-**	18
x	x	x	x	x	x	x	x	x	x	x	x	x	19
-	-	-	**40 387,3**	x	x	-	-	x	-40387,3	-	**-40387,3**	**-**	20
6,9	3,4	208,2	**9 123,5**	x	x	-	-	x	- 9 123,5	-	**- 9 123,5**	**-**	21
4,0	0,6	17,0	**383,0**	x	x	7,4	2,7	x	-	- 393,1	**- 383,0**	**-**	22
0,0	0,0	3,8	**4,1**	x	x	-	-	x	-	- 4,1	**- 4,1**	**-**	23
11,3	**4,0**	**231,6**	**49 940,1**	x	x	**- 33,4**	**- 1,4**	x	**-49508,1**	**- 397,2**	**-49940,1**	**-**	24
82,7	**40,5**	**2 411,3**	**62 914,5**	x	x	**577,9**	**3,0**	x	**- 396,4**	**- 184,5**	**-**	**62 914,5**	25
-	-	-	**9 266,1**										26
82,7	40,5	2 411,3	**53 648,4**										27

Table 6: Time input-Billion

Row No.	Uses / Supply	Input of								
		agri-culture, forestry, fishing	mining, water and energy supply	manu-facturing	construc-tion	market services	environ-mental protec-tion services	educa-tion 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	0,44	0,00	2,50	0,00	0,27	-	0,00	0,06	0,35
2	Products of mining, water and energy supply	0,05	1,09	1,29	0,01	0,55	0,03	0,04	0,14	0,41
3	Products of manufacturing	0,50	0,40	17,97	2,20	3,39	0,09	0,09	1,29	4,21
4	Construction work	0,02	0,13	0,24	0,14	0,80	0,08	0,04	0,23	0,04
5	Market services	0,26	0,49	8,68	1,18	21,71	0,06	0,21	3,58	3,65
6	Environmental protection services	0,00	0,03	0,15	0,06	0,11	0,13	0,01	0,03	0,10
7	Education services	-	-	-	-	-	-	-	-	-
8	Non-market services	0,02	0,02	0,25	0,03	0,20	0,08	0,01	2,87	0,12
9	Household production services	-	-	-	-	-	-	-	-	10,56
10	Household services related to employment	0,13	0,24	4,41	1,01	5,71	0,00	0,76	2,43	0,00
11	Household services related to education	-	-	-	-	-	-	-	-	-
12	Other household services	-	-	-	-	-	-	-	-	-
13	**Product and residual inputs, totals**	**1,43**	**2,41**	**35,50**	**4,64**	**32,75**	**0,47**	**1,16**	**10,62**	**19,43**
14	Labour inputs	2,04	0,74	13,82	3,33	17,40	0,26	1,83	6,84	82,31
15	Margin of labour and education	x	x	x	x	x	x	x	x	x
	Revenues on products									
16	Non-deductible value added tax	x	x	x	x	x	x	x	x	x
17	Taxes less subsidies on products	x	x	x	x	x	x	x	x	x
	Consumption of fixed produced assets									
18	Assets incl. consumer durables	0,38	0,65	2,31	0,17	5,24	0,11	0,28	0,32	1,02
19	Education (human)capital	0,20	0,08	1,52	0,35	2,10	0,04	0,44	0,86	6,67
	Withdrawal from the non-prod. natural capital									
20	Throughput materials	x	x	x	x	x	x	x	x	x
21	Other materials	x	x	x	x	x	x	x	x	x
	Imports from the rest of the world									
22	Goods	0,22	0,33	7,12	0,41	0,90	0,02	0,02	0,43	1,67
23	Services	0,01	0,02	0,27	0,03	0,72	0,00	0,03	0,18	0,20
24	**Primary inputs, totals**	**2,84**	**1,83**	**25,05**	**4,29**	**26,36**	**0,43**	**2,59**	**8,63**	**91,87**
25	**Gross output, balancing items**	**4,27**	**4,24**	**60,55**	**8,93**	**59,11**	**0,90**	**3,75**	**19,25**	**111,30**

output table - Germany 1990
hours

branches				Final uses									
household services (except household production)						fixed capital formation							
services related to employment	services related to studying	other services	totals	private consumption	government consumption	fixed assets (except consumer durables incl. change in stocks)	consumer durables	education capital	disposal nto the non-produced natural capital	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	
0,00	0,00	0,18	**3,82**	-	-	0,12	-	-	x	0,33	**0,45**	**4,27**	1
0,01	0,01	0,48	**4,12**	-	-	- 0,03	-	-	x	0,15	**0,11**	**4,24**	2
0,15	0,04	3,38	**33,71**	-	-	5,86	2,43	-	x	18,56	**26,84**	**60,55**	3
0,00	-	0,08	**1,83**	-	-	7,02	-	-	x	0,09	**7,10**	**8,93**	4
0,71	0,32	11,80	**52,65**	-	-	0,99	1,61	-	x	3,86	**6,46**	**59,11**	5
0,01	0,00	0,28	**0,90**	-	-	-	-	-	x	-	**-**	**0,90**	6
-	-	-	**-**	-	-	-	-	3,75	x	-	**3,75**	**3,75**	7
0,01	0,10	0,83	**4,54**	0,84	13,76	0,04	-	-	x	0,07	**14,72**	**19,25**	8
-	1,41	75,27	**87,24**	24,06	-	-	-	-	x	-	**24,06**	**111,30**	9
-	-	-	**14,69**	-	-	-	-	-	x	-	**-**	**14,69**	10
-	-	-	**-**	-	-	-	-	18,25	x	-	**18,25**	**18,25**	11
-	-	-	**-**	505,09	-	-	-	-	x	-	**505,09**	**505,09**	12
0,90	**1,87**	**92,30**	**203,49**	**530,00**	**13,76**	**13,99**	**4,04**	**22,01**	x	**23,05**	**606,85**	**810,34**	13
12,25	15,43	397,83	**554,10**	- 554,10	-	-	-	-	x	-	**- 554,10**	**-**	14
x	x	x	x	x	x	x	x	x	x	x	x	x	15
x	x	x	x	x	x	x	x	x	x	x	x	x	16
x	x	x	x	x	x	x	x	x	x	x	x	x	17
0,41	0,07	2,40	**13,36**	-	-	- 9,45	- 3,91	-	x	-	**- 13,36**	**-**	18
0,93	0,79	8,67	**22,65**	-	-	-	-	- 22,65	x	-	**- 22,65**	**-**	19
x	x	x	x	x	x	x	x	x	x	x	x	x	20
x	x	x	x	x	x	x	x	x	x	x	x	x	21
0,11	0,03	2,39	**13,64**	-	-	2,06	1,03	-	x	- 16,73	**- 13,64**	**-**	22
0,09	0,05	1,50	**3,10**	-	-	0,00	0,01	-	x	- 3,11	**- 3,10**	**-**	23
13,79	**16,38**	**412,79**	**606,85**	**- 554,10**	**-**	**- 7,39**	**- 2,87**	**- 22,65**	x	**- 19,84**	**- 606,85**	**-**	24
14,69	**18,25**	**505,09**	**810,34**	**- 24,10**	**13,76**	**6,60**	**1,17**	**- 0,65**	x	**3,21**	**-**	**810,34**	25

5. OUTLOOK

This chapter has presented three different types of I-O tables, using differing units of presentation. For facilitating comparisons, the same concepts of production and capital have been applied. Furthermore, the same classifications of activities, primary inputs and final use have been used. The presentation aimed at giving good arguments for a combined use of these tables. Each type can show only specific aspects of economic activities, while all three types together can achieve a nearly comprehensive overview. For analysing the very general concept of sustainability, it seems to be urgently needed to describe human activities with their social, economic and ecological aspects by this magic triangle of I-O data.

Further research work is necessary to develop suitable I-O models using not only one type of table, but combining data for two or three types of I-O tables. Using monetary I-O tables and linking physical data with the results of monetary I-O analysis is a relatively simple case of linking the different types. Furthermore, it is possible to merge parts of the three types to produce artificial new tables which might be more useful for I-O analysis. Examples of such merging procedures are energy I-O tables with both physical and monetary data (Beutel and Stahmer, 1982.). In more sophisticated econometric models, simultaneous use of different units of presentation could be introduced. Such models could define relationships between the elements of the different types of I-O tables [see e.g. the Osnabrück model in Meyer et al. (1999)].

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