Chapter 37
Time Use and Sustainability: An Input-Output Approach in Mixed Units

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Introduction

Industrial Ecology as coined by Frosch and Gallopoulos (1989)[1] has proven to be one operational and holistic concept for successfully implementing more sustainable policies. However, like many other concepts that have become popular in the post-Brundtland era during the late 1980s and early 1990s, such as Cleaner Production (Baas et al. 1990), Ecological Modernisation (Jänicke 1988) and Industrial Metabolism (Ayres 1989), it has been open to criticism, due to the failure of environmental policies to achieve many of their ambitious goals set out during the Rio process. The shared pathology has usually been the technocratic approach and supply-side bias, as most clearly laid out in the *sustainable consumption* debate (UNEP 2002; Princen et al. 2002).[2]

Researchers have responded to this criticism by adjusting their policy approaches. Much more emphasise has recently been given to the study of household behaviour and demand side issues (e.g. Gatersleben 2000; Jackson 2004); socio-institutional and demographic concerns have been integrated with environmental-economic ones (e.g. Cogoy 1995; Madlener and Stagl 2001); and more and more effort has been devoted to understanding and disclosing the complex relationship between consumption activities and well-being (Hofstetter and Madjar 2003; Jackson et al. 2004).

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[1] The idea of Industrial Ecology has evolved from the 1960s onwards (see Erkman 1997, among others), but it did not attract widespread attention until Frosch and Gallopoulos' (1989) contribution to Scientific America. This is, therefore, often seen as the ultimate take-off of the Industrial Ecology movement.

[2] For an overview of very recent research efforts in Sustainable Consumption Research, see the 2005 Special Issue of the Journal of Industrial Ecology **9**(1–2).

S. Suh (ed.), *Handbook of Input-Output Economics in Industrial Ecology*, Eco-Efficiency in Industry and Science 23,

However, quantitative approaches often still lack a systematic and comprehensive treatment of social and behavioural aspects. In this chapter we argue that the integration of time use data into integrated quantitative frameworks opens a whole new array of possibilities for sustainability research for doing so. This has been proposed in the international policy arena, for example in Agenda 21 (see programme area D of Chapter 8) and the System of Integrated Environmental and Economic Accounting (United Nations 1993b), in the (National) Accounting (e.g. Hawrylyshyn 1977; Pyatt 1990) as well as the Household Production Literature (e.g. Juster and Stafford 1991; Klevermarken 1999) and in different social science disciplines (e.g. Barth 1967; Gross 1984).

The section on Time Use Data gives an introduction to time use data and outlines four unique properties that allow social and behavioural aspects to be better represented in quantitative frameworks. The section on Comprehensive Sustainability Research proposes to integrate data in monetary, physical and time units in one comprehensive framework before the section on Integrating Time Use Data applies the time argument to the consumer-lifestyle debate within an input-output context. The value of the approach is demonstrated in an empirical assessment of household activities based on a unique set of input-output tables in monetary, physical and time units throughout sections on "Magic Triangle" through the Results section.

Time Use Data for Sustainability Research

Time use (or time allocation) data has been collected systematically in time budget surveys since the 1960s. The subject of measurement might be best defined as the *use of human* (or *economic) time*; that is, "the hours of time that human beings have at their disposal and that must be allocated between alternative activities" (Sharp 1981, p. 2). Essentially, these surveys provide information about what activities a sample of a given population engages in during a representative day (or a set of representative days) of a defined reporting period. These can be used to estimate the time-allocation of the population in this particular reporting period.

The information content of the raw data is depicted in Table 37.1 (see United Nations 1975). Data is usually collected through the diary method (most often for two representative days [weekday, weekend]) and often augmented by information from questionnaires or interviews. Detailed information about the design of time budget surveys and methodological procedures can be found in Szalai (1972) and Juster and Stafford (1991).

Time use data has some unique properties, which make it attractive for quantitative sustainability research:

First, there is the issue of *coverage*. It is highly intuitive that monetary data can only provide a limited picture of the human activity spectrum, as it is bound to the market institution and its associated exchange processes (Fig. 37.1). However, researchers who have subscribed to the sustainability concept are usually interested in society as a whole, rather than its economic subsystem. Because all activities take time and all members of society must allocate the same amount of time among them

Table 37.1 Basic Information Content of Time Use Data

Cross-sectional data	The following information can be analysed when referring to a single reporting period: 1. The activities realised in the course of a representative day for different purposes 2. The duration of these activities 3. The allocation or distribution of these activities during the day 4. Differences in activity patterns between social strata
Longitudinal Data	As soon as at least two comparable time budget surveys are available, the analysis can be extended to address: 5. Shifts in time use patterns regarding the information pieces 1 to 4, e.g. activities with absolute time gains or losses, shifts in the allocation or distribution of activities during the day or shifts in differences among social strata

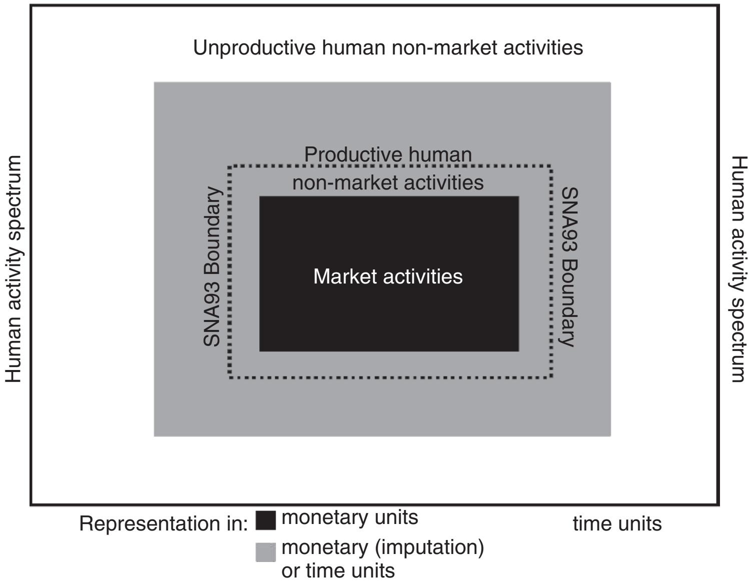

Fig. 37.1 Relationship Between Monetary and Time Use Data for the Representation of Human Activities

during a given reporting period (i.e. time cannot be hoarded – this is the *24 h add-up property*), time use data has the unique capability to capture *all* human activities under *equal coverage*[3] *of the whole population.*

To extend the scope of quantitative models, time use data can be applied not only as a standalone, but also as a basic data input for imputing the value of non-

[3] "Equal coverage" means that every citizen is represented as well as any other. This is a direct consequence of the 24 h add-up property of human time.

market activities in monetary terms. However, there seems to be an agreement in the National Accounting Literature that limits of monetisation need to be acknowledged, and imputation efforts should be restricted to *productive non-market activities* (Hawrylyshyn 1977; Stahmer et al. 2003a). Productive non-market activities are all those non-market activities with *market potential*, in that they can be carried out for someone by another third person. This is the so-called third person criterion, which can be used for their identification (see Reid 1934; Hill 1979). All activities which do not correspond to the third person criterion are "personal" in nature and not open for valuation. Hence, the entire spectrum of human activities can only be represented adequately by means of time use data, while all productive activities can also be depicted in money terms, as shown in Fig. 37.2. The appropriate representation depends on the research purpose.[4]

Second, time use data can help us to *understand and model economic decisions (or economic behaviour)* in a wider social context. The above definition of human time implies that it is a *scarce resource*, which *must* be allocated among alternative activities. Therefore, human time is at the heart of human decision making. Even in an utopian world without any material scarcity individuals are still left with the problem of how to allocate their time during a day, week, or year among alternative activities to maximise their life enjoyment. This is a standard economic problem of choice. Because the relationship between time and economic goods cannot be affected by their status as free goods, it must follow that the availability of time is also a crucial – even though often neglected – decision variable in today's world (Rosenstein-Rodan 1934).

The *third* point is closely related to the previous two. Time use data captures many interesting patterns of social life related to the temporal distribution of human

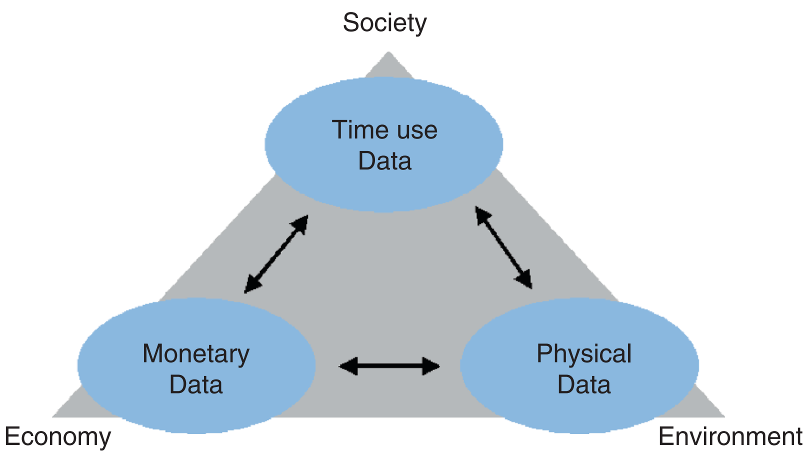

Fig. 37.2 A Magic Triangle for Quantitative Sustainability Research

[4] Note that the SNA93 production boundary also comprises some productive non-market activities (see UN, 1993a; Kendrick, 1996).

activities. This is not only limited to the duration of activities, but also their timing, frequency and sequential order (Szalai 1972). Hence, beside its larger scope, time use data carries *unique information (content)* mainly associated with the *social side* of sustainability:

> T(ime)A(llocation) measures the behavioural "output" of decisions, preferences and attitudes. It provides a measure of role performance. It measures the rates at which goods are produced. TA provides primary data on many kinds of social interaction and provides the basis for defining social groups by behaviour. TA can provide important data in studies of attitudes, values, cultural style, and emotions. Any kind of behavior with an environmental effect can be observed using TA techniques, including speaking, working, repose, leisure etc. (Gross 1984, p. 519)

Finally, time use data is a very good *anchor for linking other models or information from other data sources* related to human activities to quantitative frameworks. For example, supplementary information from time surveys, often called *context variables* (Eurostat 2000; UNST 2004), do allow for ordering human activities not only in time, but also in space (location and mode of transport) and provide scarce information on human interaction (for whom/with whom). However, all sorts of other information associated with human activities can be easily linked. This creates a whole array of new possibilities for interdisciplinary research, such as the integration of traditional environmental-economic models with models from other social science disciplines, which have much more focussed on the study of human activities and behaviour from a societal angle.

Towards a Basic Data Framework for Comprehensive Sustainability Research

For sustainability as a holistic scientific concept which is concerned with society and its natural surroundings, it is therefore crucial to integrate time use data into quantitative models for a better representation of human activities. This need has not only been stressed by researchers (e.g. Stahmer 1995; Cogoy 1995), but also in documents on the policy level such as Agenda 21 (see programme area D of Chapter 8) or in part V of the System for Integrated Environmental and Economic Accounting (United Nations 1993b).

Most importantly, combining data in monetary, physical and time units in a single integrative data framework allows for a complete coverage of the economic, social and environmental spheres.[5] but as *instrumental* Thereby, it is crucial to understand that the usefulness of the different measurement units for sustainability research is rooted in their interplay and not associated with either one of them. This is shown in Fig. 37.2. It is a particular strength of such a data framework that monetary and non-monetary phenomena are conceptually and numerically interlinked "without relying

[5] Socially scarce positional goods (see Hirsch, 1977), such as paintings of one of the great masters, or a status symbol, like a Lamborghini, might be seen as ends in themselves. However, they remain exceptions.

on theoretically faulty imputation of money values to non-monetary phenomena" (Keuning 1994, p. 41). Everything is represented in a suitable measurement unit. Such a data framework, therefore, appears as a basic platform from which sustainability studies should start, *whilst other information can and should be added depending on the research purpose*.

Unfortunately, sustainability studies have only very rarely applied data in all three different units (e.g. Schipper et al. 1989; Jalas 2002; Stäglin and Schintke 2002; Stahmer et al. 2003c, 2004). Even less work has been done by statistical offices to prepare data sets which bring together information in all three measurement units. To our knowledge, Carsten Stahmer's "Magic Triangle of Input-Output" (see Stahmer 2000; Stahmer et al. 2003a) and "Socio-Demographic Input-Output Accounting" (see Stahmer et al. 2004), as well as Keuning's "System of Economic and Social Accounting Matrices and Extensions" (SESAME) (see Keuning 1994, 2000; Kazemier et al. 1999), published by the Statistical Offices of Germany and the Netherlands respectively, are notable and visionary exceptions.

Integrating Time Use Data into the Analysis of Household Activities

Having developed the "time use argument" in the previous two Sections and established the need to integrate monetary, physical and time use data in one framework, we will try to demonstrate the power of the argument in the remaining Sections by applying it to the consumer-lifestyle debate in an input-output context. In particular, in this Section we outline why time use data might help us to improve the analysis of household consumption activities, and in subsequent Sections we will turn to an empirical application.

The relationship between household consumption activities and their associated resource use patterns is highly complex. It has been the main appeal of environmentally extended input-output models in the tradition of pioneers such as Leontief (1970) and Victor (1972) that they allow not only for estimating the resource flows triggered directly by household's purchases, but also for associating the indirect resource flows, which occur upstream in the industrial supply chain. For the analysis of household consumption, studies have usually compared the total resource use of different products or commodity groups (e.g. Kim 2002; Suh et al. 2002), functional household consumption categories (e.g. Wiedmann et al. 2006; Vringer and Blok 1995), or consumption baskets of different socio-economic groups (e.g. Wier et al. 2001; Cohen et al. 2005). The underlying household expenditure cluster – of a region or a nation as a whole, on average or across specific socio-economic groups – has often been interpreted as the manifestation of a particular lifestyle, and the approach is therefore often referred to as the "consumer-lifestyle approach" (see Weber and Perrels 2000).

However, conventional environmentally extended input-output models give an overriding importance to monetary transactions in the analysis of household consumption. Such a perception might be seen in analogy to the standard model of

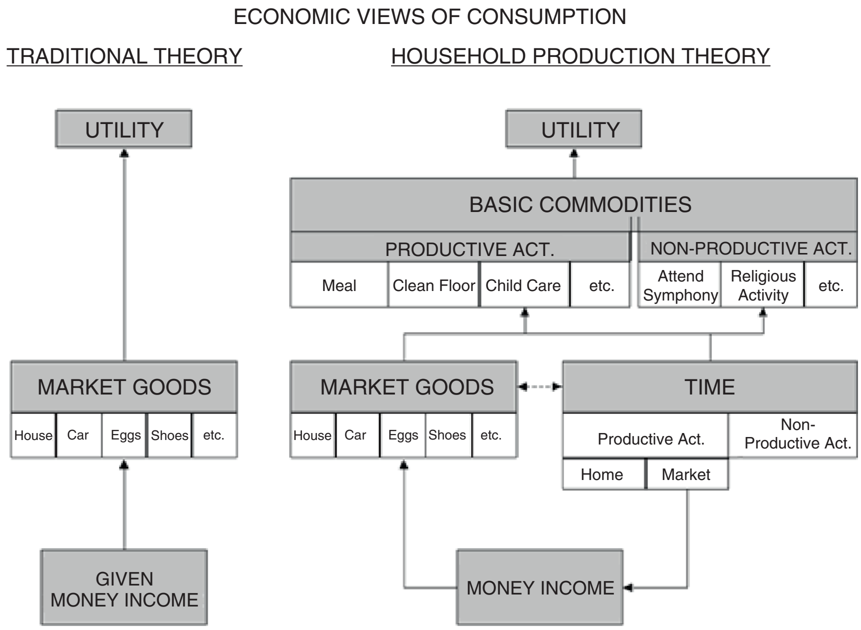

Fig. 37.3 Two Distinct Views of Household Consumption (Adapted from Hawrylyshyn [1977])

consumer demand, which views the choice of households as constrained solely by their money income. The final goods bought in the market are assumed to be ends in themselves. They are the sole providers of utility or happiness and determine the outcome of the choices based on the individual's set of preferences. This is shown on the left-hand side of Fig. 37.3.

However, goods are usually best perceived not as ends in themselves,[6] but as *instrumental* to the performance of an activity. In fact, it is difficult to think of a flow of goods being produced or used independent of involvement in an activity (Juster et al. 1981). Time is certainly another indispensable input for any human activity, as already argued in the section on Time Use Data. Therefore, household consumption activities might be better viewed as processes in which households, like little factories, combine market goods and time to produce "more basic commodities", as proposed in the household production literature (see Cairncross 1958; Becker 1965; DeSerpa 1971; Pollak and Wachter 1975). These basic commodities (Becker's "Z-goods") produced in households such as having a warm meal, seeing a play or caring for children, are the final consumption or enjoyment targets and ultimate providers of utility. This new, "productive" perception of household consumption is juxtaposed with the traditional one on the right-hand side of Fig. 37.3.

[6] Socially scarce positional goods (see Hirsch, 1977), such as paintings of one of the great masters, or a status symbol, like a Lamborghini, might be seen as ends in themselves. However, they remain exceptions.

Because households can substitute between time and market goods,[7] there are many different ways in which households can achieve a given consumption target. To have a hot meal, for example, people can cook for themselves, order take-away, or go to a restaurant. All these different "consumption technologies" for achieving a particular consumption target have very different economic and environmental implications and continuously re-define the borderline between the market and non-market spheres in consumption processes. For this reason, Cogoy (1995, 1999, 2000) convincingly argues that the consumer's decision in her socio-demographic context where to draw the boundary between the market and non-market spheres for a particular consumption activity is one major determinant of her aggregate environmental impact. A sound understanding of consumption activities then becomes crucial for learning how to effectively reduce high levels of resource use in developed countries from the demand side.

For depicting household consumption and associated resource patterns embedded in the social process, the input-output practitioner has, (1), to expand the vector of consumption expenditure into a matrix mapping the provision of final goods from industrial sectors to a complete set of human non-market activities, and, (2), to integrate a vector of (direct) time inputs by activity into the input-output framework. There are many other options for further customising the standard input-output framework for the analysis of household consumption activities, for example, by means of table design, the extension of the production boundary in monetary tables or a more far-reaching activity representation in time units. These options cannot all be discussed in detail, but the following Sections try to illustrate the relevance of some with a simple example. The interested reader is encouraged to consult the latest series of work by Stahmer and his colleagues (Stahmer et al. 2003a, 2004) for further inspiration.

It should be clear that input-output models lack a behavioural component and cannot model the underlying problem of choice. However, they can be used to analyse the outcome of choice processes. For the analysis of household consumption, we can map money, time and resource-use into an activity space in our extended framework. This enables us, for example, to observe the different consumption technologies for different activities, to identify the borderline between the market and the non-market spheres for a particular choice and to compare them through time and across socio-economic groups.

By doing so the consumer-lifestyle approach appears in a very different light. Schipper et al. (1989) have already made clear that a lifestyle is much better defined as an *activity* than as an expenditure *pattern*, which groups people according to what they *do* rather than on what they *spend*. Only such a definition takes all activities equally into account, can depict a lifestyle in its integrity and social embeddedness, and bridge the gap between the purposive ends of household consumption and associated resource use.

[7] In fact, it is also possible to think of direct substitution between time and resource use. For example, in order to save energy a person might engage in 'do-it-yourself' (DIY) activities and improve the insulation of the house. However, as there are always some market goods and services involved, this is also covered by the substitution relationship of money and time.

> Once a time dimension is introduced, the field expands considerably: commodities might be consumed once a time, or concurrently, or pure time might be consumed independently of consumer goods. (DeSerpa 1971, p. 828)

It is easy to conceive of human non-market activities which only use very little or no market goods at all, such as sunbathing, a daily walk through the village, or a housewife's afternoon nap. These activities do not contribute any less to a person's lifestyle, and the extent to which a person engages in these activities over her life-cycle should be adequately reflected in analysis. In fact, those activities might be of particular interest in a sustainability context and it should, for example, be worthwhile finding out what drives activity participation.

Cross-sectional and longitudinal analysis then opens a whole new array of research options that might allow for tackling problems, which have for a long time been at the heart of both the sustainability debate in general and the consumer-lifestyle debate in particular. For example, by observing consumption technologies across lifestyle groups, we can compare different ways of achieving a consumption target and identify key drivers behind these differences (Jalas 2002). This facilitates interesting comparisons between home-produced and market-produced services, for example, between having a dinner at home and having it in a restaurant (Jalas 2002). The availability of time use data also allows expression of resource use not only per unit of money spent, but also per hour of activity engagement (Van der Werf 2002; Jalas 2002). This provides an alternative view on resource use to policy makers and brings it much closer to the use-phase of products. Furthermore, the extensively discussed relationship between technology, time use/time saving and resource use in household production processes moves into the scope of input-output models, as analysed theoretically on the micro-level by Binswanger (2001, 2002).

Many more things can be investigated within such an extended input-output framework. Extending the SNA93 production boundary, for example, by applying time use data in imputation models allows many more household (productive) non-market activities in monetary tables to be represented. There does not seem to be any reason why the childcare, laundry, cooking and cleaning services of a housewife should be any less important for the input-output practitioner interested in sustainability than similar services provided by the market. Moreover, with an extended concept of production also comes an extended concept of income. They together allow for addressing topics such as the material well-being, poverty or income inequality of different lifestyle groups and their relationship to resource use much more appropriately than traditional models. It remains doubtful, for example, whether traditional input-output frameworks with superimposed inequality measures can reflect the distributional realities adequately, as the proportion of income to non-market output is usually "larger among the poor, and among the women, the aged, and those on farms and in rural areas" (Eisner 1988, p. 1613). In a similar line of reasoning, it remains doubtful what growth of household consumption observed in a series of traditional input-output tables really depicts. Is it growth or is it just a shift of a non-market activity into the market? Both have very different implications for human welfare and environmental considerations. Once extended monetary tables are used for analysis, this relationship between growth, well-being and resource use, which has been at the heart of the sustainability debate since its beginning (e.g. Schumacher 1974; Beckerman 1995), can be much more adequately addressed.

With the presence of time use data any other (human) activity-specific data source like subjective enjoyment ratings, or health data[8] can easily be integrated into an input-output context. Their contribution to lifestyle analysis should be clear. Moreover, institutional aspects, such as time regimes and time institutions, could be modeled (Ehling 1999). Because activities are not only rooted in time, but also in space, time use data might also facilitate a more comprehensive introduction of the space dimension into input-output modelling. Inspirations might be taken from scholars in Geography, who have been using time use and spatial data in combination for quite a while (see Carlstein et al. 1978a–c). A first attempt has already been undertaken by Schaffer (2003).

All these applications give rise to a much richer analysis of household activities and lifestyles within an input-output framework. Not only much broader analytical options, but also much more insightful links to debates in other disciplines can be established by the introduction of time use data. For the future it is our sincere hope that more use of this potential will be made and that quantitative sustainability models can help to push sustainability research another step forward towards an integrative, multi-disciplinary science and policy approach. The last Sections are devoted to a simple empirical application.

The Data Set – A "Magic Triangle of Input-Output Tables"

The data applied in this study is derived from a set of monetary, physical and time input-output tables for West Germany covering the reporting period 1990. It was compiled in a visionary effort by a group of statisticians lead by Prof. Carsten Stahmer and has become known under the heading of "Magic Triangle of Input-Output". For a detailed description of the data set, see Stahmer (2000) and Stahmer et al. (2003b).

The data set comes with two distinct monetary input-output tables: a traditional MIOT and an extended MIOT including a detailed breakdown of household activities, an explicit treatment of environmental services and a valuation of productive non-market activities. For our purpose we constructed a new table using information from both traditional and extended MIOT.

The resulting table is at a 61 sector aggregation level. In addition to the 58 sectors of the traditional German input-output publications, there are two environmental sectors and one sector for education. We aggregated both time (ZIOT) and physical (PIOT) input-output tables into the same format, and treated the ten household activities, which coincide with the ten headline activity fields of the German Time

[8] This occurred to me during a presentation by Paul Stonebrook of the Department of Health as part of the National Statistics "Time Use Seminar" (CASS Business School, London, 22 June 2004).

Table 37.2 Household Activities Distinguished in This Study

Abbreviation	Activity field
HPROD	Household production activities/household work
DIY	Do-it-yourself
COM	Paid job/job seeking (mainly commuting times to work)
VW	Voluntary and community work
EDU	Qualification/education
PR	Personal sphere, physiological regeneration
SOC	Contacts/conversations/social life
LEIS	Use of media/leisure time activities
CARE	Taking care of and attending people
RES	Non-allocatable times

Budget Survey (see Ehling 1999), exogenously as final demand like in the traditional MIOT.[9] They are listed in Table 37.2.

We further aggregated the ten household activity fields of the present study into four basic categories of time use, as is frequently done by scholars in sociology. This allows for studying major structural shifts in time-allocation and facilitates an analysis of the social process in its role distinctions (e.g. worker, spouse, parent). The basic underlying differentiation is between productive and other activities, as discussed above. Productive activities are subdivided into "contracted time" and "committed time", which are the productive market and non-market activities. The remaining (unproductive) non-market activities can be distinguished as "personal time" and "free time". "Travel" is a "floating" fifth category connecting the four different time uses (Robinson and Godbey 1997). This is shown in Fig. 37.4.

Durable consumer goods are generally separated out from households' final demand activities and recorded as investment goods, which are part of fixed capital formation. Education and household services related to study activities are treated as changes in the educational or human capital stock. Therefore, the final household activity matrix contains only zero entries in the row associated with "education services" (see Table 37.6). In order to bring all household activities into the scope of quantitative models, a hybrid concept is used for valuing the different market and non-market activities.[10] Industrial activities are estimated according to the "domestic concept" (Inlandskonzept), while household activities are recorded according to the "citizen concept" (Inländerkonzept).

From PIOT we extracted the total material flow vector of all 61 industrial sectors. Exogenizing the 61 × 10 sized household activity matrix, which records the tonnage of product used by households, required further transformations as resource inputs of four sectors (amounting to less than 1% of total sectoral resource flows) could

[9] In contrast, the extended MIOT records all goods and services used by households as intermediate inputs in the spirit of the household production literature.

[10] Stahmer et al. (2003a) points out that such a hybrid valuation causes problems when the number of citizens working abroad is not approximately equal to the number of foreigners working in the domestic economy. However, the accounting balance for cross-border commuters is pretty much balanced so that no such problems are expected here.

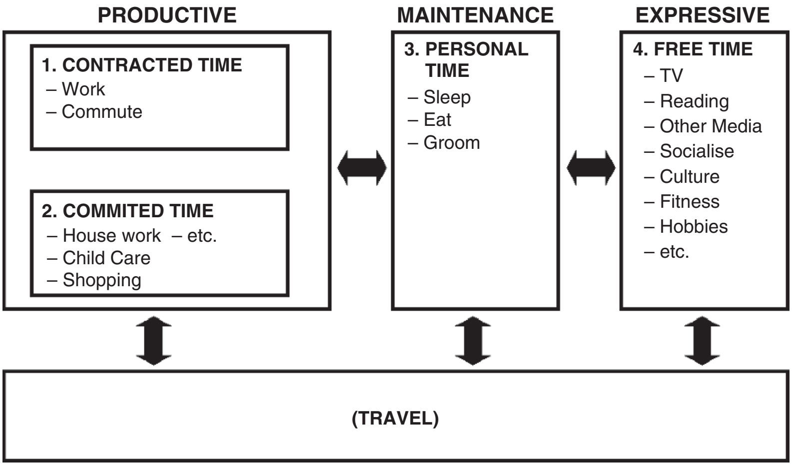

Fig. 37.4 Interrelations Across Four Types of Time (Adapted from Robinson and Godbey [1997])

Table 37.3 Socio-demographic Groups Distinguished in This Study

Abbreviation	Description
av	Average population
<12	Children aged younger than 12
12–65, nw, std	Students between 12 and 65 not enrolled in the labor market
12–65, nw	Citizens between 12 and 65 not enrolled in the labor market
12–65, w, std	Students between 12 and 65 enrolled in the labor market
12–65, w, ls	Employed citizens between 12 and 65 with low skill level
12–65, w, ms	Employed citizens between 12 and 65 with medium skill level
12–65, w, hs	Employed citizens between 12 and 65 with high skill level
12–65, w, av	Employed citizens between 12 and 65, average category
>65	Citizens aged older than 65

not be unambiguously allocated to a particular entry in the matrix. In these cases we spread the (resource) flows across sectors proportionally to their size. In addition, we allocated primary inputs across the final household activity matrix proportionally to the flows of goods delivered. The resulting matrix maps the *direct material flows* from “delivering” industrial sectors to household activities.

From the time input-output table (ZIOT) we extracted the direct time input vectors to industrial sectors sized 61×1 and to households sized 10×1. The latter fully captures the spectrum of human non-market (household) activities. Moreover, we separated out a 10×11 matrix mapping the time use of different socio-economic groups by activities from the data set. The socio-economic groups distinguished in this study are listed in Table 37.3.

Some Descriptive Statistics – An Input-Output Based Indicator Framework

Having described the construction of the data set and its main features, we now provide some basic indicators reflecting the general economic, social, and environmental conditions surrounding the average lifestyle in West Germany during 1990. These indicators can be readily obtained from the input-output tables. For instance, in 1990, approximately 63 million residents lived in West German households. The total time they could allocate among different market and non-market activities amounted to roughly 554 billion hours. Of these, only 46 billion were spent in the market, 82 billion on productive non-market activities, and 421 billion hours were allocated towards unproductive non-market activities (including sleep). Productive market activities for the provision of goods and services, as measured in the Gross National Product, amounted to 2,245 billion DM. Once productive non-market activities are included this measure rises by 40%. This points towards the importance of households in the provision of the material foundations of a society's welfare and the necessity to include them in any sort of welfare assessment. Thus, as indicated in section on Integrating Time Use Data, using input-output tables with an extended production boundary can considerably alter our view in many areas of interest for sustainability analysis, like international wealth comparisons or various intra-societal welfare assessments, such as poverty or income analysis (and their relationship to resource flows). However, note that the whole bulk of unproductive household activities, which can be expected to play a key role in the generation of human well-being, still remains unaccounted for.

The total material inputs required to provide for the West-German lifestyle summed up to 63 billion tons. Of these total material flows only about 15% were converted into goods – a basic measure of the material efficiency of the societal metabolism. While West Germany showed a positive trade balance in monetary terms, this balance was negative when measured in physical units. This is due to the fact that imports comprise mostly material-intensive goods such as raw materials and intermediate goods, while exports consists mainly of less material-intensive high-tech goods. Many more indicators of this type could be derived to characterise, for example, the different types of capital stocks (man-made, human, natural), or the use of knowledge in the various activities (and its relation to resource use), or for a more adequate (not purely monetary) description of human well-being. However, we hope that this provides sufficient indication of the richness of the data set and its potentials.

We have argued earlier that lifestyle analysis is rooted in the basic question of what people actually *do* during the day. Table 37.4 provides a *complete* picture of human activities of different socio-economic groups in West-Germany during 1990. Society's time patterns are largely dominated by "Physiological Regeneration" (PR) – due to the inclusion of sleep in this category – followed by fields such as leisure activities (LEIS), household production (HPROD) and market work (MW). The latter accounts for less than 9% of the total time use of the population.

Table 37.4 Socio-Economic and Environmental Key Indicators

Indicator	Unit	Estimate
Population	10^6 persons	63.3
Total time budget	10^9 h	554.1
Productive market activities	10^9 h	128.6
Productive non-market activities	10^9 h	82.3
Unproductive non-market activities	10^9 h	421.4
Residual	10^9 h	4.2
GNP	10^9 DM	2,245.3
GNP^{ext}	10^9 DM	3,230.2
Total material inputs (TMI)	10^9 t	63.0
Monetary trade balance	10^9 DM	118.0
Physical trade balance	10^9 t	−0.2
Employment	10^6 persons	28.5
Material efficiency[11]	%	14.7

A quick glance at Table 37.5 immediately reveals that activity patterns widely vary with socio-demographic characteristics. The distribution of time allocated to market work, for example, supports the claim that more highly skilled people tend to spend more time on their job. Children spend a considerable amount of time on leisure and regeneration activities as well as education, and therefore require significant amounts of resources from society. Employed citizens, who spend fewer hours at work, tend to spend more time on household production activities. This seems to hint that those groups make-up for their lower market income through the generation of higher non-market incomes.[12] Intuitively, we expect all these different activity patterns to involve very different sets of consumption goods and to trigger very different resource flows.

However, how much time people spend on different activities does not in itself constitute a lifestyle. It is also crucial to know "how" people perform an activity. This information can be gained from expenditure data. Table 37.6 shows how people spend their money on final products provided by the different industrial sectors, and in what activities they use them. In technical terms, this is the matrix expansion of the final household demand vector, briefly discussed in Comprehensive Sustainability Research section. Ideally, this matrix should be further disaggregated by activities and stratified according to socio-demographic characteristics. This would facilitate an in-depth cross-sectional comparison of lifestyles and their associated resource flows rooted in the different uses of time and money in the various household production processes.

Household consumption expenditure was clearly dominated by the demand for market services, which accounted for a remarkable share of 63% of the total budget,

[11] This indicator divides the total tonnage of goods and service by total material flows.

[12] This again seems to support the claim that traditional monetary input-output tables cannot appropriately reflect the distributional realities as outlined in Section 4.

Table 37.5 What do people do? Activity Patterns across Socio-Economic Groups

		MW	*HPROD*	*DIY*	*COM*	*VW*	*EDU*	*PR*	*SOC*	*LEIS*	*CARE*	*RES*
Total	10^9 hours	46.3	64.2	6.2	12.3	3.1	15.4	265.6	33.6	94.5	8.8	4.2
	%	8.4	11.6	1.1	2.2	0.6	2.8	47.9	6.1	17.1	1.6	0.8
<12	%	0.0	1.0	0.0	0.0	0.0	7.7	60.7	3.2	26.8	0.0	0.7
12–65, nw, std	%	0.0	5.3	0.9	0.0	0.3	17.9	47.0	6.9	19.4	0.7	1.7
12–65, nw	%	0.0	21.1	1.1	0.0	0.9	0.5	47.7	6.9	16.5	3.9	1.3
12–65, w, std	%	16.8	4.7	1.4	5.7	0.8	4.6	43.1	8.9	13.5	0.4	0.4
12–65, w, ls	%	16.3	11.9	1.5	4.5	0.1	0.4	44.5	5.8	13.4	1.3	0.3
12–65, w, ms	%	18.9	9.4	1.7	4.8	0.6	0.4	42.9	6.1	13.4	1.6	0.4
12–65, w, hs	%	20.5	8.1	1.5	5.3	1.0	0.5	42.5	5.9	12.6	1.8	0.5
12–65, w, av	%	18.5	9.2	1.6	4.9	0.6	0.7	43.1	6.2	13.3	1.4	0.4
65<	%	0.0	17.9	0.7	0.0	0.7	0.2	52.7	6.4	20.1	0.8	0.6

Table 37.6 Household Consumption Expenditure by Sector and Activity

Sector		HPROD	DIY	COM	VW	EDU	PR	SOC	LEIS	CARE	RES	**Sum**	Perc
Agr	10^6 DM	5,899	58	78	10	31	2,144	143	665	59	285	**9,371**	1.0%
En, Wa	10^6 DM	14,070	740	410	80	235	9,662	1,011	6,522	488	1,199	**34,416**	3.8%
Man	10^6 DM	94,799	11,603	7,557	535	1483	83,687	6,530	16,761	2,134	9,123	**234,213**	26.1%
Const	10^6 DM	862	65	69	13	0	1,260	170	817	83	183	**3,522**	0.4%
Serv	10^6 DM	103,915	13,625	20,073	1,950	10,085	223,672	31,324	123,155	8,439	25,290	**561,527**	62.5%
Env	10^6 DM	2,050	198	231	41	123	3,798	529	2,485	252	429	**10,137**	1.1%
Edu	10^6 DM	0	0	0	0	0	0	0	0	0	0	**0**	0.0%
N-serv	10^6 DM	2,619	74	313	20	2,245	12211	204	6,951	62	19,981	**44,679**	5.0%
Sum	10^6 DM	**224,214**	**26,363**	**28,730**	**2,649**	**14,203**	**336,433**	**39,911**	**157,356**	**11,517**	**56,490**	**897,865**	100 %

while 26% were directed towards manufactured goods. Hence, the demand for services from the tertiary sectors was more than double the demand for products from secondary sectors. It would be interesting to assess the actual contribution of services to a society's resource flows in absolute and relative terms, as various authors have stressed their importance in dematerialisation efforts. Unfortunately, this is outside the scope of this Chapter. Only small shares of the household budget were allocated directly to final products from agriculture and energy.

To further deepen our insights into household consumption activities, we need to leave the purely descriptive level of analysis and develop a model that facilitates the integration of data sources in different units. More specifically, we would like to attribute money, time and resource use in society to household consumption activities and other final demand entities, and analyse the mutual relationship between expenditure, material and time flows. This will be attempted in the next Section.

Model

In this Section we extend the consumer-lifestyle approach by entering time use data into a conventional environmentally extended input-output model. We use an augmented Leontief model combining monetary, physical and time allocation data to analyse household consumption activities. Production functions relate the amount of inputs used by a sector to the maximum amount of output that could be produced by these sectors with these inputs (Miller and Blair 1985). In the spirit of the household production literature we assume that for producing the total output vector $\boldsymbol{x}$ all human activities require the use of time, goods and materials, that is

$$\mathrm{x}_j = F(z_{1j}, z_{2j}, \ldots, z_{nj}, t_j, r_j) \tag{37.1}$$

where

z_{ij} = *intermediate inputs from i used in production of j*
t_j = *time input to production in j*
r_j = *material inputs to production in j*

We further assume that $F(\cdot)$ is of Leontief type. This means that the inputs are perfect complements and only used in fixed proportions. The production function exhibits constant returns to scale. We specify our general model by

$$\begin{aligned} &x_j = \min\left(\frac{z_{1j}}{a_{1j}}, \frac{z_{2j}}{a_{2j}}, \ldots, \frac{z_{1n}}{a_{1n}}, \frac{t_j}{\tau_j}, \frac{r_j}{\varepsilon_j}\right) \\ &\textit{with} \\ &a_{ij} = \frac{z_{ij}}{x_j};\ \tau_j = \frac{t_j}{x_j};\ \varepsilon_j = \frac{r_j}{x_j} \end{aligned} \tag{37.2}$$

For estimation we therefore augment the intermediate flow matrix $\mathbf{Z}$ and the partitioned final demand matrix $\mathbf{Y} = (\mathbf{Y^{hh}}|\mathbf{Y^{\neq hh}})$, where $\mathbf{Y^{hh}}$ is a matrix of household expenditure classified by household activities and $\mathbf{Y^{\neq hh}}$ is a matrix comprising the remaining final demand categories, with vectors $(\mathbf{0})$ and scalars (0) of zeros, vectors of time inputs $\mathbf{t}^{\text{prod}}$ and $\mathbf{t}^{\text{con}}$, as well as material input vectors $\mathbf{r}^{\text{prod}}$ and $\mathbf{r}^{\text{con}}$. The superscripts "prod" and "con" distinguish inputs to market and non-market activities of households. Hence

$$\mathbf{Z}^{aug} = \begin{pmatrix} \mathbf{Z} & \mathbf{0} & \mathbf{0} \\ \mathbf{t}^{prod} & 0 & 0 \\ \mathbf{r}^{prod} & 0 & 0 \end{pmatrix} \text{ and } \mathbf{Y}^{aug} = \begin{pmatrix} \mathbf{Y}^{hh} & \mathbf{Y}^{\neq hh} \\ \mathbf{t}^{con} & 0 \\ \mathbf{r}^{con} & 0 \end{pmatrix} \tag{37.3}$$

As indicated in Equation (37.2) we calculate an augmented direct coefficient matrix $\mathbf{A}^{aug}$ by

$$\mathbf{A}^{aug} = [a_{ij}] = \frac{z_{ij}^{aug}}{x_j} \tag{37.4}$$

Defining an identity matrix $\mathbf{I}$ of size $\mathbf{A}^{aug}$, we can establish the augmented, demand side Leontief model, that is

$$\mathbf{X}_{act}^{aug} = \begin{bmatrix} \mathbf{X}_{act}^{tot} \\ \mathbf{r}_{act}^{tot} \\ \mathbf{t}_{act}^{tot} \end{bmatrix} = (\mathbf{I} - \mathbf{A}^{aug})^{-1}\mathbf{Y}^{aug} = \mathbf{L}^{aug}\mathbf{Y}^{aug} \tag{37.5}$$

where $\boldsymbol{X}_{act}^{aug}$ is the augmented total output matrix consisting of the total economic output vector $\boldsymbol{iX}_{act}^{tot} = \boldsymbol{x}_{act}^{tot}$ with $\boldsymbol{i}$ being a vector of ones, $\boldsymbol{r}_{act}^{tot}$ is the total material flow vector and $\boldsymbol{t}_{act}^{tot}$ the total time flow vector with each element representing one of the k household non-market activities. From this model we can extract direct as well as direct and indirect requirement coefficients in various units. By extracting a sectoral total direct and indirect material intensity $\boldsymbol{\varepsilon}^{tot}$, we can calculate households' activity-specific material intensities in monetary and time units respectively by

$$\varepsilon_{\$}^{act} = (\varepsilon^{tot})'\mathbf{Y}^{hh}(\hat{\mathbf{y}}_{act}^{hh})^{-1} \tag{37.6}$$

where $\mathbf{y}_{act}^{hh} = \mathbf{i}\mathbf{Y}^{hh}$ is total household consumption expenditure by activity, the hat symbol ˆ indicates diagonalisation of a vector, and,

$$\varepsilon_{time}^{act} = (\varepsilon^{tot})'\mathbf{Y}^{hh}(\hat{\mathbf{t}}^{con})^{-1} \tag{37.7}$$

Results

In this Section we present some results that can be obtained from this type of model. In the first part the model estimations will be discussed. We try to demonstrate how our approach in multiple units facilitates a more far-reaching lifestyle analysis.

In the second part further extensions will be discussed, based on some preliminary estimations with U.S.-data. In relation to the Time Use Data section, the first part provides an example of how analysis can benefit from an extended scope (argument 1), and of the unique information content of time use data (argument 3). The second part stresses the "anchor" function (argument 4) of time use data and its potential to understand economic choice in a wider social context (argument 2).

Model Estimations

As argued in the Integrating Time Use Data section, it is of particular interest for the sustainability practitioner to observe the shifting borderline between the market and the non-market spheres, in order to understand the resource flows triggered by different activities (Cogoy 1995). To do so, we can either follow particular household activities through time, or compare them across socio-demographic groups or different activities. Because of the limitations in our data we are restricted to shifts of this boundary across activities, i.e. we can only study how the average household combines its time and money resources in different activities and what material (strictly speaking also time and money) flows are triggered by a particular choice of market and non-market inputs. This is shown in Table 37.7. Generally, expenditure ($\mathbf{y}^{hh}_{act}$) and resource flows ($\boldsymbol{r}^{hh}_{act}$), as well as embodied production time ($\boldsymbol{t}^{hh}_{ind}$), show very similar distribution patterns across activities, while non-market time ($\boldsymbol{t}^{con}$) seems to be allocated quite differently. Moreover, for some activities, such as household production and leisure, the direct ($\boldsymbol{r}^{con}$) and total ($\boldsymbol{r}^{hh}_{act}$) resource use patterns differ significantly.

These features become clearer when we further aggregate activities into the four major time use categories (plus travel) introduced in "Magic Triangle" section. Fig. 37.5 presents a bar chart with activity fields on the horizontal axis and the percentage share of total expenditure, time, and resource flows on the vertical axis. It should be noted that "travel" only comprises commuting to work. The other travel activities could not be separated out easily and are left as part of the committed, personal and free times.

Several informal conclusions can be drawn from Fig. 37.5. *First*, resource flows seem to follow monetary household consumption expenditures more closely than they do time expenditures. *Second*, there seems to be greater variation in time allocation than in the allocation of money and triggered resource flows across activity fields. *Third*, the relationship between direct and total resource use seems to differ depending on the activity field. *Fourth*, only for "committed time" the share of total expenditure is smaller than the percentage share of total resource flows triggered. *Fifth*, activity fields with relatively small time inputs seem to show relatively higher levels of resource use. This is suggestive of the frequent claim that the substitution of capital for time leads to an increased resource intensity of an activity, although we do not have sufficient data to assess this claim fully here. *Overall*, we might safely conclude that the boundary between the market and non-market

Table 37.7 Money, Time and Resource Flows Triggered by Household Activities.

Flow	Unit	HPROD	DIY	COM	VW	EDU	PR	SOC	LEIS	CARE	RES
$\boldsymbol{y}_{act}^{hh}$	10^9 DM	224.2	26.4	28.7	2.7	14.2	336.4	39.9	157.4	11.5	56.5
	%	25.0	2.9	3.2	0.3	1.6	37.5	4.5	17.5	1.3	6.3
$\boldsymbol{x}_{act}^{hh}$	10^9 DM	401.6	43.6	54.3	4.4	23.9	572.1	60.8	252.1	18.0	91.6
	%	26.4	2.9	3.6	0.3	1.6	37.6	4.0	16.6	1.2	6.0
$\boldsymbol{t}^{con}$	10^9 hours	64.2	6.2	12.3	3.1	15.4	265.6	33.6	94.5	8.8	4.2
	%	12.7	1.2	2.4	0.6	3.0	52.3	6.6	18.6	1.7	0.8
$\boldsymbol{r}^{con}$	10^6 tons	722	75	105	15	42	1,241	190	784	86	140
	%	21.2	2.2	3.1	0.4	1.2	36.5	5.6	23.1	2.5	4.1
$\boldsymbol{r}_{act}^{hh}$	10^6 tons	10,313	919	732	93	367	11,507	1,216	6,026	515	148
	%	33.8	3.1	2.5	0.3	1.2	37.1	4.1	19.7	1.7	4.9
$\boldsymbol{t}_{ind}^{hh}$	10^9 hours	4.02	0.40	0.44	0.03	0.24	5.61	0.47	2.06	0.11	1.13
	%	27.7	2.8	3.0	0.2	1.7	38.6	3.3	14.2	0.8	7.8

Note that the superscript hh denotes the total economic activity and material flows respectively triggered by households' consumption activities.

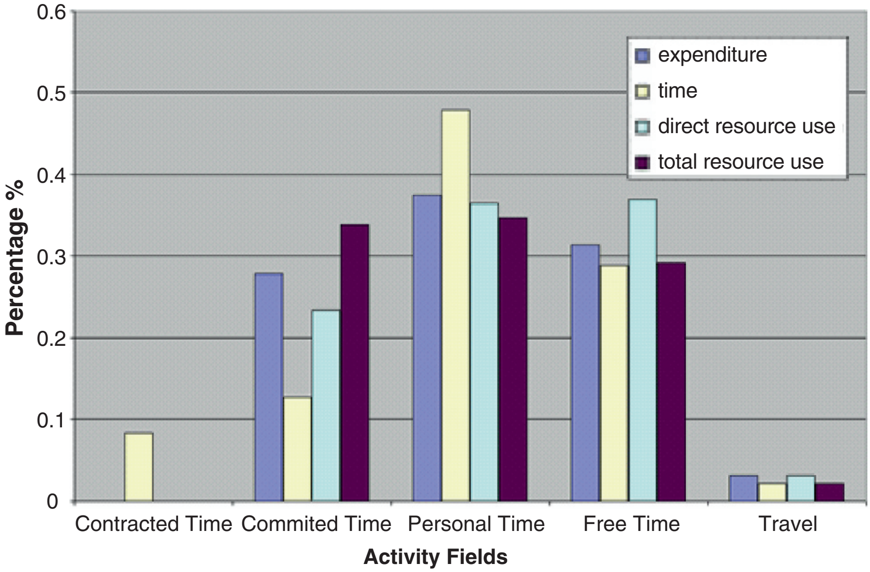

Fig. 37.5 Interrelation Between Expenditure, Time and Resource Use by Activity Field

spheres moves across activity fields, resulting in different patterns of resource use. Therefore, this approach seems to facilitate very well a detailed and insightful analysis of household consumption activities. Of course, our results are not more than a little appetizer for more detailed analysis, but it is not difficult to envision how much further analysis with some additional cross-sectional or time series data could go.

So far, the analysis has remained on a "gross"-level. However, it is often much more interesting to look at how many monetary, physical and time flows are triggered per unit change of a particular activity. This allows us to compare activities in terms of their environmental and socio-economic impact. In input-output analysis this approach goes under the name of *multiplier analysis*. In our discussion we concentrate again on the physical multipliers.

Usually, material intensities are related to the total amount of money spent during a given reporting period. We will henceforth call them "monetary material intensities" (see Equation (37.6)). Once time use data is introduced into the framework, we can also express material usage per unit of time spent on a particular activity within the given reporting period – henceforth "time material intensities" (see Equation (37.7)).

This puts resource usage in close relationship to *activity performance* and provides a new, useful perspective to policy makers (see Schipper et al. 1989; Jalas 2002; Van der Werf 2002; Hofstetter and Madjar 2003).

It is important to regard monetary and time material intensities as complements rather than substitutes, because they relate resource use triggered by different activities to the two basic inputs of household production processes. To complete the picture, it is also advisable to relate these two inputs to each other by expressing

Table 37.8 Resource Intensities by Household Activity

	Units	*HP*	*DIY*	*COM*	*VW*	*EDU*	*PR*	*SOC*	*LEIS*	*CFO*
$\varepsilon_{\$}^{act}$	t/DM	43.0	32.1	22.0	29.8	23.1	30.6	25.9	33.4	37.5
	rk	9	6	1	4	2	5	3	7	8
ε_{time}^{act}	t/h	141.3	129.4	49.8	25.0	20.9	38.0	30.3	54.4	48.4
	rk	9	8	6	2	1	4	3	7	5
ε_{hpi}^{act}	DM/h	3.5	4.3	2.3	0.9	0.9	1.3	1.2	1.7	1.3
	rk	8	9	7	1	2	4	3	6	5

consumption expenditure per unit of time or vice versa. We will henceforth call these coefficients *household production input intensities*, denoted by ε_{hpi}^{act}.

Table 37.8 presents monetary and time material intensities together with household production input intensities. The Table shows that monetary and time resource intensities vary considerably across activities. This variation is not only expected (see, Table 37.7 and Fig. 37.5), but desirable, as it provides the additional information necessary for identifying richer integrated models. Note that, because time inputs in the household production function are numerically smaller that consumption expenditures, the time resource intensity coefficients have a larger magnitude than the monetary resource intensities. As we would expect from the previous discussion, household production is the most resource-intensive activity, in terms of both money and time. In contrast, for activities such as education and socializing, time and resource intensities remain small, while they differ greatly for activities such as “commuting”, “care for others” and “DIY”.

Changes in resource intensities can be due to people consuming more or consuming differently. Assume, for example, that we observe a positive change in a time resource intensity and household production input intensity, while the associated monetary resource intensities remain stable. We can immediately infer that the change in the resource use patterns might be caused by a change in household production technology and, therefore, a shift in the dynamic boundary between the market and the non-market spheres. In other words, we are confronted with a social re-structuring of a household consumption process and can start searching for the causes of this shift.

Some Further Extensions of the Consumer-Lifestyle Approach

By going back to Fig. 37.5 we can extend our analysis further and try to answer the question *why* we might observe certain patterns of time, money and material use. As an example, consider the pattern for the activity field “committed time.” Compared with expenditure and triggered resource flows, a relatively small share of the time budget was allocated to this activity. Though it might well be in the nature of activities such as household work or do-it-yourself (DIY) activities that they require relatively more money than time inputs compared with other activities, there might be other reasons for the discrepancy between time use and expenditure and material flows across activity fields. Input-output models are not of great use themselves in explaining these discrepancies, because of their restricted production technology. An econometric approach based on a more flexible production functional form, which allows for substitutability among inputs to household production processes, might be more promising. However, what we can do is apply theoretical models for explaining the outcomes of input-output calculations.

An obvious candidate to do so would be the household production model itself. However, to make a case for the increased potentials of interdisciplinary research created by time use data, we apply a theory derived from an applied model in the sociological literature. Authors in these fields have worked a great deal with activity-specific enjoyment ratings. Robinson and Godbey (1997, p. 249) find in their analysis of enjoyment ratings, in combination with time allocation data spanning the time period from 1965 to 1995 that there is

> striking evidence for the long-disputed assumption that that there *is* a relationship between people's attitudes and their behaviour. In the course of daily life people *do* engage in activities that bring them greater enjoyment. In line with hedonistic explanations of daily life, people do what they say like to do.

This *hedonistic model* can, for example, explain many of the major shifts in activity patterns in the U.S. between 1965 and 1995.[13] Table 37.9 shows such ratings provided on a scale between 0 (dislike) and 10 (like a lot), aggregated into our four main activity fields for the year 1985.

And indeed, people seem to enjoy the activity field "committed time" least. This is mainly driven by low ratings for typical housework activities, such as cleaning or ironing. This low rating of (most) activities associated with the category "committed time" can be found for all different years (see, Robinson and Godbey 1997). Once we assume that this is a general pattern, which also holds for Germany,[14] this would

Table 37.9 Subjective Enjoyment Ratings for the Four Main Activity Fields

Activities	Rating	Smallest	Biggest	N
Contracted time	6.7	6.3	7.0	2
Committed time	6.1	4.9	8.8	8
Personal time	7.6	6.5	8.5	3
Free time	7.9	6.0	9.2	10

[13] Interestingly, one of the big exceptions is "watching television". Even though people seem to enjoy it less and less, they do it more and more. All increases in free time in the U.S. between 1965 and 1985 were completely re-invested into watching television!

[14] Clearly, this data is for the U.S. and cannot be just applied to Germany, where people might have very different attitudes towards activities. However, there might be good reasons to believe that Germany shows similar trends. If we assume that the hedonistic model also applies to other countries, there are good reasons to believe that similar low enjoyment ratings would be given in Germany, as a comparison of the time use for housework between 1992 and 2000 shows that the absolute amount of time invested into this kind of activities has declined despite an increase in the population (Statistisches Bundesamt, 2003, p. 11).

provide another explanation of why the time input into housework activities might be so low. The high expenditure might then be interpreted as an indication that people have tried to "save" time by increasing the capital intensity of housework processes by buying dishwashers, vacuum cleaners, washing automates or coffee machines, or by substituting activities like eating out for of preparing the meal at home and having to do the washing-up afterwards. Scholars in the environmental debate have argued that this continuous investment into time saving technology is another important factor in explaining the high level of resource use of housework (Binswanger 2001; Jalas 2002). Hence, we have built a little theory explaining the outcomes of our input-output model; that is why money and resource use are comparatively high and time use is comparatively low for this activity field.

Finally, we would like to briefly sketch how input-output models can be used to disentangle the relationship between well-being and resource use. This has not been comprehensively attempted so far by input-output practitioners. In Table 37.4 it was already shown that productive non-market activities significantly contribute in building up the material foundations for the creation of well-being. From an accounting perspective we can only speak about economic welfare in any meaningful way if these activities are included. Calculating the resource use associated with the different productive market and non-market activities and relating them to their "welfare contribution" would already mark a first step into this direction.

However, there is a long line of criticism of monetary welfare measures from other social sciences and within the economic literature itself. Monetary welfare measures do not only leave out the great bunch of unproductive non-market activities, which can be assumed to play a major role in the creation of human well-being as explained earlier. They are generally too narrow and measure at best only the material foundations of the welfare creation process. To overcome this we can incorporate activity-specific enjoyment ratings into the input-output framework in order to model life enjoyment as an indicator of well-being associated with a particular lifestyle. This certainly is another, more far-reaching step on the way to disclosing the relationship between the material foundations of well-being (provision of goods and services), resource use and well-being itself. Thereby, not only the enjoyment of different activities can be compared, but also indices for the average life enjoyment of a lifestyle group can be calculated. The latter is shown in Table 37.10, which again combines data from Germany and the U.S.

It should be clear that our table assumes that there are no meaningful differences in enjoyment ratings across socio-economic groups: indices for all different groups are calculated from enjoyment ratings of the average population. This is clearly not the case, as shown by various authors (see Frank 1997). Enjoyment ratings differ significantly across socio-demographic groups with characteristics such as income, employment status, age etc. However, as most groups seem to like similar types of

Table 37.10 Enjoyment Associated with Activity Pattern of Different Socio-economic Groups

	Ø	<12	12<>65, nw, std	12<>65, nw	12<>65, w, std	12<>65, av	>65
Average enjoyment	7.36	7.65	7.51	7.25	7.39	7.30	7.36

activities more or less (see, Robinson and Godbey 1997), we should be able to get a good picture about more or less desirable activity patterns in general even though we cannot be confident about the absolute level of enjoyment. It is not surprising that children are perceived to have the most enjoyable time patterns, because of their larger amount of personal and free times and their little engagement in activities associated with "committed time". And in fact, the appreciation of this life period is often expressed by people when they speak about their "easy and carefree childhood". It is also not surprising that the activity pattern associated with the lifestyle of students, who are not enrolled in the labor market, comes second. The category comprising unemployed people and housewives shows the least desired activity pattern, and old people live what might be called an "average life".

Conclusion

In this chapter we have proposed the integration of time use data into monetary-physical data frameworks. The appeal of time use data relates to four major capabilities, which allow representing social and behavioural issues in quantitative frameworks much more comprehensively. First, time use data allows for extending the scope of quantitative models to cover all human activities. Second, it helps in understanding and modelling economic decisions in a much wider social context. Third, the unique information carried by time use data allows for representing patterns of social life quantitatively. Fourth, time use data can serve as a very powerful "anchor" to incorporate other models and data into quantitative frameworks. Integrated data frameworks in monetary, physical, and time units therefore can cover all dimensions of sustainability comprehensively and appear as a good platform for sustainability research.

In an empirical application we have demonstrated how lifestyle analysis can benefit from the introduction of time use data through the adoption of a household production view on the meso-level, and we have demonstrated how this can be achieved in an input-output context. Such a productive view of household activities corresponds much better with the basic intuition of the Industrial Ecology approach, as it allows for analysing the production and consumption ends of the economy within one coherent framework and for providing a large array of new and interdisciplinary research options. The empirical analysis has been restricted by the available data. However, the results from our simple application have hopefully provided a flavour of how much further sustainability inquiries can go once monetary, physical and time use data have been integrated. So far our interdisciplinary journey into the time use literature has been very exciting and interesting and we sincerely hope that we have provided some inspiration to other researchers interested in the sustainability issue to join in.

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