Session Number: Session 7D
Time: Friday, August 29, AM

Paper Prepared for the 30th General Conference of
The International Association for Research in Income and Wealth

Portoroz, Slovenia, August 24-30, 2008

Clustering Households by Time Use Patterns
– An empirical investigation using the German Time Use Survey 2001/02

Stéphanie Grossmann
Prof. Dr. Rainer Hufnagel

For additional information please contact:

Stéphanie Grossmann / Prof. Dr. Rainer Hufnagel
Westfälische Wilhelms-Universität Münster
Philippistrasse 2
48149 Münster
Germany
grossmann@uni-muenster.de
hufnagel@hw.uni-muenster.de

This paper is posted on the following website: http://www.iariw.org

Clustering Households by Time Use Patterns

An empirical investigation using the German Time Use Survey 2001/2002

Summary

Clustering individuals or households on the basis of socio-economic variables has become a widespread practice in German social research over the past few decades. This paper is part of a research project that explores results which may be obtained when time use patterns are chosen as the basis of numerical classification. Over the past few years, results relating to single households were published by the authors. The present paper extends the analysis to families.
The investigation uses data from the German Time Use Survey 2001/2002. It is shown that the clustering process fulfils the criteria required by stochastic and qualitative social science. Furthermore, evidence is provided that including cluster memberships as dummy variables into a regressor set increases the predictive capabilities of a common multivariate analysis of correlations between socio-economic variables. Especially concerning health, meaningful interconnections between household styles and health state are detected.

1. Introduction

In Germany, for about thirty years, the social sciences have used clustering techniques to identify and define different types of social behavior and status. The clusters found through such research are entitled lifestyle ("Lebensstil", "Milieu").[1] The variables used to define distances between individuals or households are generally the usual socio-economic and socio-demographic ones, and further variables are attitudes, actions and some which describe socio-esthetic expression. This paper is part of a series of investigations that concentrate on actions. In particular, we use the information given by the Scientific Use File of the German Time Use Survey (SUF), and we cluster households only by their actions, i.e. the activities reported for three days of the week. That reliable and valid results can be achieved through this method has been shown by Hufnagel (2004) and Grossmann (2007) for the case of single households. The present paper shows corresponding results for the case of men and women living together as a couple, married or unmarried and either with or without children.

Clustering individuals into types or lifestyles is not always possible. There are technical criteria, given by stochastics, which mean that the fusion process is not statistically sound. The remaining handful of clusters must permit a meaningful and understandable description or characterization. If a researcher is successful in this stage of analysis, he can be regarded as having made a contribution to descriptive social science.

[1] For an overview see e.g. Geißler (2006, p. 193-120).

The proper criterion for success, however, is whether the work also makes a contribution to explicative social science. The decisive point is whether the fact that a certain individual is member of a certain cluster, facilitates more accurate predictions of the usual socio-economic variables than merely relying on a multivariate analysis, using only the usual variables.

We have succeeded in making a contribution for the case of singles, as mentioned above. The clusters we yield by using only time use activities as a basis for the clustering process are referred to as “household styles”. The present paper reports that this approach also applies to couples.

We proceed as follows. The second section gives a description of the data set on which the present analysis is based. The method (cluster analysis) is then explained in more detail in the third section, after which, the results are presented. It can be shown that the cluster analysis leads to well-defined types of different household styles for the persons under investigation. The resulting clusters are characterised by their time use and socio-demographic parameters, and in addition, their modal day-courses are displayed.

Section 4 reports the results of discriminant analysis. Firstly, this is explained briefly and secondly, the analysis is applied to the clusters identified by the cluster analysis. The results, especially the discriminatory force of the variables, and the cluster-averages for the discriminatory variables, are documented in the form of tables and diagrams.

The question of whether the cluster affiliation provides an autonomous explanatory contribution for socioeconomic variables is tested in Section 5. In this manner evidence is provided that the cluster analytical approach increases the predictive power of socioeconomic theory in comparison to the exclusive use of conventional multivariate analysis. Section 6 concludes and outlines the need for further research.

2. Description of the data used for the investigation

Our investigation is based on the Time Use Survey 2001/2002 of the Statistisches Bundesamt Deutschland (German National Office of Statistics)[2]. We use the 95% Scientific Use File (SUF) which has been available from the Statistisches Bundesamt since 2005. The sample size is approximately 5500 households comprising about 14500 people. Data was collected by means of the following methods:

- household questionnaires (one per household)
- personal questionnaires (to be completed by all household members older than 10 years)
- time diaries (also to be completed by all household members older than 10 years).

The usual socio-economic and socio-demographic data were collected for households and their members. In particular, data is available for household composition, income, living conditions, profession and education, health and satisfaction (with work and leisure-time activities). Based on the time diaries, a computer file was constructed that indicates how much time was used for which activity each day.[3] The list of activities comprises 272 items. The activities are classified hierarchically by subject. For example, we have Activity Number 312 "baking" that belongs to Activity Group Number 31 "preparing meals". Again, Activity Group Number 31 is subsumed under Activity Field 3 "housekeeping".

Time use is documented in a file which shows, for each individual older than 10 years, which activities had been conducted in 10-minute intervals. Normally, such information is available with respect to the activities conducted in three days by each person.

In this investigation, we used a sample of 1996 couples with children and 990 couples without children.[4] Tables 1 to 4 show the sample means of the variables that we use later on to characterise the detected clusters.

[2] For a detailed description of these activities, see the handbook from the SUF of the Statistisches Bundesamt.
[3] See Gershuny (1990), p.23
[4] Homosexual couples were not included, but no distinctions were made between adopted children, stepchildren and legitimate children.

Table 1: Variables and their means for the sample of parents – individual characteristics

Variable	Description	Mean fathers	Mean mothers
ALTER	Age	43,8	41,8
SEX	0=male, 1=female	0	1
HPW	Weekly working hours	41	14,2
SPONTAN[5]	Degree of spontaneity of time use	-0,09	-0,15
GESUND[6]	Self-estimated state of health	2,85	2,88
OSA	No graduation	0,01	0,01
HS	Extended primary school is highest level of education attained	0,28	0,2
RS	"Realschule" is highest level of education obtained	0,29	0,45
ABI	University-entrance diploma	0,42	0,34
LEHRE	Vocational training completed	0,62	0,67
SG	Student	0,01	0,07
MEISTER	Extended vocational training completed	0,13	0,03
UNI	University degree	0,37	0,21
ERWERBSSTAT[7]	Employment	1,21	3,7
HAUPTERWERBS-EINKOMMEN[8]	Salary	8,2	2,3
STAT[9]	Social rank	3,79	6,53
QUANTFREI[10]	Contentment with amount of leisure time	1,34	1,35
QUANTBER[11]	Contentment with amount of working time	2,40	2,54
QUANTEHR[12]	Contentment with amount of time for volunteering	3,10	3,16
QUANTFREU[13]	Contentment with amount of time for friends	1,50	1,44
QUANTHAUS[14]	Contentment with amount of time for household	1,90	2,11
QUANTPARTNER[15]	Contentment with amount of time for partner	1,38	1,48
SATBER[16]	Contentment with working time	3,73	3,28

[5] 1 = not spontaneous, 2 = spontaneous, 3 = differing
[6] Range from 0 (very bad) to 4 (very good)
[7] Range from 1 (full-time work) to 7 (unemployed)
[8] Income classes from 0 - 13
[9] 1=farmer/self-employed, 2=family workers, 3= public servant, 4=salaried employee, 5=worker, 6= commercial and technical apprentices, 7=industrial apprentices, 8=military/civilian service, 9=pupils, younger than 15 years, 10= pupils, 15 and older, 11=students, 12=retiree, 13=registered unemployed, 14=other non-workers
[10] 1= too little, 2=right, 3=too much, 4=n/a
[11] See above
[12] See above
[13] See above
[14] See above
[15] See above
[16] Range from 1(very content) to 7(very discontent)

Tab. 2: Variables and their means for the sample of couples without children– individual characteristics

Variable	**Description**	**Mean men**	**Mean women**
ALTER	Age	58,7	56
SEX	0=male, 1=female	0	1
HPW	Weekly working hours	17,7	12,6
SPONTAN	Degree of spontaneity of time use	-0,03	-0,06
GESUN	Self-estimated state of health	2,73	2,59
OSA	No graduation	0,01	0,01
HS	Extended primary school is highest level of education attained	0,45	0,41
RS	"Realschule" is highest level of education obtained	0,26	0,37
ABI	University-entrance diploma	0,28	0,21
LEHRE	Vocational training completed	0,72	0,63
SG	Student	0	0,05
MEISTER	Extended vocational training completed	0,18	0,03
UNI	University degree	0,29	0,17
ERWERBSSTAT	Full-/part-time work	4,16	4,65
HAUPTERWERBS-EINKOMMEN	Salary	3,5	2,1
STAT	Social rank	7,61	8,56
QUANTFREI	Contentment with amount of leisure time	1,69	1,61
QUANTBER	Contentment with amount of working time	1,65	1,64
QUANTEHR	Contentment with amount of time for volunteering	2,08	3,3
QUANTFREU	Contentment with amount of time for friends	3,23	3,45
QUANTHAUS	Contentment with amount of time for household	2	2
QUANTPARTNER	Contentment with amount of time for partner	3,51	3,55
SATBER	Contentment with working time	3,04	3,12

Tab. 3: Variables and their means for the sample of parents –household characteristics

Variable	Description	Mean
HILFE[17]	Help received from others	0,61
SOZIALHILFE	Welfare aid	0,01
STUETZE	Unemployment compensation	0,1
HHEINKOMMEN[18]	Household net income (class)	5,0
WOHNFLÄCHE	Living space [m²]	124
PKW	Number of cars	1,56
PC	Number of personal computers	1,45
VIDEO	Number of video recorders	1,23
LAVADORA	Number of dishwashers	0,87
MIKRO	Number of microwaves	0,77
RAD	Number of bicycles	3,64
TELE	Number of telephones	1,34
HGROESSE	Number of members of household	3,91
OSTWEST[19]	Old /new federal states	1,19
TV	Number of TV sets	1,98

Tab. 4: Variables and their means for the sample of couples without children–household characteristics

Variable	Description	Mean
HILFE	Help received from others	0,3
SOZIALHILFE	Welfare aid	0,003
STUETZE	Unemployment compensation	0,1
HHEINKOMMEN	Household net income (class)	4,46
WOHNFLÄCHE	Living space [m²]	105
PKW	Number of cars	1,16
PC	Number of personal computers	0,7
VIDEO	Number of video recorders	0,93
LAVADORA	Number of dishwashers	0,66
MIKRO	Number of microwaves	0,67
RAD	Number of bicycles	1,86
TELE	Number of telephones	1,15
HGROESSE	Number of members of household	2
OSTWEST	Old /new federal states	1,19
TV	Number of TV sets	1,62

Couples without children have an average age greater than that of parents. This fact results from the selected definitions of parents, and for couples without children. Parents are defined as couples whose children are younger than 18 and still living in the same household. Couples without children are those couples who either do not have children or whose children no

[17] Number of different forms of support
[18] Income classes from 1-7
[19] 1=former West Germany, 2=Easr Germany

longer live in the same household as their parents. For this definition, childless couples apparently must be older than the parents.

3. Classification

Cluster analysis is an attempt to identify homogeneous subgroups of cases in a population. That is, cluster analysis tries to identify a set of groups which both minimize within-group variation and maximize between-group variation. The simultaneous consultation of all known properties of the objects is one of the main characteristics of cluster analysis.[20] The specific property of the present investigation is that we use only the sequence of daily activities as individual properties. A distance between two individuals, must, therefore, be defined as dissimilarity between time use sequences. This is described in the following section.

3.1 Calculation of a distance matrix

Hierarchical clustering allows users to select a definition of distance, and then to select a linking method for forming clusters, and after that, to determine how many clusters best suit the data. The first step in cluster analysis is the definition and calculation of the similarity or distance matrix. This matrix is a table in which both rows and the columns are the units of analysis. The cell entries are a measure of similarity or distance for any pair of cases. The distance or dissimilarity function measures the degree of difference between data elements. Identical pairs have zero distance or dissimilarity and all others have a positive distance or dissimilarity.

The documented time use of each individual (with number i) formally constitutes a 288-dimensional vector for each of the documented weekdays (Monday – Friday). [21]

$$z^{\langle i \rangle} = (a_1^{\langle i \rangle}, ..., a_{288}^{\langle i \rangle}).$$

The coordinates assume qualitative values that are the activities from the list of the Statistisches Bundesamt.[22] This list implies a certain hierarchy and thus information about the distance. For instance, Activity 012 (to lay the table) is more similar to Activity 013 (to clean the dishes) than to Activity 021 (care and cleaning of clothes and leather). Yet, the latter is still more similar to Activity 012 and 013 than activities from Group 6 (contacts, talks and

[20] See to this Backhaus et al (2006), p. 12
[21] Weekdays are used here because of the differences between weekdays and weekends which are not limited to work, see also Lesnard (2004), p. 62
[22] See Table E (Appendix)

sociability) are. Due to these facts, the distance d_t between two objects i and j in a given 10-minute-pulse t is defined as follows:

$$(1)\ d_t = \begin{cases} 0 & if\ \ a_t^{\langle i\rangle} = a_t^{\langle j\rangle} \\ 1 & if\ \ a_t^{\langle i\rangle}\ and\ a_t^{\langle j\rangle} only\ differ\ in\ ones\ columns. \\ 2 & if\ \ a_t^{\langle i\rangle}\ and\ a_t^{\langle j\rangle} differ\ in\ decades\ but\ not\ in\ hundreds. \\ 3 & if\ a_t^{\langle i\rangle}\ and\ a_t^{\langle j\rangle} differ\ in\ hundreds. \end{cases}$$

Using (1), the distance between two days can be defined as:

$$(2)\ d(z^{\langle i\rangle}, z^{\langle j\rangle}) = \sum_{t=1}^{T} d_t .$$

The distance for the whole day is therefore defined as the sum of the pulse distances. For each person, three weekdays are documented.

Firstly $D_{p,q}^{\langle i,j\rangle}$, the distance between object i's p^{th} weekday and object j's q^{th} weekday is defined as follows:

$$(3)\ D_{p,q}^{\langle i,j\rangle} = \begin{cases} \infty\ \ if\ \ i's\ p^{th}\ weekday\ or\ j's\ q^{th}\ weekday\ is\ not\ documented \\ d(weekday(p,i), weekday(q,j)) \qquad otherwise \end{cases}$$

For all p,q $\in \{1,2\}$.

The distance between the objects i and j can now be defined as minimum of the weekday distances:

$$(4)\ \widetilde{D}^{\langle i,j\rangle} = \underset{p,q\in\{1,2\}}{MIN}\,(D_{p,q}^{\langle i,j\rangle}) .$$

Because the distance defined in this manner did not differentiate clearly enough between the objects within the cluster analysis, Formula (4) had to be modified. The following definition leads to a clearer distinction of the objects:

(5) $D^{\langle i,j \rangle} = (\widetilde{D}^{\langle i,j \rangle} - \widetilde{D}_{\min})$

with

(6) $\widetilde{D}_{\min} = \underset{i,j \in \{1,\ldots,z\}}{MIN}(D^{\langle i,j \rangle})$

(z = 1996 for the case of parents and z = 990 for the childless couples).

The modification consists of sub-ducting the smallest weekday distance from the minima of the weekday distances $\widetilde{D}^{\langle i,j \rangle}$ determined in (4). For the following cluster analysis, the distance matrices were calculated by means of (5).

3.2 The cluster analysis

As the average-linkage method used in the present investigation, hierarchic agglomerative techniques starts with treating every object as an own cluster. The various hierarchic methods only differ as to the formula that is used to recalculate the distances to the new cluster resulting from fusion.[23]

They commence with each member of the set in a cluster of its own and then fusing the nearest clusters according to the chosen distance. Then, in each subsequent step, the two most similar clusters are merged. That is, in hierarchical clustering, larger clusters created at later stages may contain smaller clusters created at earlier stages of agglomeration. Each agglomeration occurs at a greater distance between clusters than the previous agglomeration, and the researcher can decide to stop clustering either when the clusters are too far apart to be merged (distance criterion), when all clusters are combined into one single cluster or when there is a sufficiently small number of clusters according to a predetermined quantity (number criterion). Another possibility that was used in this present analysis entails stopping the process of cluster agglomeration on the basis of a specified criterion when a certain number of clusters has been formed. These various hierarchic methods only differ as to the formula that is used to recalculate the distances to the new cluster resulting from fusion.[24]

[23] See to this Steinhausen (1977), p. 76 f

[24] See to this Steinhausen (1977), p. 76 f

3.3 Results

The analysis is conducted through the SAS-procedure CLUSTER.[25] "Average" was selected from the numerous methods of clustering objects. A local maximum of the pseudo-F value at n, simultaneously with a local maximum of the t^2-value at n+1, serves as the termination condition.[26] Using the distance matrices of the 1996 mothers and fathers and the 990 couples without children, the analysis yielded different numbers of clusters for each of the investigated group of people, because of multiple local maxima. The decision on the number of clusters was reached by considering the contextual criteria.

Finally the analysis yielded 36 clusters for the mothers, 43 for the fathers, 27 for the female side of the couples without children and 35 for the male side. Using these numbers, the students or apprentices constitute their own clusters, just as the retirees and employees.

In Tables 5 to 8, the larger clusters of each investigated group are described. The short characterisations are specified in more detail below.

The clusters resulting from this analysis show that the process delivers a classification in terms of students/apprentices, employees and retirees. Especially for the retirees and employees, different housekeeping styles are identified. All withstand a check of plausibility.

3.3.1 Parents

Using the distance matrix of the 1996 mothers and the abovementioned termination condition, the results of the cluster analysis are presented in Table 5. While the cluster analysis yields 36 clusters for the mothers, only 20 of the 36 clusters have 20 or more members, and the remaining ones cannot be allocated to the larger clusters.

[25] SAS-Institute (2003), p. 834 ff
[26] SAS-Institute (2003), p. 840

Tab. 5 Clusters of mothers

Cluster No.	Number of members	Description
1	110	Full-time employees
2	157	Full-time employees, get up earlier than Cluster 1 and need longer for personal hygiene
3	120	Part-time employees, shift workers
4	76	Full-time employees, early shift
5	91	Part-time employees, working predominantly in afternoons and evenings
6	31	Apprentices
7	175	Part-time employees, working in the mornings
8	126	Part-time employees, working predominantly in the morning, but less hours than Cluster 7 and earning less
10	82	Working regularly, but less than 18 hours, sleep long hours, strollers
11	29	Pupils/students, spend a lot of time preparing for school/lectures
12	151	Pupils/students, watch a lot of TV
13	115	Working regularly, but less than 18 hours, spend a lot of time for shopping
14	53	Occasional employees, homely
15	221	Scholars
17	123	Unemployed
18	122	Occasional employees, are younger, sleep earlier and get up earlier than cluster 14
19	22	Unemployed, honorary engagement
20	22	Occasional employees, partygoers
21	119	Occasional employees with young children
22	20	Employees working only few hours

Regarding the 1996 fathers and their distance matrix, the cluster analysis yields 43 clusters, of which 19 have 25 or more members. With regard to women, some objects cannot be classified into the large clusters. Table 6 shows the 19 large clusters of fathers.

Tab. 6: Clusters of fathers

Cluster No.	Number of members	Description
1	246	Full-time employees, normal shift
2	57	Full-time employees, early shift
3	141	Full-time employees, early or normal shift, working longer than cluster 1 and 2
4	83	Full-time employees, late shift, working more than 10 hours a week
5	181	Full-time employees, get up later than cluster 7 and having a shorter distance to work
7	273	Full-time employees, early riser, long distance to work
8	128	Full-time employees, early shift, long distance to work
9	49	Full-time employees, work from noon onwards
10	36	Full-time employees, late shift, partner also works
11	37	Full-time employees, normal shift, socialise in the evening
12	87	Full-time employees, only work in the morning
14	69	Apprentices, have plants at home and keep pets
15	65	Part-time employees, homemaker
17	31	Full-time employees, public servant
20	25	Part-time employees, hobbyists, voluntary workers
22	63	Part-time working employees, higher income than cluster 20
24	79	Apprentices
26	63	Apprentices, part-time employees, partner earns about the same amount
28	33	Apprentices, homemaker

3.3.2 Couples without children

With regard to women who are part of a couple and do not have a child living in the household, the cluster analysis yields 27 clusters, of which 17 include more than 20 observations. These are documented in Table 7. The smaller clusters are disregarded.

Table 7: Clusters of childless women

Cluster No.	Quantity of members	Description
1	81	Full-time employees, normal shift
2	83	Part-time employees
3	60	Full-time employees, early shift
4	113	Retirees/older unemployed, long break at noon
6	41	Apprentices
7	88	Unemployed
8	68	Retirees
9	26	Part-time employees, housework in the morning, paid work from afternoon until evening
10	74	Retirees
11	25	Occasional employees, invalids
13	86	Unemployed, spend a lot of time at home
15	22	Retirees, housework in the morning, socialise in the afternoon
16	45	Occasional employees, cleaning the home in the morning, washing clothes and dishes in the afternoon
17	32	Retirees and older unemployed, housework in the morning, gardening in the afternoon
18	27	Retirees, spend much time at home, washing in the afternoon
19	27	Occasional employees, housework in the morning, shopping and ironing from late afternoon until evening
21	24	Occasional employees, go to bed early, early riser, spend much time at home

The cluster analysis for the corresponding men yields 16 clusters with 20 or more members, as shown in Table 8.

Tab. 8 Clusters of childless men

Cluster No.	Quantity of members	Description
1	141	Full-time employees, normal shift
2	115	Full-time employees, normal shift, longer commute to work, early riser
3	24	Full-time employees, late shift
4	30	Part-time employees
5	45	Occasional employees, very homely, late riser
7	41	Retirees, go shopping in the morning and socialise with friends in the afternoon
8	64	Retirees or older unemployed, watch TV in the afternoons
11	27	Retirees, work in the garden, especially in the morning
15	28	Occasional working employees, spend a lot of time looking after their plants
17	37	Occasional employees, work in the morning, take a long break at noon at watch lots of TV in the evening
18	76	Apprentices / pupils
19	32	Occasional employees, spend very much time at home, long break at noon
20	50	Older retirees, long break at noon
21	63	Retirees, spend very much time at home, early riser
25	26	Retirees or older unemployed, go shopping in the morning, stay at home in the afternoon
28	34	Occasional employees, voluntary work in the morning, socialise in the afternoon

3.4 Modal day-courses

To demonstrate which day-courses were joined to a cluster, Figures 1-5 show the modal day-courses exemplarily for some of the mothers' clusters. The modal day-courses were created by determining the modal activity, which means the activity most cluster members do, for each of the 144 daily pulses. For this reason, the daily courses show the most frequently performed activity for each point of time and can hence be characterized as representative or typical. However, it would be misunderstanding to see them as really existing day-courses in the observed sample. The visualization of the day-courses is not easy. While the two-dimensional form is better arranged as the three-dimensional, it contains less information. The three-dimensional form does not only show the modal activity, but also all the other activities performed at each point of time. Additionally, it informs about the percentage of cluster-members that are doing the different activities. Figure 1 exemplarily shows the modal day-course for cluster 1 of the mothers in three-dimensional view and demonstrates that always a high percentage of the cluster-members perform the modal activity except during the changes between two activities. This fact is valid for all the clusters of mothers, fathers and childless

women and men. The day-courses of cluster 2-5 are shown two-dimensional because of the better arrangement. [27]

Figure 1: Modal day-course of cluster 1- three-dimensional view (mothers)

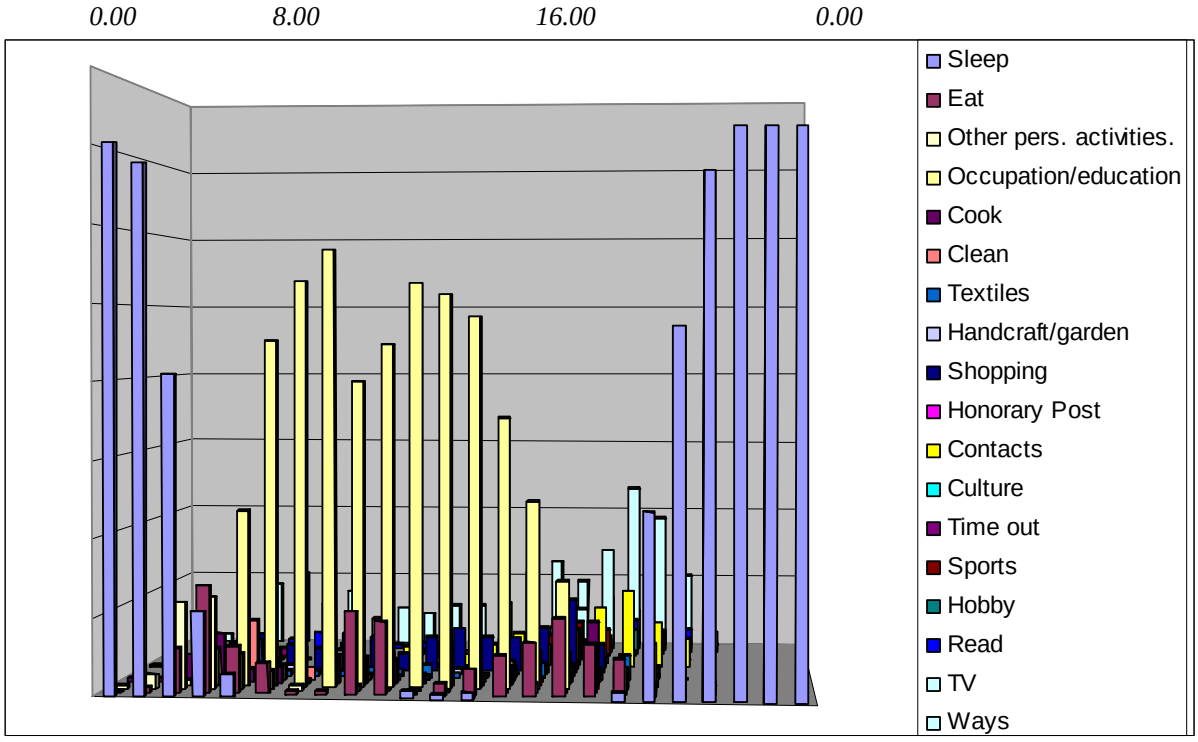
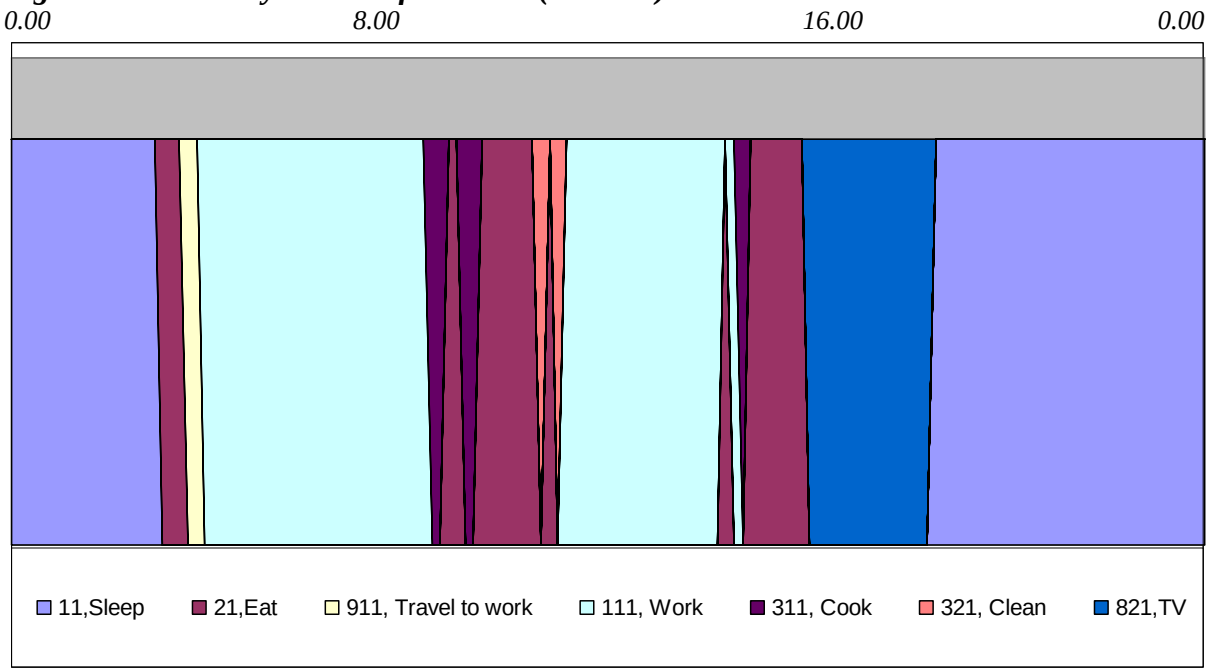


Figure 2: Modal day-course of cluster 1 – two-dimensional view (mothers)

0:00-7:10	7:10-8:00	8:00-20:00	20:00-22:30	22:30-0:00
Sleep	Eat	Work	TV	Sleep

[27] For more information about the difficulties of visualization see Ellegård and Cooper (2004), p.38ff and Michelsen and Crouse (2004), p.86 ff

Figure 3: Modal day-course of cluster 2 (mothers)

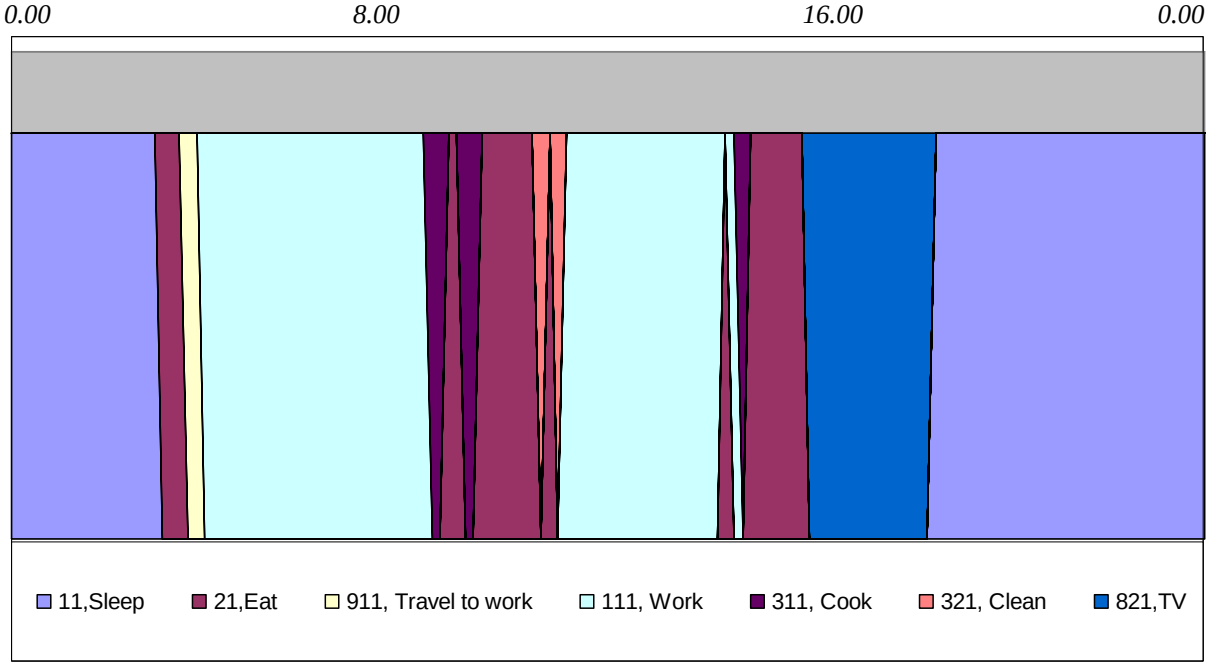


0:00-6:20	6:20-6:40	6:40-7:00	7:00-7:10	7:10-7:30
Sleep	Pers. hygiene	Eat	Pers. hygiene	Travel to work

7:30-17:30	17:30-17:50	17:50-18:00	18:00-20:00	20:00-22:00
Work	Eat	Shopping	Eat	TV

22:00-0:00
Sleep

Figure 4: Modal day-course of cluster 3 (mothers)



0:00-7:00	7:00-7:30	7:30-7:50	7:50-12:20	12:20-12:40

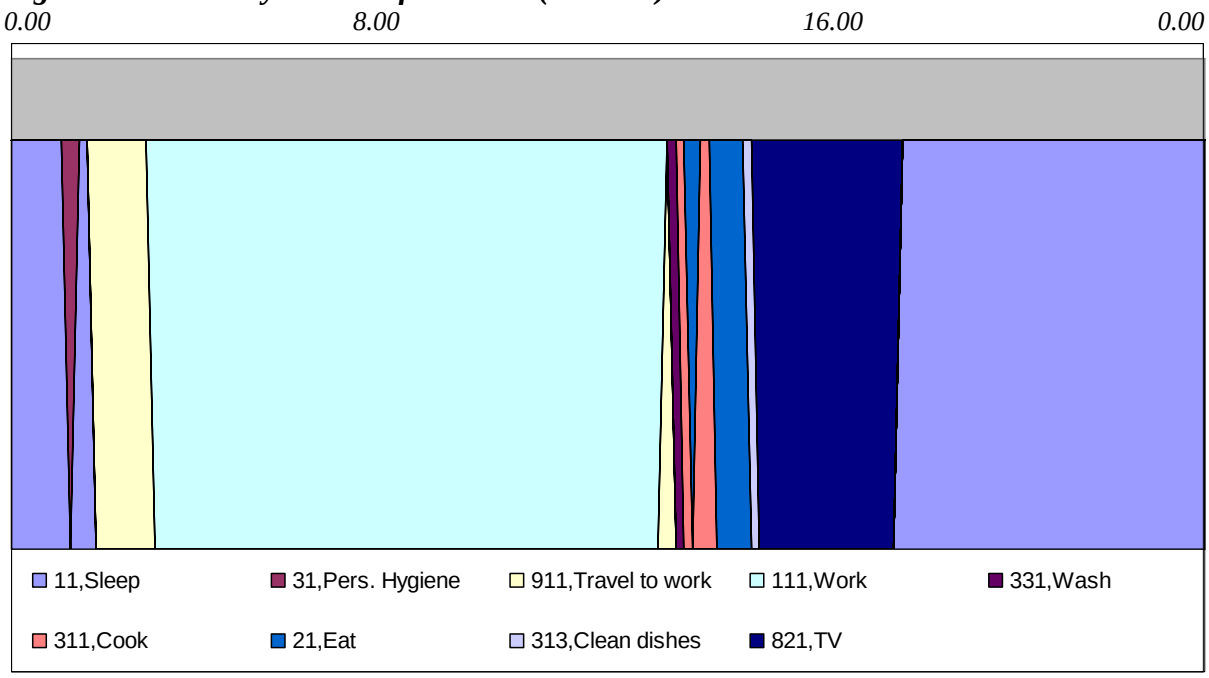
Sleep	Eat	Travel to work	Work	Cook

12:40-13:00	13:00-13:20	13:20-14:30	14:30-14:40	14:40-15:00
Eat	Cook	Eat	Clean	Eat

15:00-15:10	15:10-18:10	18:10-18:20	18:20-18:30	18:30-18:40
Clean	Work	Eat	Work	Cook

18:40-19:50	19:50-22:30	22:30-0:00
Eat	TV	Sleep

Figure 5: Modal day-course of cluster 4 (mothers)

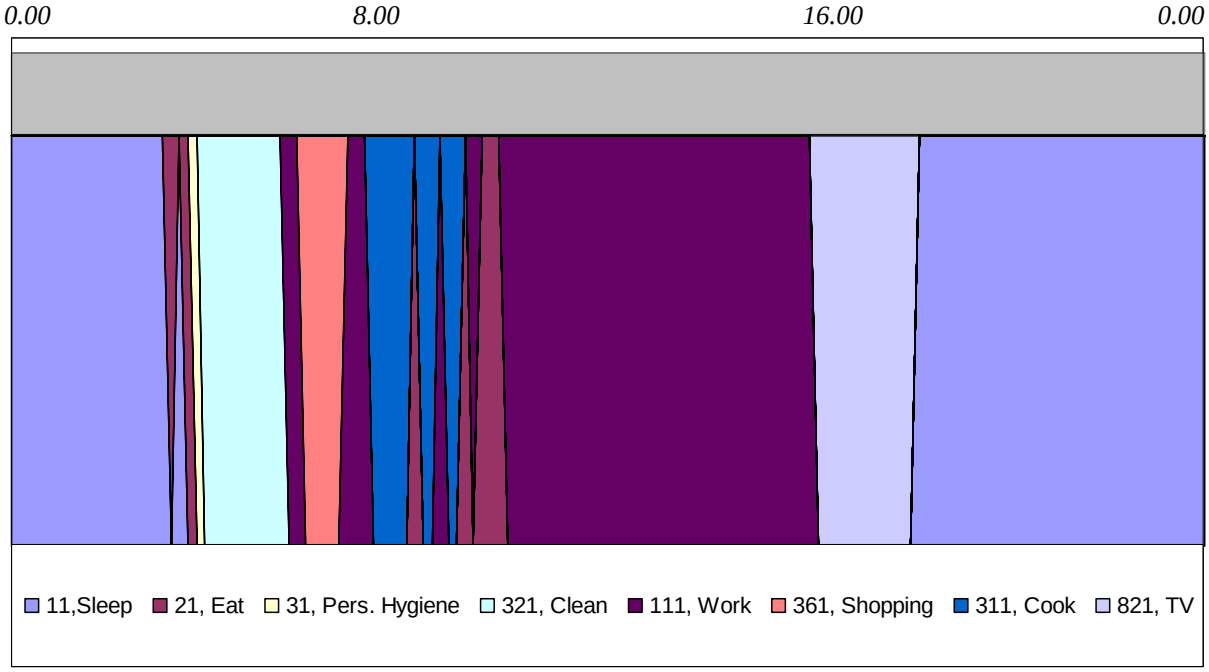


0:00-5:10	5:10-5:20	5:20-5:40	5:40-6:50	6:50-17:00
Sleep	Pers. hygiene	Sleep	Travel to work	Work

17:00-17:10	17:10-17:20	17:20-17:30	17:30-17:40	17:40-18:00
Travel to work	Wash	Cook	Eat	Cook

18:00-18:40	18:40-18:50	18:50-21:40	21:40-0:00
Eat	Clean dishes	TV	Sleep

Figure 6: Modal day-course of cluster 5 (mothers)



0:00-7:10	7:10-7:20	7:20-7:30	7:30-7:40	7:40-7:50
Sleep	Eat	Sleep	Eat	Pers. hygiene

7:50-9:30	9:30-9:50	9:50-10:40	10:40-11:10	11:10-12:00
Clean	Work	Clean	Work	Cook

12:00-12:10	12:10-12:30	12:30-12:40	12:40-13:00	13:00-13:10
Eat	Cook	Work	Cook	Eat

13:10-13:20	13:20-13:50	13:50-20:00	20:00-22:00	22:00-0:00
Work	Eat	Work	TV	Sleep

4. Socioeconomic description

Tables 1 and 2 (for parents) and Tables 3 and Tab. 4 (for couples without children) list the 32 variables that are taken into consideration for the socioeconomic description of the clusters. Using the SAS-procedure STEPDISC, a discriminant analysis is run according to the method of stepwise selection of variables. It aims at dissociating the detected clusters, based on the time use by means of multiple (socio-economic) attributes.[28]

4.1 Discriminant Analysis

The discriminant analysis is closely related to cluster analysis methods. It serves to assess the adequacy of classification, given the group memberships of the objects under study and thus has a descriptive objective.

[28] Compare SAS-Institute (2003), p. 2947

Some group assignments must be known before carrying out the discriminant analysis. Such group assignments, or labelling, may be conducted in a number of different ways. Hence, discriminant analysis can be used as an effective supplement to cluster analysis (in order to evaluate the results of the latter). The linear discriminant analysis (LDA), historically the oldest method, forms the basis of all the statistic program packages. It leads to dissociating classes (clusters) by means of multiple attributes.

In this paper, discriminant analysis is used to decide which of the variables summarised in Tables 1 to 4 are best suited for dissociating the clusters. Furthermore, the method is used to determine whether the clusters differ significantly from one another and how the differences between the clusters can be explained. The stepwise LDA was selected for the actual investigation. It is usually the appropriate method when the discriminatory contribution of the variables is of interest.[29] The principle behind this method is that of initially running the discriminant analysis with one variable only, then with two variables and so on. In each step, the variable that optimises a certain quality factor or selection criterion, in combination with the previously used variable, is included. Consequently, the admission order of the variables gives an indication of their relevance. An F-test (Wilks' lambda) is used to test if the discriminant model as a whole is significant.[30]

4.2 Results

The SAS-Procedure STEPDISC was applied to the described clusters by setting the level of significance at 5%. Tables 9 to 12 contain the resulting variables for the couples with and without children and demonstrate how the clusters differ regarding the averages of these variables. The coefficients of determination (R-squared), obtained through the discriminant analysis, form the first line of each table, while the second line includes the levels of significance. All the lines below describe the average of the variables in the clusters indicated on the left margin given in the heading.

4.2.1 Parents

As shown in the first two lines of Tables 9 and 10, the working hours per week have the strongest discriminatory power for both mothers and fathers. This is also evident regarding the canonical projection which is demonstrated for the mothers in Figure 1 in the next section. Social status takes second place for the mothers and third place for the fathers.

[29] See, for instance, Erb (1990), p. 1 onwards
[30] See SAS-Institute (2003), p. 3171

Tab. 9 Cluster averages of the discriminating variables (mothers)

	HPW	STAT	OSTWEST	HHGROESSE	HAUPTERWERBS EINKOMMEN	TV	HS	STUETZE	QUANTFREI	HHEINKOMMEN	WOHNFLAECHE	SG	QUANTHAUS	INTERNET	HIFI
Part-R^2[%]	**43**	**12**	**7**	**6**	**4**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**
α[%]	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,03**	**0,08**	**0,1**	**0,9**	**0,9**	**0,9**	**1,5**	**2,1**	**3,4**	**1,9**
CL1	28	4	1,3	3,7	5	2	0,2	0,04	1,3	5,3	120	0,03	1,8	0,8	1,7
CL2	32	4	1,4	3,7	5	2,1	0,1	0,03	1,2	5,2	117	0,07	2	0,7	1,8
CL3	17	4	1	3,9	3	1,9	0,2	0,03	1,3	5,1	126	0,03	2	0,8	2
CL4	36	4	1,6	3,5	5	1,9	0,1	0,08	1,1	4,9	111	0,17	1,9	0,6	1,5
CL5	23	4	1,2	3,9	3	2,2	0,2	0,03	1,3	4,9	121	0,04	2,1	0,7	1,8
CL6	15	6	1,2	4	3	1,8	0,2	0,08	1,4	5	144	0,08	2,3	0,7	1,9
CL7	23	4	1,1	3,9	4	2	0,2	0,05	1,3	5,1	125	0,09	2,1	0,6	1,9
CL8	20	4	1,1	3,7	3	2,2	0,2	0,02	1,3	5,1	116	0,03	2,2	0,9	1,9
CL10	9	8	1,2	4,1	2	1,9	0,2	0,24	1,4	4,5	120	0,11	2,2	0,7	1,8
CL11	7	8	1,3	3,8	1	1,8	0	0,26	1,2	5	120	0,11	2	0,7	1,6
CL12	5	9	1,1	4	1	2	0,2	0,16	1,4	4,8	119	0,05	2,2	0,8	1,8
CL13	8	8	1,3	3,6	1	2	0,1	0,15	1,4	4,6	116	0,06	2,1	0,7	1,5
CL14	5	8	1,2	3,7	1	2,5	0,3	0,21	1,7	4,9	115	0,07	2,2	0,7	2
CL15	2	10	1,2	3,9	0	1,9	0,4	0,19	1,6	4,5	122	0,05	2,1	0,5	1,7
CL17	1	10	1,1	4,4	0	1,9	0,2	0,06	1,3	4,6	137	0,12	2,2	0,6	1,5
CL18	7	9	1,1	3,9	1	1,5	0,2	0,09	1,3	4,8	118	0,05	2,3	0,6	1,6
CL19	8	3	1	4,3	1	1,9	0,3	0	1,5	5,1	126	0	2,1	0,8	1,5
CL20	11	8	1,2	3,6	2	2,1	0,3	0,16	1,5	5,2	125	0,05	2,2	0,6	1,7
CL21	7	8	1,1	4,1	1	1,7	0,1	0,07	1,4	5,1	137	0,11	2,2	0,9	1,6
CL22	16	6	1,1	4,3	3	2,1	0,3	0	1,1	5,3	146	0,29	1,9	0,6	2,6

Tab. 10: Cluster averages of the discriminating variables (fathers)

	HPW	UNI	STAT	HAUPTERWERBS EINKOMMEN	OSTWEST	HS	WOHNFLAECHE	SOZIALHILFE	STUETZE	OSA	HHEINKOMMEN	GESUND
Part-R^2 [%]	**24**	**11**	**8**	**6**	**6**	**3**	**3**	**3**	**2**	**2**	**2**	**2**
α [%]	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,02**	**0,11**	**0,82**	**1,27**	**1,95**	**4,57**
CL1	46	0,6	2,7	10	1,1	0,1	133	0	0,04	0	5,4	2,9
CL2	36	0,2	4,2	8	1,1	0,5	116	0,02	0,09	0	5	2,9
CL3	50	0,3	3,1	8	1,2	0,3	131	0	0,07	0,01	4,8	2,8
CL5	43	0,5	3,5	9	1,1	0,2	126	0,01	0,04	0	5,1	2,9
CL7	40	0,3	4	9	1,2	0,3	122	0	0,03	0,1	4,9	2,9
CL8	39	0,2	4,4	8	1,4	0,4	115	0,01	0,06	0,01	4,8	2,8
CL9	38	0,1	4,8	8	1,3	0,4	111	0	0,04	0,06	4,7	2,9
CL10	38	0,3	3,4	8	1,1	0,3	118	0	0	0,03	4,8	2,7
CL11	39	0,5	3,3	10	1,1	0,2	129	0,03	0,05	0	5,3	2,8
CL12	39	0,02	4,7	8	1,2	0,6	112	0	0,07	0,02	4,6	2,7
CL14	12	0,2	9,1	2	1,3	0,5	119	0,01	0,28	0,01	4,6	2,4
CL15	23	0,3	7,2	5	1,2	0,3	114	0,08	0,15	0,03	4,6	2,4
CL17	39	0,5	3,4	9	1,1	0,2	128	0	0,03	0	5,3	2,9
CL20	29	0,2	6,2	5	1,3	0,3	108	0,04	0,28	0	4,3	2,8
CL22	17	0,2	8,4	4	1,2	0,5	111	0	0,33	0,02	4,6	2,2
CL24	14	0,3	8,1	3	1,3	0,3	113	0,01	0,35	0,04	4,3	2,6
CL26	20	0,4	7,1	5	1,1	0,3	138	0	0,14	0,03	4,7	2,6
CL28	15	0,2	8,2	3	1,1	0,4	131	0,06	0,27	0,09	4,5	2,6

4.2.1 Couples without children

As shown in the first two lines of Tables 11 and 12, working hours per week, social status and age have the highest discriminatory power with respect to women without children. For

childless men, the same variables appear in the analysis. Clearly, the variables concerning schooling are significant, especially for men (with and without children)

Tab. 11 Cluster averages of the discriminating variables (childless women)

	HPW	STAT	ALTER	OSTWEST	ABI	QUANTBER	QUANTEHR	SAT	STUETZE	CAM	INTERNET
Part-R^2 [%]	**67**	**20**	**8**	**6**	**5**	**5**	**5**	**4**	**4**	**4**	**4**
α [%]	**0.01**	**0,01**	**0,01**	**0,01**	**0,04**	**0,09**	**0,3**	**1,3**	**1,4**	**2,3**	**2,5**
CL1	**32**	**4**	**45**	**1,3**	**0,4**	**2,5**	**3,4**	**0,4**	**0,1**	**0,3**	**0,6**
CL2	**35**	**4**	**43**	**1,2**	**0,4**	**2,5**	**3,4**	**0,3**	**0,04**	**0,2**	**0,6**
CL3	**34**	**4**	**47**	**0,5**	**0,1**	**2,4**	**3,5**	**0,5**	**0,1**	**0,3**	**0,4**
CL4	**2**	**11**	**62**	**0,4**	**0,1**	**3,6**	**3,5**	**0,3**	**0,1**	**0,2**	**0,2**
CL6	**18**	**4**	**51**	**1,1**	**0,3**	**2,2**	**2,7**	**0,3**	**0,1**	**0,2**	**0,6**
CL7	**2**	**11**	**64**	**1,3**	**0,2**	**3,7**	**3,7**	**0,4**	**0,1**	**0,2**	**0,2**
CL8	**1,2**	**12**	**66**	**1,3**	**0,2**	**3,8**	**3,3**	**0,5**	**0,05**	**0,1**	**0,2**
CL9	**22**	**4**	**52**	**1,2**	**0,1**	**2,4**	**3,3**	**0,4**	**0,03**	**0,2**	**0,3**
CL10	**2**	**11**	**63**	**1,2**	**0,2**	**3,8**	**3,4**	**0,4**	**0,1**	**0,1**	**0,3**
CL11	**10**	**10**	**56**	**1,3**	**0,2**	**3,3**	**3,6**	**0,3**	**0,1**	**0,1**	**0,4**
CL13	**5**	**11**	**59**	**1**	**0,2**	**3,4**	**3,2**	**0,4**	**0,02**	**0,3**	**0,4**
CL15	**4**	**11**	**61**	**1,3**	**0,05**	**3,7**	**2,9**	**0,2**	**0,1**	**0,2**	**0,2**
CL16	**3**	**11**	**60**	**1,1**	**0,2**	**3,4**	**3,5**	**0,5**	**0,2**	**0,4**	**0,2**
CL17	**2**	**11**	**61**	**1,1**	**0,3**	**3,5**	**1,9**	**0,3**	**0,2**	**0,3**	**0,3**
CL18	**0**	**12**	**64**	**1,2**	**0,1**	**3,9**	**3**	**0,6**	**0**	**0,1**	**0,1**
CL19	**10**	**10**	**53**	**1,1**	**0,2**	**3,6**	**3**	**0,6**	**0,2**	**0,4**	**0,5**
CL21	**2**	**10**	**60**	**1,3**	**0,2**	**3,5**	**3,1**	**0,4**	**0,05**	**0,1**	**0,4**

Table 12: Cluster averages of the discriminating variables (childless men)

	HPW	ALTER	HS	STAT	OSTWEST	OSA	QUANTEHR
Part-R^2 [%]	**70**	**8**	**7**	**6**	**6**	**5**	**4**
α [%]	**0,01**	**0,01**	**0,01**	**0,02**	**0,04**	**0,3**	**2,2**
CL1	**42**	**50**	**0,2**	**3**	**1,2**	**0**	**3,1**
CL2	**39**	**49**	**0,5**	**4**	**1,2**	**0,01**	**3,3**
CL3	**45**	**46**	**0,4**	**4**	**1,2**	**0**	**3,5**
CL4	**33**	**53**	**0,6**	**5**	**1,2**	**0,1**	**3,3**
CL5	**6**	**59**	**0,6**	**9**	**1**	**0**	**3,4**
CL7	**3**	**64**	**0,5**	**11**	**1,1**	**0,03**	**3**
CL8	**2**	**67**	**0,5**	**11**	**1,6**	**0,03**	**3,3**
CL11	**3**	**67**	**0,5**	**11**	**1,1**	**0,08**	**3,5**
CL15	**3**	**66**	**0,5**	**10**	**1,2**	**0**	**2,9**
CL17	**8**	**60**	**0,7**	**9**	**1,3**	**0,03**	**3,3**
CL18	**3**	**63**	**0,5**	**10**	**1,4**	**0**	**3,4**
CL19	**11**	**64**	**0,3**	**9**	**1**	**0**	**3,9**
CL20	**2**	**69**	**0,6**	**11**	**1,2**	**0**	**3,2**
CL21	**1**	**68**	**0,5**	**11**	**1,3**	**0**	**3,2**
CL25	**4**	**66**	**0,5**	**10**	**1,3**	**0**	**3,5**
CL28	**6**	**62**	**0,3**	**9**	**1,1**	**0,03**	**2,9**

4.3 The canonical analysis

Canonical analysis is a statistical model for studying relationships between groups of variables in a data set. Hence, it serves to control the discrimination criteria. The data set is split into two groups or matrices. For the present investigation, Clusters 1 – 17 build the first matrix($x_1 \ldots x_m$), while the second matrix ($y_1 \ldots y_m$) consists of the discriminating variables. All the variables are scaled metrically. In the canonical analysis, one of the matrices is constrained by the other and both are examined simultaneously. The emphasis is on the question of whether there is a correlation between the groups of variables.

The SAS-procedure CANDISC is run stepwise: it works by finding the linear combination of x variables (x_1, x_2) etc. and linear combinations of y variables (y_1, y_2) etc.:

$a_1 = c_{11}x_1 + \ldots + c_{1m}x_m$

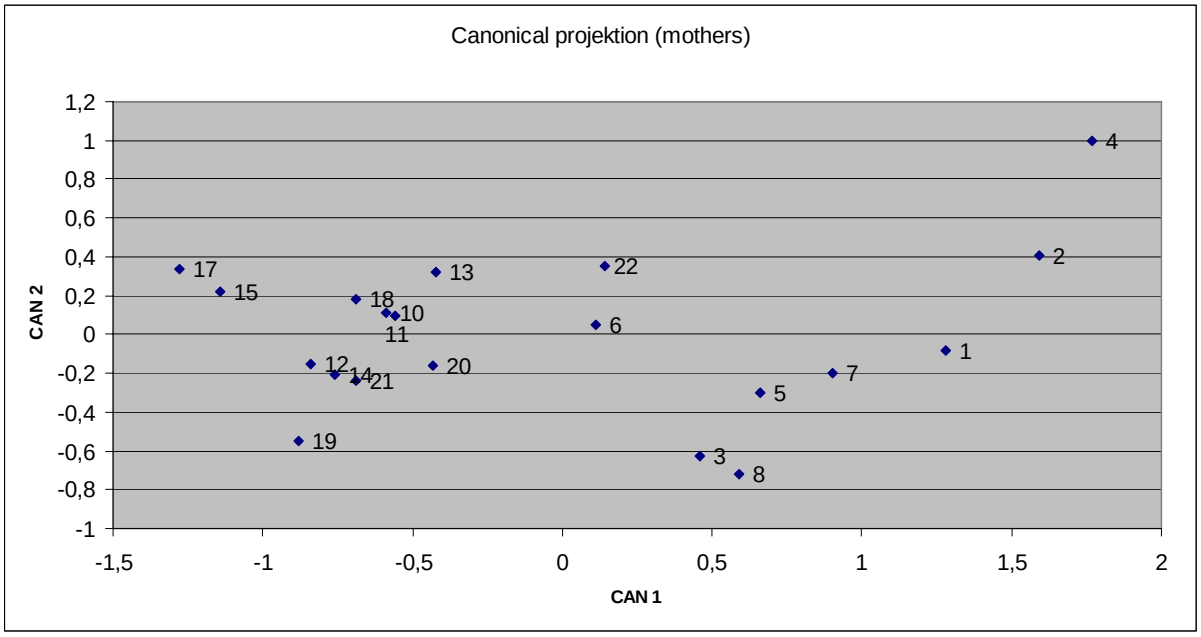
$b_1 = d_{11}y_1 + \ldots + d_{1m}y_m$

which are most highly correlated $(r_{a_1 b_1} \rightarrow Max)$. This combination is known as the "first canonical variates", which are usually denoted α and β, with the pair of α_1 and β_1 being referred to as a "canonical function". The next canonical functions, α_2 and β_2, are then restricted so that they are uncorrelated with α_1 and β_1: $r_{a_1 a_2} = 0, r_{b_1 b_2} = 0, r_{a_1 b_2} = 0,$ $r_{a1a2}=0$ und $r_{b_1 a_2} = 0.$

All variables are scaled, so that the variance equals 1.

In Figure 1, the first canonical variant is labelled CAN1 and the second CAN2. The planar presentation of CAN1 and CAN2 is called canonical projection. In Figure 1, we show – as an example – the canonical projection for the clusters consisting of mothers.

Fig. 7 Canonical projection (mothers)



The clusters of all the full-time employees (1, 2, 4) are located in the north-east of the projection, while the part-time employees (Cluster 3, 5, 7, 8) lie in the south-east. In the middle of the figure, all the employees that work only a few hours and the apprentices can be found. In the west the unemployed and the scholars are located.

5. Explanatory power of cluster-affiliations in a socio-economic context

In this section, it is shown that the cluster affiliation has the potential to forecast socioeconomic dimensions. Some dimensions selected as examples will be analysed randomly for that purpose. The set of variables in the tables is enlarged by means of dummy variables that can only take the values 1 or 0 and describe the affiliation to a cluster. This means that 20 dummy variables were added for the mothers, 19 for fathers, 17 for childless women and 16 for childless men.

At any time, one of the variables from Tables 1 to 4 was chosen as the dependent variable, while the cluster affiliations and all other variables were chosen as explanatory variables. A multiple linear regression was run. As expected, not all the regressors turned out to be significant (a level of 10 % was selected). The "Forward Selection-option" of the SAS-Procedure REG[31] was used in order to eliminate the non-significant variables. If any cluster-affiliations (dummy variables) persist in the remaining set of variables, the cluster-affiliation must be considered as a significant variable in the analysis. Because it does not seem

[31] See SAS-Institute (2003), p. 2947

meaningful to demonstrate all regressions at this point, as an example, a short overview is provided in Tables 13 to 16. Plus and minus signs marked by a " * " indicate that the cluster affiliations are even significant at a level of significance of 5%. Plus signs mean that the corresponding dummy variable has a positive influence on the dependant variable; a minus sign means that the corresponding dummy variable has a negative influence on the dependant variable.

The variables declared as independent are located in the first line. An entry for this variable in the table means that the cluster-affiliation, located in the first column, is a significant variable in the analysis, besides other socioeconomic variables. A plus sign signals a positive coefficient and vice versa.

Tables 13 to 16 show that cluster affiliations compete with other socioeconomic variables, while indicating that the variables in the heading are dependent. According to the results given in Tables 13 to 16, it can be assumed that affiliation to a certain household style must be regarded as an autonomous category for analysis. This enables an improvement in the proportion of explained variance and predictive power.

5.1 Parents

The variables age, working hours per week, health state and number of internet connections are regarded as examples of dependent variables. As can be seen in Tables 13 and 14, cluster affiliations remain in the linear regression at a level of significance of 10%, in some cases even at a level of significance of 5%. While the tables mentioned above only demonstrate examples, the complete regressions are shown in Table A and B (in the appendix).

Tab. 13 Cluster affiliations as significant regressors (mothers)

CLUSTER	CHARACTERISATION	ALTER	HPW	GESUND	INTERNET
1	Full-time employees		+*		
2	Full-time employees, get up earlier than Cluster 1 and need longer for personal hygiene		+*		
3	Part-time employees, shift workers		+*	+*	
4	Full-time employees, early shift		+*		
5	Part-time employees, working predominantly in afternoons and evenings		+*		
6	Apprentices			+*	
7	Part-time employees, working in the mornings		+*		-*
8	Part-time employees, working predominantly in the morning, but less hours than Cluster 7 and earning less		+*		+*
10	Working regularly, but less than 18 hours, sleep long hours, strollers				
11	Pupils/students, spend a lot of time preparing for school/lectures				
12	Pupils/students, watch a lot of TV			-*	
13	Working regularly, but less than 18 hours, spend a lot of time for shopping			-*	
14	Occasional employees, homely				
15	Scholars				
17	Unemployed				
18	Occasional employees, are younger, sleep earlier and get up earlier than cluster 14				
19	Unemployed, honorary engagement				
20	Occasional employees, partygoers				
21	Occasional employees with young children				
22	Employees working only few hours	+*			

Tab. 14 Cluster affiliations as significant regressors (fathers)

CLUSTER	CHARACTERISATION	ALTER	HPW	GESUND	INTERNET
1	Full-time employees, normal shift		+*		
2	Full-time employees, early shift				
3	Full-time employees, early or normal shift, working longer than cluster 1 and 2		+*		
4	Full-time employees, late shift, working more than 10 hours a week		+*		
5	Full-time employees, get up later than cluster 7 and having a shorter distance to work		+*		
7	Full-time employees, early riser, long distance to work		+*		
8	Full-time employees, early shift, long distance to work		+*		
9	Full-time employees, work from noon onwards				
10	Full-time employees, late shift, partner also works		+*		
11	Full-time employees, normal shift, socialise in the evening				-*
12	Full-time employees, only work in the morning		+*	-	
14	Apprentices, have plants at home and keep pets	+*			-*
15	Part-time employees, homemaker				
17	Full-time employees, public servant				
20	Part-time employees, hobbyists, voluntary workers				
22	Part-time working employees, higher income than cluster 20			-*	
24	Apprentices		-		
26	Apprentices, part-time employees, partner earns about the same amount				
28	Apprentices, homemaker				

5.2 Couples without children

The same examples were used with regard to childless couples. For childless women and men, cluster affiliations also remain in the linear regression analysis at a level of significance of 10% (Tables 15 and 16). The complete regressions for the childless couples are listed in Table C and D in the appendix.

Tab. 15 Cluster affiliations as significant regressors (childless women)

CLUSTER	CHARACTERISATION	ALTER	HPW	GESUND	INTERNET
1	Full-time employees, normal shift	**-***	**+***		
2	Part-time employees	**-***	**+***		**-***
3	Full-time employees, early shift	**-***	**+***		-
4	Retirees/older unemployed, long break at noon				
6	Apprentices		+		
7	Unemployed			**-***	
8	Retirees				
9	Part-time employees, housework in the morning, paid work from afternoon until evening		**+***		
10	Retirees				
11	Occasional employees, invalids				
13	Unemployed, spend a lot of time at home				
15	Retirees, housework in the morning, socialise in the afternoon			**+***	
16	Occasional employees, cleaning the home in the morning, washing clothes and dishes in the afternoon			-	-
17	Retirees and older unemployed, housework in the morning, gardening in the afternoon				
18	Retirees, spend much time at home, washing in the afternoon				
19	Occasional employees, housework in the morning, shopping and ironing from late afternoon until evening	**-***			
21	Occasional employees, go to bed early, early riser, spend much time at home				

Tab. 16 Cluster affiliations as significant regressors (childless men)

CLUSTER	CHARACTERISATION	ALTER	HPW	GESUND	INTERNET
1	Full-time employees, normal shift		+*		
2	Full-time employees, normal shift, longer commute to work, early riser		+*		
3	Full-time employees, late shift		+*	+*	-*
4	Part-time employees		+*		
5	Occasional employees, very homely, late riser				
7	Retirees, go shopping in the morning and socialise with friends in the afternoon				
8	Retirees or older unemployed, watch TV in the afternoons	+			
11	Retirees, work in the garden, especially in the morning				
15	Occasional working employees, spend a lot of time looking after their plants				
17	Occasional employees, work in the morning, take a long break at noon at watch lots of TV in the evening				
18	Apprentices / pupils				
19	Occasional employees, spend very much time at home, long break at noon				
20	Older retirees, long break at noon	+*			
21	Retirees, spend very much time at home, early riser	+			
25	Retirees or older unemployed, go shopping in the morning, stay at home in the afternoon				
28	Occasional employees, voluntary work in the morning, socialise in the afternoon				

In conclusion, one can say that cluster affiliations, used as examples of variables, are significant in addition to other socioeconomic variables for all the investigated variables introduced as dependent variables. Therefore, cluster affiliations must be regarded as an independent category for analysis. They increase the explained variance and our ability to forecast socio-economic variables.

6. Conclusions and future research

The aim of the present investigation was to demonstrate the potential to identify household styles by means of cluster analysis on the basis of individual time-use patterns. This aim was indeed achieved with respect to the analysed groups - couples with and without children. The emerging clusters are clearly differentiated and withstand a plausibility check. A comparison of the results of the procedure STEPDISC has shown that there are several similarities between singles, couples with children and childless couples. The variable HPW (working hours per week) has the greatest discriminatory strength for all investigated groups of persons. It is hence best suited for discriminating between the clusters.

Furthermore, it could be demonstrated that the cluster analysis approach raises the predictive strength of socioeconomic theory, compared to the exclusive use of more conventional multivariate analysis, given that the cluster affiliation provides an autonomous explanation of the socioeconomic dimensions to be defined or specified.
The results from Hufnagel (2004) and Grossmann (2007) concerning single households could successfully be extended to the case of couples.

From a practical point of view, the most useful result seems to be the connection of cluster affiliations with the state of health. Further in-depth investigation is required to determine in which way certain household styles influence individual health.

Regarding to the results of the present analysis, which was limited to couples with and without children, the investigation should be extended to multi-person households. The results allow for the assumption that the clusters can be differentiated even more distinctly from one another by including not only the time pulses, but also those socioeconomic variables which contribute to differentiating the clusters with a high level of significance. Hence, it is necessary to test whether both groups of variables can be linked in calculating the distances, so as to form the most differentiated clusters possible.
Finally, the calculation of distance matrices needs to be varied. For example, the definition of distances could be softened by allowing time lags between the daily courses of the analysed persons. Furthermore distances between households must be defined so that, using the concept of Minkowski norms, they aggregate the individual distances of household members. Finally, Minkowski-like distances must be compared to genom-distance-like concepts, which were suggested for time-use comparisons by Wilson (1999).

Appendix

Table A: Cluster affiliations as significant regressors (mothers)

	CLUS1	CLUS2	CLUS3	CLUS4	CLUS5	CLUS6	CLUS7	CLUS8	CLUS10	CLUS11	CLUS12	CLUS13	CLUS14	CLUS15	CLUS17	CLUS18	CLUS19	CLUS20	CLUS21	CLUS22
OSA	-		**+**						**+**		-		**+**							
HS	**-**										**-**									
RS	**-**										**-**									
ABI	**-**										**-**									
LEHRE											-			-		**+**				**+**
UNI														-						
SPONTAN													+							
HEE		**+**																		
SATHAUS														**-**		**+**				
QUANTFREI				-						**-**			+							
QUANT-HAUS										**-**										
EKK						-														
SOZIAL-HILFE										**+**	**+**									
STUETZE					**-**															
PKW										+										-
LAVADORA																			**-**	
MIKRO								**+**										-		
S						**+**			**+**											
OSTWEST			**-**				**-**	-												
SAT	**+**											**+**								
PAYTV									**+**											
HIFI					+										**-**		-			
PC													**+**							
VIDEO								**-**							+					
DVD	+						**-**													
CAM	+		**+**											**+**						

Table B: Cluster affiliations as significant regressors (fathers)

	CLUS1	CLUS2	CLUS3	CLUS4	CLUS5	CLUS7	CLUS8	CLUS9	CLUS10	CLUS11	CLUS12	CLUS13	CLUS14	CLUS15	CLUS17	CLUS20	CLUS22	CLUS24	CLUS26	CLUS28
OSA		-						+											-	
HS		-						+						+					-	
RS		-					+	+						+						
ABI		-						+						+						
LEHRE				-																
UNI	+																		+	
SPONTAN			-										-	-				-		
HEE		+		-	+	+		+		+	+		-							
SATHAUS																		-	-	
QUANTFREI																	+			
QUANT-HAUS		+		-					+											
EKK				+					-											
SOZIALHILFE														+						
STUETZE							-				-									
PKW	+					+				+								+		
LAVADORA			-						-											
MIKRO									+		-									
RAD											-								-	
S													-							
OSTWEST							+												-	
SAT																	-	+	-	
PAYTV																	+			
HIFI							-				+								-	
PC		+				-											-			
VIDEO	+						+										+			
DVD				+										+						
CAM									-								+			

Table C: Cluster affiliations as significant regressors (childless women)

	CLUS1	CLUS2	CLUS3	CLUS4	CLUS6	CLUS7	CLUS8	CLUS9	CLUS10	CLUS11	CLUS13	CLUS15	CLUS16	CLUS17	CLUS18	CLUS19	CLUS21
OSA					+												
HS							+	-									
RS							+	-									
ABI							+	-									
LEHRE						-											
UNI	-																
SPONTAN				+						+							
HEE		+			+												
SATHAUS			-														
QUANTFREI		-															
QUANTHAUS	-	-			-			+					+				
SATFREI		+															
EKK											+						
SOZIALHILFE											+						
STUETZE							-						+	+	-		
HH-EK											+						
PKW													+				
LAVADORA						-											
MIKRO					-				-							-	
RAD																	
S								+		-		+	+				
OSTWEST			+			+	+					+					+
SAT				-													
KABEL													-				-
PAYTV			+									+				+	
HIFI			-		+		-	-					+				
PC							-										
VIDEO									+		-					+	
DVD		+															+
CAM											+		+			+	

Table D: Cluster affiliations as significant regressors (childless men)

	CLUS1	CLUS2	CLUS3	CLUS4	CLUS5	CLUS7	CLUS8	CLUS11	CLUS15	CLUS17	CLUS18	CLUS19	CLUS20	CLUS21	CLUS25	CLUS28
OSA				**+**			**+**									+
HS							+				**-**			+		
RS							**+**							**+**		
ABI							**+**							**+**		
LEHRE										**+**	**+**				**+**	
UNI	**+**							+				+			+	
SPONTAN	**-**							**+**						**-**		
HEE	**+**	**+**	**+**	**+**								**+**				
SATHAUS										+						
QUANTFREI		+		+												
QUANTHAUS	**+**															
EKK			**+**						**+**							
SOZIALHILFE						+				**+**						
STUETZE						+										
HH-EK			**+**						**+**							
PKW	-								**+**							
LAVADORA			**-**													
MIKRO					+	**-**	+									
S					+											
OSTWEST									+	**+**	**+**			**+**		
SAT																**-**
KABEL	**-**						**+**						**+**			-
PAYTV			**+**													
HIFI							+	**+**				+				
PC												-				
VIDEO							-									
DVD	**+**															
CAM			+											-		

Table E: List of activities

0. Hauswirtschaftliche Tätigkeiten
01. Beköstigung
011 Zubereitung von Mahlzeiten
012 Tisch auf- und abdecken
013 Geschirreinigung
014 Haltbarmachen/Konservieren von Lebensmitteln
015 Lebensmittel einräumen
019 Nicht genau zuteilbare Tätigkeiten im Bereich 01.
02. Wäschepflege
021 Pflege und Reinigung von Leder, Textilien und Bekleidung
022 Herstellung und Reparatur von Leder, Textilien und Bekleidung
029 Nicht zuteilbare Tätigkeiten im Bereich 02.
03. Pflege und Reinigung von Haus und Wohnung
031 Pflege und Reinigung innerhalb von Haus und Wohnung
032 Pflege und Reinigung außerhalb von Haus und Wohnung
039 Nicht genau zuteilbare Tätigkeiten im Bereich 03.
04. Pflanzen- und Tierpflege
041 Zier- und Nutzpflanzenpflege
042 Zierpflanzenpflege
043 Nutzpflanzenpflege
044 Haus- und Nutztierpflege
045 Haustierpflege
046 Nutztierpflege
049 Nicht genau zuteilbare Tätigkeiten im Bereich 04.
050 Einkäufe überwiegend für den hauswirtschaftlichen Bereich
06. Behördengänge, organisatorische und dispositive Dinge des Haushalts
061 Planung und Organisation von eigenen Leistungen des Haushalts
062 Inanspruchnahme von Fremdleistungen im Bereich Planung und Organisation für den Haushalt
063 Reisevorbereitungen
069 Nicht genau zuteilbare Tätigkeiten im Bereich 06.
070 Rüstzeiten für hauswirtschaftliche Tätigkeiten
08. Wegezeiten für familiale/hauswirtschaftliche Tätigkeiten
081 zu Fuß
082 mit dem Fahrrad
083 mit dem Kraftrad (Moped, Mofa, Motorrad etc.)
084 mit dem Auto (auch Mitfahren im Auto, aber nicht Taxi)
085 mit öffentlichen Verkehrsmitteln
086 Sonstiges (Taxi, Flugzeug, Schiff etc.)
087 ohne Angabe des Verkehrsmittels
09. Wegezeiten für organisatorische und dispositive Dinge des Haushalts (Wegezeiten für die Signiernummern 06.)
091 zu Fuß
092 mit dem Fahrrad 183 mit dem Kraftrad (Moped, Mofa, Motorrad etc.)
093 mit dem Kraftrad (Moped, Mofa, Motorrad etc.)
094 mit dem Auto (auch Mitfahren im Auto, aber nicht Taxi)
095 mit öffentlichen Verkehrsmitteln
096 Sonstiges (Taxi, Flugzeug, Schiff etc.) 097 ohne Angabe des Verkehrsmittels
099 Sonstige nicht zuteilbare Tätigkeiten im Bereich 0..

1.. Handwerkliche Tätigkeiten
110 Fahrzeugreparatur und -pflege (Auto, Fahrrad, Motorrad usw.)
12. Reparatur und Herstellung von Gebrauchsgütern
121 Reparatur und Herstellung von Gebrauchsgütern für den Haushalt
122 Reparatur und Herstellung von Gebrauchsgütern für Freizeitaktivitäten
123 Reparatur und Herstellung von Möbeln 124 Kunsthandwerk
125 Reparatur und Herstellung von sonstigen Gebrauchsgütern
129 Nicht genau zuteilbare Tätigkeiten im Bereich 12.
13. Bauen und Renovieren
131 Hausbau
132 An- und Umbau
133 Ausbau und Renovieren
139 Nicht genau zuteilbare Tätigkeiten im Bereich 13.
140 Sonstige Arbeiten im handwerklichen Bereich
150 Einkäufe überwiegend für den handwerklichen Bereich
16. Planung und Organisation im handwerklichen Bereich
161 Planung und Organisation von eigenen Leistungen im handwerklichen Bereich
162 Inanspruchnahme von Fremdleistungen für den Haushalt im Bereich Handwerk
169 Nicht genau zuteilbare Tätigkeiten im Bereich 16.
170 Rüstzeiten für handwerkliche Tätigkeiten
18. Wegezeiten für den handwerklichen Bereich im Zusammenhang mit handwerklichen Tätigkeiten (ohne Wegezeiten für Signiernummer 16.)
181 zu Fuß
182 mit dem Fahrrad 196 Sonstiges (Taxi, Flugzeug, Schiff etc.)
184 mit dem Auto (auch Mitfahren im Auto, aber nicht Taxi)
185 mit öffentlichen Verkehrsmitteln
186 Sonstiges (Taxi, Flugzeug, Schiff etc.)
187 ohne Angabe des Verkehrsmittels
19. Wegezeiten für den handwerklichen Bereich für Planung und Organisationvon eigenen und fremden Leistungen (Wegezeiten für Signiernummer 16.)
191 zu Fuß
192 mit dem Fahrrad
193 mit dem Kraftrad (Moped, Mofa, Motorrad etc.)
194 mit dem Auto (auch Mitfahren im Auto, aber nicht Taxi)
195 mit öffentlichen Verkehrsmitteln
197 ohne Angabe des Verkehrsmittels
199 Sonstige nicht zuteilbare Tätigkeiten im Bereich 1..

2. Erwerbstätigkeit/Arbeitssuche
21. Erste Erwerbstätigkeit
211 Zeit am Arbeitsplatz, Dienstreise, Dienstgang
212 Praktikum
213 Interne Fort- und Weiterbildung während der Arbeitszeit
219 Nicht genau zuteilbare Tätigkeiten im Bereich 21.
220 Zweite Erwerbstätigkeit /Nebenerwerbstätigkeit
23. Unbezahlte Arbeiten für den Erwerbsbereich (außerhalb der Arbeitszeit)
231 Direkte Gespräche/Kontakte für den eigenen Erwerbsbereich
232 Telefonate für den eigenen Erwerbsbereich (außerhalb der Arbeitszeit)

233 Unbezahlte Arbeiten von abhängig Erwerbstätigen zu Hause für den eigenen Beruf (außerhalb der Arbeitszeit)
234 Unbezahlte Arbeiten von mithelfenden Familienangehörigen im familieneigenen Betrieb 235 Unbezahlte Arbeiten für die Erwerbstätigkeit/Qualifikation anderer Haushaltsmitglieder bzw. Personen
239 Nicht genau zuteilbare Tätigkeiten im Bereich 23.
240 Tätigkeiten im Zusammenhang mit der Arbeitssuche
250 Mittagspause zwischen der Erwerbstätigkeit ohne weitere Angaben
270 Rüstzeiten in Verbindung mit der Erwerbstätigkeit/Arbeitssuche
28. Wegezeiten für die Erwerbstätigkeit/Arbeitssuche
281 zu Fuß
282 mit dem Fahrrad
283 mit dem Kraftrad (Moped, Mofa, Motorrad etc.)
284 mit dem Auto (auch Mitfahren im Auto, aber nicht Taxi)
285 mit öffentlichen Verkehrsmitteln
286 Sonstiges (Taxi, Flugzeug, Schiff etc.)
287 ohne Angabe des Verkehrsmittels
29. Fahrdienste für Erwerbstätige /Arbeitssuchende
291 zu Fuß
292 mit dem Fahrrad
293 mit dem Kraftrad (Moped, Mofa, Motorrad etc.)
294 mit dem Auto (auch Mitfahren im Auto, aber nicht Taxi)
295 mit öffentlichen Verkehrsmitteln
296 Sonstiges (Taxi, Flugzeug, Schiff etc.)
297 ohne Angabe des Verkehrsmittels
299 Sonstige nicht zuteilbare Tätigkeiten im Bereich 2..

3.. Ehrenamt/soziale Hilfeleistungen (unbezahlt)

310 Ehrenamtliche Funktionen und Wahrnehmung von Aufgaben
32. Pflege und Betreuung im Rahmen von sozialen Hilfeleistungen
321 Pflege und Betreuung von Personen bei Wohlfahrtsverbänden
322 Pflege und Betreuung von Personen bei kirchlichen und weltanschaulichen Organisationen
323 Pflege und Betreuung von Personen bei Selbsthilfeorganisationen/-gruppen
329 Nicht genau zuteilbare Tätigkeiten im Bereich 32
370 Rüstzeiten für Ehrenämter/soziale Hilfeleistungen
38. Wegezeiten im Zusammenhang mit Ehrenämtern/sozialenHilfeleistungen
381 zu Fuß
382 mit dem Fahrrad
383 mit dem Kraftrad (Moped, Mofa, Motorrad etc.)
384 mit dem Auto (auch Mitfahren im Auto, aber nicht Taxi)
385 mit öffentlichen Verkehrsmitteln
386 Sonstiges (Taxi, Flugzeug, Schiff etc.)
387 ohne Angabe des Verkehrsmittels
399 Sonstige nicht zuteilbare Tätigkeiten im Bereich 3.

4.Qualifikation/Bildung

410 Schule/Studium
420 Fort- und Weiterbildung für die Berufstätigkeit (außerhalb der Arbeitszeit für die Berufstätigkeit)
430 Qualifikation für Haushalt und Familie
440 Qualifikation aus persönlichen Gründen
450 Mittagspause von Schülern und Studenten ohne weitere Angaben
470 Rüstzeiten für Qualifikation und Bildung
48. Wegezeiten für die Qualifikation/Bildung
481 zu Fuß
482 mit dem Fahrrad
483 mit dem Kraftrad (Moped, Mofa, Motorrad etc.)
484 mit dem Auto (auch Mitfahren im Auto, aber nicht Taxi)
485 mit öffentlichen Verkehrsmitteln
486 Sonstiges (Taxi, Flugzeug, Schiff)
487 ohne Angabe des Verkehrsmittels
499 sonstige nicht zuteilbare Tätigkeiten im Bereich 4.

5. Persönlicher Bereich physiologische Regeneration

51. Schlafen/Ausruhen
511 Schlafen
512 Ausruhen/Nichtstun
519 Nicht genau zuteilbare Tätigkeiten im Bereich 51.
52. Körperpflege
521 Allgemeine Körperpflege
522 Erledigungen in persönlichen Angelegenheiten
529 Nicht genau zuteilbare Tätigkeiten im Bereich 52.
53. Essen
531 Essen zu Hause
532 Essen im Restaurant/öffentlichem Gastgewerbe
533 Essen in der Kantine
539 Essen, sonstiges
570 Rüstzeiten für den persönlichen Bereich/die physiologische Regeneration
58. Wegezeiten für den persönlichen Bereich/die physiologische Regeneration
581 zu Fuß
584 mit dem Auto (auch Mitfahren im Auto, nicht Taxi)
585 mit öffentlichen Verkehrsmitteln
586 Sonstiges (Taxi, Flugzeug, Schiff etc.)
587 ohne Angabe des Verkehrsmittels
599 Sonstige nicht zuteilbare Tätigkeiten im Bereich 5

6. Kontakte/Gespräche/Geselligkeit

61.Direkte Gespräche/Kontakte
611 Gespräche persönlichen Inhalts
619 Nicht genau inhaltliche zuteilbare Gespräche
62. Telefonate
621 Telefonate persönlichen Inhalts
629 Nicht genau inhaltlich zuteilbare Gespräche
63. Geselligkeit
631 Zu Besuch/Besuch empfangen
632 Familienfestlichkeiten
633 Ausgehen
639 Nicht genau zuteilbare Tätigkeiten im Bereich 63.
640 Ausflüge
670 Rüstzeiten für Kontakte/Gespräche/Geselligkeit
68. Wegezeiten für Kontakte/Gespräche/Geselligkeit
681 zu Fuß
682 mit dem Fahrrad
683 mit dem Kraftrad (Moped, Mofa, Motorrad etc.)
684 mit dem Auto (auch Mitfahren im Auto, aber nicht Taxi)
685 mit öffentlichen Verkehrsmitteln
686 Sonstiges (Taxi, Flugzeug, Schiff etc.)
687 ohne Angabe des Verkehrsmittels
699 Sonstige nicht zuteilbare Tätigkeiten im Bereich 6.

7.Mediennutzung/Freizeitaktivitäten

71. Mediennutzung
711 Fernsehen/Video
712 Radio hören
713 Musik hören (Platte, CD, Kassette)
714 Bücher lesen
715 Tageszeitungen lesen
716 Zeitschriften lesen
717 Sonstiges Lesen
718 Tätigkeiten am Computer
719 Nicht genau zuteilbare Tätigkeiten im Bereich 71.
72. Spiel und Sport

721 Sport
722 Spazierengehen
723 Spielen
724 Besuch von Freizeitveranstaltungen in Schulen/Jugendzentren/ Gemeinden für Kinder/Jugendliche
729 Nicht genau zuteilbare Tätigkeiten im Bereich 72.
73. Musik und Kultur
731 Musizieren
732 Besuch von politischen/religiösen/kulturellen/sportlichen Veranstaltungen
733 Besuch von Ausstellungen/Museen/Theater/Kino/Kabarett
739 Nicht genau zuteilbare Tätigkeiten im Bereich 73.
740 Sonstige Freizeitaktivitäten
770 Rüstzeiten für Mediennutzung/Freizeitaktivitäten
78. Wegezeiten für Freizeitaktivitäten
781 zu Fuß
782 mit dem Fahrrad
783 mit dem Kraftrad (Moped, Mofa, Motorrad etc.)
784 mit dem Auto (auch Mitfahren im Auto, aber nicht Taxi)
785 mit öffentlichen Verkehrsmitteln
786 Sonstiges (Taxi, Flugzeug, Schiff etc.)
787 ohne Angabe des Verkehrsmittels
799 Sonstige nicht zuteilbare Tätigkeiten im Bereich 7.

8. Pflege und Betreuung von Personen

81. Kinder (unter 16 Jahren*)
811 Lernen mit Kindern
812 Spielen/Sportausüben/Spazierengehen mit Kindern
813 Betreuung von Kindern im kurzfristigen Krankheitsfall
819 Sonstige Betreuung von Kindern
82. Betreuung von Erwachsenen und Jugendlichen (16 Jahre und älter)
821 Betreuung im kurzfristigen Krankheitsfall
822 Betreuung von längerfristig pflegebedürftigen Personen
823 Sonstige Betreuung von Personen
824 Betreuung von Kindern, die dauernd pflegebedürftig sind
870 Rüstzeiten für die Kinderbetreuung
875 Rüstzeiten für die Erwachsenen- und Jugendlichenbetreuung
88. Fahrdienste/Wegezeiten für die Betreuung von Kindern (unter 16 Jahren)
881 zu Fuß
882 mit dem Fahrrad
883 mit dem Kraftrad (Moped, Mofa, Motorrad etc.)
884 mit dem Auto (auch Mitfahren im Auto, aber nicht Taxi)
885 mit öffentlichen Verkehrsmitteln
886 Sonstiges (Taxi, Flugzeug, Schiff etc.)
887 ohne Angabe des Verkehrsmittels
89. Fahrdienste/Wegezeiten für die Betreuung von Erwachsenen und Jugendlichen (16 Jahre und älter)
891 zu Fuß
892 mit dem Fahrrad
893 mit dem Kraftrad (Moped, Mofa, Motorrad etc.)
894 mit dem Auto (auch Mitfahren im Auto, nicht Taxi)
895 mit öffentlichen Verkehrsmitteln
896 Sonstiges (Taxi, Flugzeug, Schiff etc.)
897 ohne Angabe des Verkehrsmittels
899 Sonstige nicht zuteilbare Tätigkeiten im Bereich 8.

9. Nicht zuteilbare oder zuzuordnende Zeiten

910 Tagebucheintragungen
920 Fehlende Eintragungen
970 Nicht zuteilbare Rüstzeiten
98. Nicht zuteilbare Wegezeiten/Fahrdienste
981 zu Fuß
982 mit dem Fahrrad
983 mit dem Kraftrad (Moped, Mofa, Motorrad etc.)
984 mit dem Auto (auch Mitfahren im Auto, aber nicht Taxi)
985 mit öffentlichen Verkehrsmitteln
986 Sonstiges (Taxi, Flugzeug, Schiff etc.)
987 ohne Angabe des Verkehrsmittels

References

Backhaus, K. et al (2006): Multivariate Analysemethoden, Berlin.

Ellegård, K. and Cooper, M. (2004), Complexity in daily life – a 3D-visualisation showing activity patterns in their contexts, Electronic international journey of time use research, Vol. 1, Number 1, Lueneburg, p. 37-59, retrieved July 18th, 2008 from http://ffb.uni-lueneburg.de/eijtur/pdf/volumes/eIJTUR-1-1.pdf#page=44

Erb,W.-D. (1990): Anwendungsmöglichkeiten der linearen Diskriminanzanalyse in Geographie und Regionalwissenschaft, Hamburg.

Geißler, R. (2006), Die Sozialstruktur Deutschlands – Zur gesellschaftlichen Entwicklung mit einer Bilanz der Vereinigung, Wiesbaden, p. 23-54.

Gershuny, J. (1990), International Comparisons of Time Budget Surveys – Methods and Opportunities. Von Schweitzer, R. et al. (eds.), Zeitbudgeterhebungen – Ziele, Methoden und neue Konzepte, Wiesbaden

Grossmann, S. (2007), Empirische Ermittlung von Haushaltsführungsstilen mit Daten der Zeitbudgeterhebung 1991/92. WWU Münster, Institut für ökonomische Bildung, Diskussionspapier 3/2007.

Hufnagel, R. (2004), Empirische Ermittlung von Haushaltsführungsstilen mit Daten der Zeitbudgeterhebung 2001/2002. Statistisches Bundesamt (ed.), Alltag in Deutschland - Analysen zur Zeitverwendung, Band 43 der Schriftenreihe Forum der Bundesstatistik, Wiesbaden, p. 274-303.

Lesnard, L. (2004), Schedules as sequences: a new method to analyze the use of time based on collective rhythm with an application to the work arrangements of French dual-earner couples, Electronic international journey of time use research, Vol. 1, Number 1, Lueneburg, p. 60-84, retrieved July 18th, 2008 from http://ffb.uni-lueneburg.de/eijtur/pdf/volumes/eIJTUR-1-1.pdf#page=67

Michelsen, W. and Crouse,D. (2004), Examining Large-scale Time-use Files through Graphic Representation, Electronic international journey of time use research, Vol. 1, Number 1, Lueneburg, p. 85-100, retrieved July 18th, 2008 from http://ffb.uni-lueneburg.de/eijtur/pdf/volumes/eIJTUR-1-1.pdf#page=92

SAS Institute (2003), SAS/STAT® User's Guide, Version 8.1, North Carolina, USA.

Wilson, C. (1999), Sequence Alignment Analysis of Daily Activities. Merz, J., Ehling, M. (eds.), Time Use - Research, Data and Policy, Baden-Baden, p. 505-516.