electronic International Journal of
Time Use Research

volume 5
number 1
november 2008
ISSN 1860–9937

contents

electronic ***International Journal of Time Use Research***
2008, Vol. 5, No. 1, 1-25.

Changes in the use of time and the state of health of the Russian population in the 1980s-1990s

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Abstract

This is an attempt to answer a question about how changes in the time use and in health the population relate to each other, what connection exists between duration and character of work and the state of health. The paper draws on the data from two rounds of time budget surveys of: 1) families who kept record of their incomes and expenditures (the RF Goskomstat, 1977-1990 – over 28 thous. families), 2) the rural population of the Novosibirsk region (IEIE SB RAS, 1975-1999, 1400-1100 persons in each). In these rounds the "previous day" approach was used. Used were also the data of questionnaire surveys and official statistics. Last 20 years are a unique period in the Russian modern history reflected in most different forms on all aspects of life, including time use, everyday activity and health of population. The analysis of relationship between time use and health was made at macro levels. Health is presented by life expectancy. Time use is presented by aggregated structure of average time budget, respectively. The assessment by respondents of changes in living conditions and in their own state is seen as a measure of social-psychological well-being of the population. The direction and degree of influence between "time use – state of health" depend on macro and micro life conditions, on social-psychological well-being of the society and individual, on the "initial' state of health of the individuals.

JEL-Codes: I18, J11, J22, P29

Keywords: Time budget, everyday activity, living conditions, life expectancy, social changes

Research was financed by the Russian Humanitarian Foundation (project No. 07-03-00521).

1 Introduction

Last 15 years are a unique period in the Russian modern history reflected in most different forms on all aspects of life, including se of time, everyday activity and health of the population.

Above all, we are interested in everyday life of the majority of the population, conditions and quality of their life, satisfaction of their needs. According to Zaslavskaya (1997), “base layer” accounts for 2/3 of the population with 9-12% of “the honest poor who live on or beyond the poverty line”. We view rural population as an important indicative group showing the state and trends of everyday activity, the state and prospects of the Russian society.

Social time appears in our paper in two “modi”: as “historical” (axis of “historical” time) and as “structural” (Artemov, 1987) (as time budgets).

This is an attempt to answer a question about how changes in the use of time and in health of the population relate to each other.

2 Information base and methodology

Information base includes: a) the data of the survey and time budget obtained in the longitudinal surveys of the rural population in Novosibirsk (oblast) region (1986-1987, 1993-1994, 1999); b) statistical data on working time duration in the RSFSR on the basis of the surveys conducted by Central Statistical Department of the RSFSR (1977, 1980, 1985, 1990); c) cross-country life-span data; d) other data from literature.

2.1 Longitudinal Survey of the 1970-1990s

We conducted the longitudinal study in the rural area of Novosibirsk oblast (region) as a typical rural area both for the south of Western Siberia and the whole country. (In particular, the data obtained in 1999 on comparable indicators of families’ economic behavior, value orientation, assessment of carried reforms are very close to the results of the All-Russian survey (see Konturi socialnoj politiki, 2000).

In 1975-76, 1986-87, 1993-94, 1999 there were conducted four bi-seasonal surveys of living conditions, time use, and everyday activity of the population. In every survey, but the last, 1500 people were surveyed; in the last survey because of organizational and financial difficulties only 1170 people were surveyed.

The main objective in our research was to explore changes in the use of time, in the overall framework of the average time budget. This is what allowed us to prepare this paper, using also statistical and other research data.

2.1.1 Time "spots"

The research includes the “spots” of historical time relating to substantially different periods of the last quarter of the century that vary both in objective economic, social and political characteristics and in the people’s state of mind and real activities.

The middle of the 1970s is the point of the evolutionary period, with its stability and gradually falling economic efficiency, heavy burden of expenditures on defense, too slow rise of well-being and general lagging behind advanced western countries.

There is no doubt that at the present time, the period of 1986-1987 is the reference point for all changes over the last 15 years. It is the beginning of significant and radical changes both for the state and society. The period of 1993-1994 is the starting point of social-economic stabilisation with the sharp decrease of living conditions for the majority of the population to the level of survival. 1999 is the year of the next bi-(or poly-)furcation state of the society with vague perspectives.

2.1.2 Methods and organization of the survey

We aimed to eliminate to the maximum the influence of organizational and methodological causes on obtained empirical data.

Sampling population

Before the preparation of our first rural survey began, the three-factor social-economic-demographic typology of rural communities had been already built up and substantively described: by two classes of the urbanization factor, by three classes of industrialisation factor and by two classes of the natural population change factor.

In essence, we were the first to make use, in the formation of a sampling population of objects (in our case - rural settlements) in an empirical sociological study, of computers and the cluster analysis algorithm and of the typology of rural settlements developed under the direction of Zaslavskaya (1977; 1980). The sample of rural settlements of different types was retained. So far there has been no doubts in its representativeness with regard to the absolute number of rural places in the oblast or even in Russia as a whole, for that matter.

Another significant characteristic of the sampling population was the functional "subsystem of the rural side" and groups of nonworking population. The distribution of respondents among all these groups was retained in the selection of respondents in 1986-87 and 1993-94. With constraints on the total size of base population and the need to survey small number groups, a non-proportional quota random sample was used. The selection of respondents was made from register books on random by several stages according to the predesigned quotas for groups.

The composition of the used data

For the analysis of the dynamics of time use, apart from time budget data, used was information of several kinds, i.e. information given by rural residents themselves: a) the characteristic of the population itself, of individual-household living conditions; b) information on behaviour; c) evaluation of particular activities; d) evaluation of changes of family living conditions and material standing, state of mind, and, finally, statistical data on the settlement and on some characteristics of the residents.

Method and instruments

One and the same method was used in collection time use data, i.e. retrospective survey about the previous day. Questionnaires, forms for collection of data on the settlements, instruction of interviewers inspecting the coding personnel were stable, with minimum changes. This method is retrospective - they ask respondents for a time allocation of the previous day. It is proved, by an experimental way, that the time diaries method gives the reliable measurement, while the others methods are unsatisfactory (Juster et al., 1991, 482-484).

Organization of the survey

The composition of the research team was relatively stable (more than by half) which secured the conformity in the work of interviewers and coders. The time of survey in fact did not differ: summer (but not peak) - June - and winter months - November and December constantly chosen.

Base period of time use analysis

The calendar 7-day week is the most convenient period for time use analysis. According to this, in surveys where time record of respondents is kept for one or several days, a rated week budget of several types is introduced. 1) The budget of a seasonal calendar (work) week was estimated on the basis of the number of work and off days in the 7-day (winter or summer) week and the appropriate time budgets. 2) The budget of average seasonal week is the average arithmetic week on the basis of winter and summer budgets.

Our surveys, therefore, present highly stable organizationally, methodologically and substantive-analytically measurements of the real activities of the population. These studies allow to make generalised conclusions about changes in the activities, conditions and life ways of people as well as to pose more specific questions for estimation and interpretation of the detected trends.

"Dynamic" arrays

In longitudinal studies it turns out very useful for statistical analysis to connect data relevant to different time points. Thus obtained "dynamic" arrays permit one to easily employ standard statistical packages of programmes for implementation of comparative studies. Pulling together all eight arrays of rural surveys of the 1970-1990 made it possible to perform an additional analysis of the changes in the population's use of time which occurred over the given period. "Dynamic" arrays allow to considerably improve, deepen and, at the same time, statistically support, technically to ease the analysis of social shifts, in particular of changes in the time use.

2.2 Methodology of analysis

The analysis of relationship between time use and health was made at macro levels. At the macro level health (as physical, psychical and social well-being) is presented by indicator of the expectation of life of birth. Use of time is presented by aggregated structure of average time budget including duration of the total work load as one of the main time use indicators. The assessment by respondents of changes in living conditions and in their own state is seen as a measure of social-psychological well-being of the population.

The key method of analysis was comparison of changes in the time use and health state indicators together with the subjective perceptions of other changes given in answers of the representative and relatively permanent group of the surveyed workers versus a more general statistical body of the population.

Here are the results of our longitudinal survey concerning the working population calling our attention to the 1980-1990s. Notice that the revealed trends are, to a high degree, a consequence of the state of the society at large and of its changes rather than the reflection of the regional specifics.

3 Changes in the use of time and in the life expectancy

3.1 Changes in the time budget

In general, our 25-year research period can be divided, according to the character and direction of changes in the use of time, into three unequal sub-periods: 1975-1985, 1986-1994, 1995-1999.

In the 1950s-1970s, after ex-orbital work load of the last pre-war, war and first after-war years, the working time of the rural, mostly agricultural, workers was decreasing. This process of decrease lasted down to 1985 as shown by the data from the time budget surveys made by the Russian Statistical Service in 1977, 1980, 1985, 1990 (see Byudzhet vremeni, 1978; 1980; 1985; 1990).

During the period under consideration there was a very substantial redistribution of time within its weekly stock between different activities: time of work in its three major domains, of physical needs, including sleep, and of free time.

Free time and after that working time were the most mobile sections of the time budget, a kind of “source”, “time resource” for changes of other activities. “Mobile” was also the most stable and steady component of the time budget, that is the time of sleep.

Overcoming of extreme situation in the sphere of work, as we call it after the survey of 1986-1987, has started in the beginning of the 90s. The survey of 1999 revealed the continuation of this trend (Table 1).

In 1999 comparing to 1986-1987, work time in average seasonal week decreased by 8.2 hours among women and by 10.2 hours among men. The total work load also decreased, notably among women (by 7.6 and 3.8 hours, respectively). Among men the released work time went mainly to household production (over a half) and to housework and physical needs; among women, to time of sleep and of work in household production (comparing to 1993-1994 there was decrease), but the major change was increased amount of free time - nearly by 5 hours a week. Female-male difference in total work load decreased (from 13.2 hours in 1975 to 8 hours in 1999). A difference among men and women in agriculture decreased bin time of paid work, housework and household farming. It was mainly due to men: they reduced their paid work time and increased work in house and household farming. While the decrease of difference in the amount of free time was due to its growth among women.

Duration of working time which we traditionally understand as paid work outside the home was decreasing during the whole of the period under consideration. In general, this can be interpreted as a positive fact if we take total duration of women’s work which increased in 1986-1987 and became perceptibly lower only in the 1999 survey. Working time was changing under the influence of economic depression in two forms – as reduction of the real (really worked) contracted time and of employment.

In comparison with the period of 1975-1976 working population share in the total workload in *household production and private plot* per averaged seasonal week in 1999 increased on 10.7 percent points, with the percent point of woman-workers (on 6.1% for agricultural woman-workers) being 57.7% (49.5%) from the duration of the total workload. For male these figures are 15.1%, (16.9%), 35.6%, (35.2%) correspondingly.

The changes of amount of time spent on *care of children and child rearing* (largely of pre-school and primary school age) is the consequence of change of value of children, understanding of importance of interaction with children and reduction in the number of children as well. But per kid time spent on children has even increased.

Table 1
Time budget of the working rural population (Hours per "averaged" work week)*

Activities	**Women**				**Men**			
	1975 -1976	**1986 -1987**	**1993 -1994**	**1999**	**1975 -1976**	**1986 -1987**	**1993 -1994**	**1999**
Number	*821*	*726*	*689*	*501*	*635*	*475*	*525*	*373*
Working time	43.9	43.4	36.5	**35.2**	54.4	54.5	49.6	**44.3**
Time related to work	4.2	4.6	4.2	4.4	4.1	4.4	4.8	4.1
Household obligations and errands	23.3	24.5	25.7	**24.1**	5.0	5.0	5.4	**6.8**
prepare food	8.9	9.8	10.5	**11.1**	0.9	0.6	0.7	0.9
indoor cleaning	4.4	4.0	4.0	4.0	0.7	1.2	1.1	1.8
laundry, ironing, clothes upkeep	3.4	2.9	4.1	**2.7**	0.4	0.1	0.3	0.1
shopping	0.8	0.8	0.7	**1.1**	1.9	2.4	0.9	0.3
Work on the private plot	12.9	15.2	18.6	**17.6**	9.4	13.9	17.1	**19.4**
work on household plot	4.7	4.8	6.1	5.6	3.2	3.1	3.6	3.1
care of livestock and poultry	6.4	7.6	10.0	**8.5**	4.1	6.6	9.2	**11.4**
other operations	1.8	2.8	2.5	**3.5**	2.1	4.2	4.3	**4.9**
Child care/contact with children	3.7	4.3	3.7	**3.2**	1.5	2.6	1.7	1.3
child care	2.2	3.0	2.4	**1.8**	0.7	1.1	0.6	0.5
playing, talking with children	1.5	1.3	1.3	**1.4**	0.8	1.5	1.1	0.8
Personal needs	61.5	60.9	61.2	**63.4**	66.8	63.2	63.3	**65.6**
sleep	51.0	48.9	48.6	**50.2**	55.7	51.5	49.7	**52.0**
Free time	17.7	14.7	16.4	**19.1**	25.9	23.7	24.3	**24.6**
Education and self-education	0.6	0.2	0.1	0.2	0.5	0.2	0.3	0.1
watching TV	4.6	5.6	7.3	**9.4**	6.2	10.3	11.9	**14.4**
entertaining or visiting friends	4.3	3.1	3.6	**3.3**	4.8	3.0	3.8	**3.3**
reading	1.8	1.8	2.1	1.7	3.3	2.3	2.3	**1.1**
active rest and sport	0.8	0.4	0.3	0.2	2.6	3.0	1.6	0.9
Other	0.8	0.8	1.7	1.0	0.9	0.7	1.8	1.8
Total workload *including child-care*	*86.8*	*90.7*	*87.4*	***83.1***	*73.6*	*78.9*	*77.5*	***75.1***
Free time *including contacts with children*	*18.9*	*15.6*	*17.7*	***20.5***	*26.7*	*25.2*	*25.4*	***25.4***

* Time use in this Table was averaged for summer (June) and a winter (November). In thick print in this Table noticed time expenditures changes of what are statistically significants relatively 1986-1987 simultaneously on criteria of Mann-Whitney and Kolmogorov-Smirnov with a probability more 99%.

Source: Own survey of time budgets, everyday activity and life conditions of rural population 1986-1987, 1993-1994, 1999.

Labour division was established gradually in a fourth of families and in nearly two thirds it was the way of life that was established by itself. Only 2% said that this matter was up to the head of the family. By large, both men and women have rather concerted opinion about their and the spouse's participation in household affairs. But the actual division of labour between the members of a family was reported to be the best one by only 63% of working women

(84% of men). Still lower proportion of women (59%) thought this division fair (83% of men). 40% of women saw injustice in men's lower home duties and in their own excessively high load in home and at work (25%). It should be noted that over half men acknowledged that women had to bear an excessively high burden in home and on job. The data of time budgets show, as if in consequence of these opinions, that really the difference between working men and women in time spent on paid work, in home and in household production was perceptibly reduced. Both men (37%) and women (47%) thought that each should take his (her) part of duties, but the higher proportion of women (40% against 35% of men) thought that the main part of home duties should be assigned to the woman.

Women have more egalitarian beliefs than men. For example, 42% of men thought it were men who should perform the most part of work in household production, among women this view was held by only 33%; the opinion that each has to perform his (her) share of work was supported by 51% of men and 57% of women.

The main functions of free time were reported to be rest and socialising. In 1986-1999 reduction was in percentage of those indicating the informative (especially among men - to a half) and utilitarian (especially among women) functions of leisure.

Satisfaction with leisure behaviours increased in 1999 over 1993, but remained lower than in 1986 with a much higher dissatisfaction among women. The increased role of money as a cause for dissatisfaction sharply increased. The effect of tiredness with work in household as cause for dissatisfaction with free time much declined (Table 2). People have resigned to the necessity of spending much time on work in household and outside the home. On the other hand, in 1999 time opportunities improved, especially for women as is shown by changes in time budgets. The reliance on one's household still prevails.

Table 2
What prevents to spend free time as one could have wished (main causes) (% of response)

Causes, conditions	1986	1993	1999
Household work, a private plot	22	46	15
Tiredness from primary and household work	9	26	11
Lack of means	4	14	36
Bad health	4	4	4
Insufficient conditions for leisure spending	23	28	28
Not enough free time	31	55	40
Inability to organize a leisure	2	1	1
Not enough the skills, abilities	<1	1	4
Other	6	3	5
Nothing prevents	32	10	<1

Source: Own survey of time budgets, everyday activity and life conditions of rural population 1986-1987, 1993-1994, 1999.

In general, changes in time budgets correspond to changes in answers about frequency of particular behaviours in free time and attendance of cultural and sporting events. As before, the educating function of free time was becoming weaker and watching "television" and its use as a source of information became stronger. The share of watching television in total free time increased comparing to 1986-1987 from 38% to 49% among women and from 43% to 59% among men.

Expected use of supplementary free time reflected both the degree of relative shortage of free time and the need in a particular activity. Here a consistent rise was observed only in the proportion of those who wanted to use it in household production (Table 3). In other activities fluctuation in both directions was observed which is associated with the real living conditions and state of people in different points of time. For example, the proportion of those wishing to use additional free time for passive rest sharply increased in 1993 which was the consequence of total fatigue from extremely high work load from the mid 1980s and emotional depression in the early 1990s. In the late 1990s the need in a secondary earning activity to increase one's income became stronger, and the proportion of women wishing to upgrade their training, qualification increased while motives to hobby activities reduced.

Table 3
Expected use of supplementary free time of the rural workers (% of response)

Activities	**Women**				**Men**			
	1976	**1986**	**1993**	**1999**	**1976**	**1986**	**1993**	**1999**
Household work	5	9	10	12	7	15	18	14
Work on the private plot		2	5	6		8	15	21
Personal hygiene/ Medical treatment	3	3	3	2	2	2	1	2
Learning, acquiring new skills	3	2	1	4	4	3	0	1
Secondary job	0	0	1	2	0	1	2	4
Passive leisure, rest	27	13	21	16	18	12	23	16
Interaction with children and family	10	15	18	15	6	11	7	9
Hobbies	16	33	27	20	5	10	7	3
Outdoors, walking, fishing, hunting	6	5	11	2	24	21	33	24
Movies, shows	16	17	12	9	8	9	2	6
Reading fiction, novels	25	27	25	21	18	12	4	3
Sport and athletics	0	9	2	2	4	12	3	2
Watching TV	3	0	2	4	3	4	2	4
Interaction outdoor family	3	6	4	3	5	4	5	5
Uncertain	10	7	8	11	12	8	6	9

Source: Own survey of time budgets, everyday activity and life conditions of rural population 1986-1987, 1993-1994, 1999.

One could observe a process of the reduction time use differences in basic social working groups: agricultural workers, social sphere workers. The most notable evening-out took place in the value of time expenditure at work on the private plot for women. In 1999 differences between managers and specialists, and ordinary workers practically vanished in the structure of winter time budget. Total Work Load (TWL) was among managers and specialists 78.4 hours and 77.6 hours among ordinary workers a week, including working time 35.9 hours and 35.2 hours, respectively, free time 26.6 hours each, sleep, meals, personal hygiene 66.6. and 66.0 hours, respectively. Remind that in winter 1975 working time and free time among women specialists was 2.4 and 4.6 hours more than among ordinary workers, and time of work in home and household was minus 7 hours. At present, women of the first group differ from the second only slightly which is in the use of free time. On the whole the rural intelligentsia became more “peasant-like”.

Average time expenditures on consolidated average seasonal activities are fairly stable. In view of this, even small changes are, in our opinion, remarkable. The everyday routine is conservative, stable, and those “disturbances”, changes which take place in our data testify essential enough changes in the real life. Estimations made on an aggregated file of data from all eight surveys conducted in 1970s-1990s have shown statistical significance of changes at the level of most groups of time expenditures of both men and, in particular, women.

3.2 Change in the life expectancy at birth

The duration of life expectancy reflects the most fundamental living conditions, characteristics of the routine activity, value orientations, economic, political, social-psychological state of the society. The studies show that the life expectancy is “the crucial and reliable indicator of health” (UNICEF, 2001, 48).

We present the national data (Table 4) on the life expectancy because we could not collect data for all years of consideration either on the agricultural population, or on the Novosibirsk region. But the similarity of the presented trends and points of turn with changes occurring in our local communities confirm the results of special estimations for 1989-1998 on the urban and rural population of the Novosibirsk region, West Siberia, Siberia as a whole made at this Institute under the direction of Soboleva (2001).

The Life expectancy at birth was being greatly changing in the 1980s-1990s. Here also it is possible to discern periods and “spots”. First are the years 1986-1987 when this indicator had reached its peak for two decades. Then there was a period of a moderate, then by a sweeping reduction of life expectancy down to its minimum level in 1994. This period was replaced by some recovery of what had been lost, but in 1999 and 2000 this indicator fell again.

This indicator was changing to the most degree in the age group of 40-59 years of age and of men after 70 years of age. In 1998 the life expectancy increased the most among rural men in the age group of 44-49 years of age (112% to the 1994 level).

Table 4
National life expectancy at birth (all population of Russia), years

Year	All	Women	Men
1975-1976	68.1	73.0	62.3
1983-1984	67.9	73.3	62.0
1984-1985	68.1	73.3	62.3
1985-1986	69.3	74.0	63.8
1986-1987	**70.1**	**74.6**	**64.9**
1988	69.9	74.4	64.8
1989	69.6	74.5	64.2
1990	69.2	74.3	63.8
1991	69.0	74.3	63.5
1992	67.9	73.8	62.0
1993	65.1	71.9	58.9
1994	**64.0**	**71.2**	**57.6**
1995	64.6	71.7	58.3
1996	65.9	72.5	59.8
1997	66.6	72.9	60.8
1998	**67.0**	**72.9**	**61.3**
1999	65.9	72.4	59.9
2000	65.3	72.2	59.0

Source: Rossiyskiy, 2001 and Soboleva, 2001.

As is seen, the time points of our longitudinal study of the time budgets of the rural population almost fully coincide with the peaks and drops in the life expectancy curve, with points of turns.

3.3 Social-demographic characteristics, material standing, household production, assessments of changes in the living conditions, the values of rural workers

Some social-demographic characteristics

In our surveys we tried to preserve our sample at four parameters: total number, the share of residents living in rural settlements with different types of urbanization and industrialization, the share of groups of working and non-working pensioners and employed in household production and private plot, the share of employees engaged in functional sub-systems of the village. To some degree it worked well except the last bi-seasonal survey.

Remind, that in selection of workers from basic sectors of the economy we used a quota principle. In our sample, in comparison with the statistical data 1.1.1999, the share of public health, education, and culture is twice as high, with the share of agricultural workers, employed in commerce, public catering, consumer services, housing and communal services, being similar. On the other hand, in the sector of services, in particular, medical and educational services, most workers are women.

The workers' time budget is influenced by *changes in family membership*: number of the earners, of those doing unpaid work about the home, pensioners, the unemployed, the children, in particular those in pre-school and early school ages (Table 5). There was a constant reduction in the number of earners and an increase in the number of the unemployed in the working ages, and during the last decade also an increase in the number of those working only in home. After 1993, due to birth rate reduction, the number of children in the pre-school ages fell to about a half, the reduction was still greater in the number of the children served by children's facilities.

Table 5
The average family makeup of the surveyed rural workers, persons per 100 families

Family members	1975	1986	1993	1999
Total number of the family members	*395*	*370*	*376*	*366*
Working	208	200	191	180
Non-working	2	4	16	22
Employed in household	10	4	5	15
Pensioners, disabled persons	28	24	26	24
Children of pre-school age	49	55	47	24
go to kindergarten	10	23	14	4
Schoolchildren	82	73	81	83
Other students	16	10	10	12
Children of 7-17 age, which do not go to school and do not work	-	-	-	6

Source: Own survey of time budgets, everyday activity and life conditions of rural population 1986-1987, 1993-1994, 1999.

Judging from self-assessment of the population, *material standing of families* continued to deteriorate (Table 6). Taking into consideration multi-oriented changes in the concept of "basic necessities of life", it should be mentioned that on average, the level of these "necessities" decreased.

The families of the workers who estimated their financial position as "there is enough money for everything" had per capita income of 1833 rubles (USD 75) in May, 1999 (including 1000 rubles – USD 41 - from private holdings). Under assessment "overall, we have enough money", their income accounted for 711 rubles (USD 29). Those who considered that "there is enough money for necessities only" had income of 391 rubles (USD 16). For those, who said "there is not enough money for the basic necessities" income was 202 rubles (USD 8.3).

Table 6
Self-assessment of family material standing: working population, in %

Assessment	1987	1993	1999
We can afford everything, there is enough money for everything	10	1	<1
Overall, we have enough money	42	13	4
There is enough money for necessities only	39	45	41
There is not enough money for the necessities	8	41	53
Uncertain	1	0	2

Source: Own survey of time budgets, everyday activity and life conditions of rural population 1986-1987, 1993-1994, 1999.

In terms of numbers, basically, the adequate provision with durable consumer goods in 1986-1999 has changed slightly. The share of families possessing such “interest” goods as musical instruments, sporting equipment, libraries have decreased. However, the share of families who can afford vacuum cleaners, tape recorders, video cameras, video players (from 0 to 28%), and cars (from 21 to 36%) has notably increased. As far as the purchase of durable consumer goods is concerned over the last two years before the survey, in 1999 there was a reduction in the majority of goods in comparison with 1994 except TV-sets (increase from 12% in 1994 to 14% in 1999), cars (4% and 8%), and video players (almost 0% to 7%). The total share of those who bought nothing from the list of everyday goods given to the respondents over the last half a year before the survey has remained unchanged (6%), but the share of those who were buying goods has decreased. At the same time, the share of those who were buying construction materials and medical products (drugs) has increased.

And the indigence is not overestimated, the needs are at the level of physical and social survival, so they are rather underestimated. It turned out that in 38% of families incomes were insufficient to provide “normal nutrition”, and in another 21% “not always were sufficient”. A third of families with children could not afford paying for children’s facilities or education. Only half families who needed medicines and medical services had sufficient incomes to pay for them. Over 80% of families could not afford domestic appliances and cheap furniture and nearly two thirds of families could not afford cheap shoes or clothes.

Family production of goods and services (Household Production)

At the beginning of the 90s, as a continuation of the trends of the second half of the 80s there was observed a predominantly extensive growth of private plot: upsizing of almost all basic elements, work on it, share of this work in total work load. In the end of the 90s, the trends of the beginning of the decade changed drastically (Table 7). The size of some elements of private plot tended to increase (livestock of pigs increased in 1.5 times), while the number of others decreased (15% reduction of livestock of cows, other cattle – 1/3 reduction, the number of goats and sheep decreased at 250 heads per 100 families). However, the livestock population of horses as important “natural” means of production grew significantly. The importance of private plot for survival tended to increase. Given the decline in jobs, workplaces, and remuneration of work, the share of workers (33%) suppose that the family could survive only due to their private plot. At the same time, only 10% of the respondents consider it to be possible to survive without private plot, while 86 % found them vitally important. Almost 2/3 (60%) of the respondents supposed private plot to be a *forced necessity*.

Table 7
The cattle and poultry population at a private plot of the rural workers (heads per 100 families of workers)

Cattle, poultry	1975	1987	1993	1999
Cows	66	63	97	84
Other cattle	45	67	105	71
Sheep, goats	294	467	540	295
Pigs	39	70	120	188
Poultry	1189	1164	1603	1749
Horses	-	1	9	16

Source: Own survey of time budgets, everyday activity and life conditions of rural population 1986-1987, 1993-1994, 1999.

On the whole, the support from agricultural enterprises to private plot tends to decrease. Rarely do new forms of backing occur. In due time such an interaction between agricultural enterprises and private plot was mutually beneficial with a clear feedback between the level of economic development of an enterprise and a quantity and size of private plot on the “territory of an enterprise” (Kolosovskiy, 1982). The studies of the end of the 90s show that the strategy for the family to survive to a great extent depends on the level of social-economic development of an enterprise: the lower the level, the greater the role of private plot for the family survival, with family intentions changing from “to become richer” (26%) to “to remain at the same level” (49%) and “if only to survive” (23%) in efficient enterprises, while in the enterprises with “destructive adaptation model” these figures correspond to 6%, 25%, 66% (see Kalugina, 2000, 84-88). It should be mentioned that in the villages with effective agricultural enterprises population growth or at least its preservation is observed, whereas in the others the reduction process takes place.

The tendency to reinforce self-service can be clearly traced (Table 8). According to the respondents, the reason for non-use of the services listed in the questionnaire was self-service (50% in 1994 and 66% in 1999) and lack of money (35% and 39% correspondingly). Most likely, self-service together with family and neighborly mutual aid became more significant. On the whole, the reason is obvious – reduction of service sector in rural area and lack of money to pay for services or to private service. Perhaps, there is also a deep motion towards various and intensive “horizontal” interaction between families.

Table 8
Using of services and self-service (% of response)

Kind of service	1986		1993		1999	
	Services from the side	Originally	Services from the side	Originally	Services from the side	Originally
Sewing, knitting, clothes repair	66	34	36	51	10	87
Sewing and shoes repair	no data available				34	55
Repair of TV and radio mechanics	84	8	78	17	56	21
Repair of domestic appliances	77	9	71	23	41	20
Repair of house, flat	4	94	3	96	2	96
Repair of car, other vehicle	5	55	6	62	6	57
Transport service	72	27	66	30	47	30

Source: Own survey of time budgets, everyday activity and life conditions of rural population 1986-1987, 1993-1994, 1999.

Assessments of changes in the living conditions and in the own state

The workers' estimation of changes, which take place in the local living conditions or in the family strongly influences on their internal state and their real behavior. As Sorokin pointed out "poverty or well-being of a person is not determined by what he possesses at the given moment, but what he possessed earlier and comparing with the other members of the community". In the 90s, these estimates (Table 9) have changed almost to the opposite as compared to the 80s.

Over the last five years, the share of negative estimates of changes in conditions of leisure and rest, upbringing of children and education has increased. On the whole, only the changes in goods supply were positively estimated.

The assessments *of personal state and state of mind*: health, certainty in the future, feeling of personal safety became more negative (Table 10). Only did the changes in relations between people become less negative than in 1993.

The overall estimate of the outcomes of current "reforms" logically results from particular personal changes. In 1999 it remained the same as in the end of 1994: 81% of the respondents negatively estimated these results, while 5% were positive and 14% found difficulty to estimate it.

Value orientations

In the period under study the role and significance of family for survival continued to grow among the rural population which was shown by their answers to rather diverse questions. Among the main life values "*family*" was indicated by most of surveyed women and men (Table 11). 75% of family persons (80% of men and 68% of women) thought that family gave them a feeling of stability and protection.

Table 9
How did working population in the rural areas assess changes in living conditions compared to 3-5 years ago (% of response)*

Living conditions statement	**1987**		**1993**		**1999**	
	Conditions of life 3 to 5 years ago were:					
	better	**worse**	**better**	**worse**	**better**	**worse**
Work conditions	48	8	n/a**		3	75
Transport, roads condition	64	8	17	50	15	63
Medical services	56	6	5	49	5	73
Convenience services, repairs	51	17	4	66	4	67
Upbringing of children and education	44	11	8	33	9	55
Shopping	40	26	25	46	48	35
Conditions for leisure and rest	22	19	9	37	10	56

* The percentages do not add up to 100 because some respondents were not sure about the direction of change.
** n/a: no data available
Source: Own survey of time budgets, everyday activity and life conditions of rural population 1986-1987, 1993-1994, 1999.

Table 10
How did working population in the rural areas assess changes in their statement and the family living conditions compared to 3-5 years ago (% of response)*

Living conditions, statement	**1993**		**1999**	
	better	**worse**	**better**	**worse**
Family's housing conditions	29	18	11	33
Feeling of personal safety	3	32	2	40
Perceived state of health	3	44	2	49
Financial position	9	64	7	73
Certainty in the future	6	69	2	71
Degree of personal freedom	14	13	13	17
Relations between people	2	72	3	69

* The percentages do not add up to 100 because some respondents were not sure about the direction of change.
Source: Own survey of time budgets, everyday activity and life conditions of rural population 1986-1987, 1993-1994, 1999.

Stability of relations in the family was indicated in 87% of answers. 78% of women and 81% of men thought that “only kids make the life meaningful and significant” and 69% and 76%, respectively, agreed that man’s assignment is to earn money and woman’s assignment is to keep house, family. (However the really paid wage in May 1999 was for women slightly above that for men). Add to this, that only a third of respondents thought: “one parent can raise the kid no worse than both parents”.

Table 11
What is the main in life, what has the greater value* (% of response)

Value	Women		Men	
	1994	1999	1994	1999
Good friends	27	27	35	34
Interesting work	29	33	31	29
Family	78	81	70	70
Material welfare	44	53	45	39
Interesting leisure	3	1	6	5
Good relations between people	27	30	16	25
Good education	2	4	1	1
Living conditions stability	13	28	12	25
Free choice (of activities, job, way of life, etc.)	1	2	2	6
Good state of health	45	60	31	45
Respect from the associates, the feeling of self-significance	11	15	6	14
Other	1	1	1	2
Uncertain	2	4	-	2

* The question was closed, the order of "values" is the same in questionnaire and table.
Source: Own survey of time budgets, everyday activity and life conditions of rural population 1986-1987, 1993-1994, 1999.

The highest growth was observed in the proportion of those who reported such values as “stability in living conditions” (meant was at least their non-deterioration) and “good state of health”. Among women increase was in the proportion of those who mentioned “material well-being” (among men the change was reverse), “exciting job” and “family”. Women attached a higher value to “family” and “health” than men, and in 1999 “material well-being” was added.

The value attached to *work in a collective farm or state organisation* as a sphere self-realisation and a source of deep satisfaction further diminished with a notable difference between men and women (Table 12). The value of housework increased still more. The value of leisure activity and talking and reading to children declined because of decrease in their number.

3.4 Central time point of changes

Now we briefly characterize the three time points in the aspect we are concerned with.

1986-1987 is the beginning of the period of great changes in all spheres of the life in the society, start of “restructuring” with its slogans of “more democracy”, “more socialism”, “intensification and efficiency of production – through scientific-technological progress”, “toward a high standard of living” and so on.

Table 12
Spheres, where the respondents have most satisfaction (% of response)

Spheres, activity	Sex	Year 1986	1993	1999
Primary work	female	65	52	40
	male	78	52	45
Work on a private plot	female	7	8	9
	male	9	31	18
Household obligations and errands	female	31	40	46
	male	22	30	33
Public work	female	5	5	3
	male	5	2	3
Leisure	female	5	9	6
	male	11	13	6
Interaction with children	female	30	28	23
	male	17	17	13
Uncertain	female	11	6	8
	male	6	6	8

Source: Own survey of time budgets, everyday activity and life conditions of rural population 1986-1987, 1993-1994, 1999.

Time budget 1986-1987

Increased total working load (TWL), especially manual work in individual household farming, maximum duration of TWL in all four points. Decreased time of sleep and its minimum amount (among men employed in agriculture the time of sleep, including “intoxicated” sleep, had decreased comparing to 1975-1976 by 6.6 hours per average seasonal week). Despite minimum amount of free a high intensity of real and potential leisure activity was witnessed: reading, attendance of cultural establishments, talking or reading to children. We consider this process with primarily by improved living conditions in that period and by moral atmosphere in those years.

Living conditions continued to improve, but slowly. The assessment of their changes for the preceding three to five years is noticeably positive. The family material standing was assessed mostly as satisfactory.

The second half of the 1980s is characterized by optimism, expectation of substantial changes hoped to bring affluence to the most of the population (but especially to those who were highly skilled and hard working), of the removal of barriers in the sphere of work, ownership, information, and election of bodies of authority.

Unfortunately, characteristic for these years are such statements as: “representative polls on social issues” are “extremely rare”, “the data of conducted polls are neither analyzed, nor made known to the public”, “there are censorial restraints on publication of facts and conclusions about the current and past reality" (Postijenije, 1989, 10-11). The surveys were usually conducted on the order of the central bodies of the Party by a special department of the Institute for Social Research of the Academy of Sciences of the USSR and by the researchers of the Academy of Social Sciences attached to the Central Committee of the Communist Party of the Soviet Union. According to the data from one of such surveys conducted in 1986, 88% of the urban and rural workers said their performance could be much higher and 90% said that there was untapped possibility to improve the quality of products (Toschenko et al., 1988).

These moods and urges were in line with those novelties that were emerging in the organization, incentives, industrial relations in collective and state farms, in inter-farm cooperation, development of processing and market facilities. Along with this, the rural material resources continued improving in both economic and social spheres. In this period, the average wages in agriculture had at last reached the national average.

At the same time, according to the data from the above mentioned survey, about 40% of the respondents foresaw the future material difficulties in the period of changes. The pattern of behavior in the second half of the 1980s was characterized by people's deliberate or intuitive efforts to hoard or increase the material resources in any possible form in order they would allow to survive the most hard times that were in store. For town-dwellers these resources included stocks of goods or even foods as well as suburban plots of land that could be taken for use, construction on them wooden or brick buildings. Rural inhabitants exposed quite another pattern – they were increasing the scales of household production on land plots, mainly the herd size, and, accordingly, time of work on them.

According to this, it was the family, its well-being, its rich potential, its economic activity that came to the fore as the key primary social cell, of which the community is composed.

This pattern exposes optimism, confidence in the future and understanding the importance of rearing the children so that they duly continue the family line, become well educated, good-natured and honest people, skilled and healthy workers able to provide for their families. This mood was typical of most rural inhabitants, and, in our view, reflected itself on noticeable increase of time expenditures (not counting subsidiary activities) on child care and, especially, on talking and reading to them.

The years 1986 and 1987 account for the highest direct expenditures of time on teaching children and for the highest provision of pre-school child facilities. This trend of increase of time spent on children in the second half of the 1980s was also shown by other time budget surveys, namely, by our survey in the town of Rubtsovsk and by the study made by the Russian Statistical Service of the sample of public-sector employees' families. It is also revealing that such time expenditures notably increased among males. A certain parity was achieved between father and mother in this sphere of everyday activity. However, subsequent adverse changes in the living conditions and in the employment again reversed the situation, and feminized this activity still more.

In the mid 1980s, the growing concern with health and improved family and workplace conditions found its expression in *the anti-alcoholic campaign of 1985-1986, deep decrease of production and consumption of alcohol.* A positive assessment of this campaign is evident from the data collected as part of our 1986-1987 survey.

In the Summer of 1987, in response to the question "How did the life in your village change after the announcement of the anti-alcoholic measures?", 66% of respondents stated that the streets became safer; 22% pointed to the decline of alcohol consumption at work. Only 14% did not see any change, and 10% complained that it became more difficult to buy liquor, the lines to buy liquor became longer, etc. (Vershinina, 1990). Similar results were obtained in a survey of 4000 thousand Moscow inhabitants in June 1987: over a half of the surveyed noted positive changes and about a fourth did not note them (Express-information, 1987, 145). Statistics of trespasses, morbidity, mortality, including suicides, alcohol poisoning, murders as well as low natality corroborate these opinions very well. For example, in 1986-1987 the birth rate in rural areas was 19.1 (national averages were 17.2 and 17.1 [10, p. 349]) which is noticeably higher than in preceding and following years. Especially increased the proportion of second and third births (Vishnevskiy et al., 1988, 56).

One third of all interviewed respondents would have liked the campaign to continue, another third favoured introduction of even stricter measures, while only 9% preferred abandoning the campaign, and the rest did not express an opinion (Vershinina, 1990).

In consequence of these and other changes, in 1986-1987, after the stable period, the life expectancy went up and reached its peak for our period of research.

1993-1994 is the turning point in the period of “restructuring” – “reform” – “revolution” started in 1985 and now completing it with a dramatic fall in living standards (to a half or a third) and with the robbery of inhabitants made time and again by the state or with its support. The mass collapse of industrial and agricultural enterprises and of social services continued. Next was a relatively stable period when most Russian people began to adapt themselves to the market system at the level of survival.

Time budget 1993-1994

In the very beginning of the 1990s there existed a kind of equilibrium between the duration of working time and the duration of work in the household at the maximum of cumulative work expenditures. This period could be followed either by reduction of work in household production if the reorganization of collective and state farms led to their economic independence and higher efficiency and output; or, in the absence of such changes, by reduction of working time in the collective-state farms. Actually just the latter with a great set of negative consequences took place.

The high level of work load persisted until the early 1990s, at a certain trend to decline. Work time decreased substantially on primary job and considerably increased in household farming. The time of sleep and relaxation again decreased reaching the minimum for all four “points” and the maximum of those who wanted to use the projective free time on rest. The time of child care decreased. Free time among females increased but at deterioration of its use.

The time of work in household farming increased primarily due to increased number of animals requiring constant care and heavy manual work. In 1995, as is shown in statistics, the herd size began to decrease.

It was a process of rapidly increased income polarization. Wage and pension arrears were increasing. Their purchasing power fell greatly. Self-assessments of family material standing dropped dramatically.

The assessment given by rural workers to changed living conditions had reversed comparing to 1986; changes in one's own standing also got negative assessment.

Our hypothesis about negative consequences of the extreme duration of TWL on the state of health was proved although it was not the work load alone. The shock struck by the breakdown of the USSR and giant jump of prices in 1992 turned into a national stress. Expectations of 1985-1987 brought about by the noticeable improvement of living conditions, primarily material ones, as the key element of the social-psychological state of the most of population, were destroyed by the jump of prices, sharp fall of living level and depreciation of savings. Liquidation of the state monopoly on production and sales of alcohol drinks brought to a considerable increase of alcohol consumption. It was as if on purpose: "after you got a very strong physical and emotional blow, get drunk not to feel pain in body and soul". All this along with amassed fatigue and lack of confidence in the future led, in our opinion, to substantial reduction by 1994 of life expectancy, especially so among men, to a record minimum of this indicator. Revealing is also the change in the number of suicides as one of the key indicators of physical, social and mental state of the people. In 1980 there were 34.6 suicides per 100 thousand population, in 1984 37.9, in 1985 31.0, in 1986 23.1, in 1987 23.2, then this figure was increasing up to 1994 (43.1), by 1998 it decreased (35.4), and in 1999-2000 it rose to 39.3. A similar movement of this indicator was with respect to accidental poisoning with alcohol and to killings, other causes of death, and mortality in general (Rossiyskiy, 2001). To a certain degree, health deterioration was also a consequence of insufficient personal concern, responsibility, activity toward its preservation and improvement. However, this attitude has some other reasons behind it, too. It is remarkable that the surveyed workers of the town of Rubtsovsk (1990) thought: "need in health care should be fully provided by the state" – 50%, "by the state and the citizens on a par" – 25%, "fully by citizens themselves" 4% (others were uncertain). With respect to child care the answers were: 18%, 54%, 16% and 12%.

Therefore, in the 1985-1994 decade the Russian populace underwent two peak states with the opposite "sign". In the beginning it was the state of enthusiasm, great expectations, optimism, working and leisure activities and was clearly reflected on the use of time. The end of this period was at first the national shock, then a stress of the same force, and in general the catastrophe.

1999 is the point of the period of more or less pronounced positive social and economic trajectory for a small minority of enterprises and companies of the so called real sector at no more than a level of survival and continued degradation for the most.

Time budget 1999

Minimum (among women) for all four points total work load and minimum working time. Degradation of most agricultural enterprises, reduction of budget funding that led to a considerable reduction of working time. The proportion of working time in the TWL per average seasonal week decreased among the agricultural workers in 1999 against 1975-1976 from 77% to 59% for men and from 52% to 44% for women. Russian Longitudinal Monitoring Survey data (a part of questionnaire - time budget) over the period of 1995-1998 also testify to the reduction, working time (except of capital cities women) and work on the private plot (Gvozdeva, 2000, 62).

On the whole, “time pressure” of the 1986-1994 period gave place to its opposite because of the sharp reduction of time of primary work. The time of work in household production if we take the summary time of the major workers in a family, the man and the woman, rose to 37 hours in 1999 per average seasonal week (in 1975-1976 23.2 hours). The time of sleep increased.

The situation of working women has slightly improved due to redistribution of labour within the family and increased men’s participation in family duties. The reduction of work load coincided also with a certain rise in birth rate in 1999. But this change is not steady.

The maximum (for women) amount of *free time* was achieved under the lowest leisure activity and maximum proportion in the free time of television and video watching. The relative increase of time spent on talking to children under its minimum absolute amount and recovery of the obvious pre-eminence of women in these behaviors. A substantial men-women approximation took place in the duration of total work load (with emerging priority of men in time spent on household farming). Almost totally disappeared the difference in time budgets between large social groups of women on paid jobs.

In families the proportion of people doing unpaid work substantially increased. The number of children of pre-school ages has fallen to the minimum.

There occurred a relative stabilization in living conditions at the general trend to deterioration. The assessment of the family material standing became lower, the assessment of changing living conditions and own standing and mood became still more negative. The general assessment of the current results of “reforms” remained at the same lowest level as in 1993. Under reduced assistance from the agricultural enterprises to families’ household farming there was a perceptible contraction of household production elements under increased head of pigs, poultry, and horses.

There were no notable changes in the use of different ways to upkeep and improve material standing. The share of those having more or less constant secondary job was most stable (14-16%), the number of those willing to have the secondary job increased in 1.5 times (growth from 26% in 1993 to 39% in 1999). Being initially low, the activity of the families of rural workers in businesses (except private plot) providing them with additional money income or necessary services and goods including those for exchange has shown a downward tendency. The share of such families in 1999 as compared to 1993 halved (from 9% to 4%).

Relative marketability and profitability of private plot has increased. In particular, in 1994, 7% of families sold for cash more than half of production, in 1999 this figure almost doubled (13%). At the same time, the share of those families who consumed all or shared the part of the production with relatives notably declined. According to the data, money income from private plot over the month period prior to the survey became comparable to the total money wage paid to the working members of the family, whereas, in 1993 it accounted for only 2%. The analysis on the basis of "budget" family data made by Goskomstat and World Bank surveys in the villages of Saratov oblast (region) (Kutenkov et al., 2000), revealed that in 1997-1998 gross income of a rural family consisted of money including cash received from private plot, which accounted for 33%, 2/3 of "in kind" (28% - payment in kind and 39% - products of private plot). Moreover, production resources for cattle breeding prevailed in payment in kind. From 1/3 (according to the budget survey data) up to 1/2 (according to the polling) of money income was obtained from the sale of private plot products.

The signs of tendency to greater efficiency of family household are shown in the real common and local social-economic conditions. Family household adapts to the deteriorating conditions of its keeping and to the family labor potential and motivation.

A new reality in the everyday life has appeared which is declined share of skilled labour in total work load, a certain balance in work inputs, size of household production and cash-kind incomes that correspond to level of survival.

1994 was a turning point. Changes on the last round testify to the transition from extensive household growth to the "lifesaving" regime with relatively minimal level of labor cost and consumption.

There occurred some notable changes in *value orientations*. The share of those who mentioned "health"(it has moved to the second place after "family", having left behind "material well-being") "stability of living conditions", "relations between people", "respect from the associates, the feeling of self-significance" was observed noticeably rising).

It should be noted the increased value attached to health and the opinion about the effect made on it by work on household plots. "Health" as a value which in 1994 yielded both to "family" and to "material well-being", in 1999 had overtaken the latter although the material standing of the families continued deteriorating. The negative effect of work in household farming on the state of health was reported by 38% of working men and 47% women. The proportion of those who said their state of health was bad decreased in 1999 compared to 1993 (from 21% to 17%; in 1986 the proportion was 14%).

It is noted the lowest level of the value attached to the primary work, to talking and reading to children as a sphere of self-realization and getting satisfaction.

4 Conclusions

1. In the research of changes in everyday activities and substantial changes in the society the time budget method has proved its high informative value and reliability. Information obtained by time budget method shows very clearly the consequences of different macro events as they are reflected on everyday activities.

2. Our statements should be taken as firm conclusions about the relationship of the given facts and, the more so, as their functional relationship but only as assumptions requiring, before they are confirmed or rejected, an additional analysis with the use of various data and as much direct as possible correlation of data of individual, group, social-spatial and socium level.

3. At the macro level, in the beginning of the second half of the 1980s we notice maximum (among three time points) duration of work load, minimum amount of free time *and* maximum life expectancy, high leisure activity, the highest time spent on being with children *under* positive assessment of changes in living conditions. Persistence of high work load *at* sharp decline of living standards, negative assessment of material well-being, of changes in living conditions and own standing, rise of alcohol consumption were behind the drastic reduction of life expectancy by 1994. Persistence of high work load *at* sharp decline of living standards, negative assessment of material well-being, of changes in living conditions and own standing, rise of alcohol consumption were behind the drastic reduction of life expectancy by 1994.

4. The direction and degree of influence between “use of time – state of health” depend on macro and micro life conditions, on social-psychological well-being of the society and individual, on the “initial’ state of health of the individuals.

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electronic **International Journal of Time Use Research**
2008, Vol. 5, No. 1, 26-42.

Entropy and stability in time use – An empirical investigation based on the German Time Use Survey

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Abstract

Flexibility is a tool for preserving the stability of a system. In general, we can expect that the more variant its behaviour, the more stable a system will be. The investigation provides an example of this principle within the discipline of home economics. For a sample of single-person households from Germany's national Time Use Survey 2001/2002, it can be shown that the stability of activity sequences is greater, the higher the entropy of time use. For this purpose, a Markov model is derived from heuristic considerations. The Markov matrices are estimated and their eigenvectors and eigenvalues then calculated. It is evident that the entropy of an attractor is higher, the lower the norm of the second eigenvalue of the corresponding Markov matrix. The main components of this relationship, namely diversity and stability in time use, turn out to be only weakly associated with the usual socio-economic regressors. Hence, new empirically and theoretically relevant dimensions for socio-economic research emerge.

JEL-Codes: A21, C32, C51, D13

Keywords: Time use survey, Markov process, system stability, entropy, teaching

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The author is grateful to Dr. Brian Bloch for his comprehensive editing of the manuscript.

1 Introduction

Although this paper may seem merely to protocol econometric results drawn from the German Time Use Survey 2002/2003 (GTUS), it makes a contribution through reporting and analysing progress in basic research with respect to a dynamic theory of the household. GTUS is based on time diaries, hence the concept of Scientific Use File (SUF) of GTUS documents, the sequence of activities in a special computer file. The dynamic features of this file have not been used much in research so far. Most published research simply argues on the basis of the overall frequencies of different activities. Use has rarely been made of the fact that data are also available that document not only the frequency, but also the sequence of activities.[1] Intuitively, there should surely be measures of the diversity, monotony, stability, variation, complexity, determination and randomness of these dynamics, but there is no consensus on the definitions through which these pre-concepts could be formalized. There are also many ways of defining the relevant concepts. One critical condition is that a definition not be self-contradictory. A “good” definition, however, becomes meaningful in the sense that the entity defined is also the object of a theorem.

Take, for example, the field of physics. We have a pre-theory intuitive concept of heat, of the space filled by gas, the elastic resistance that it exerts against compression. The definitions of “pressure” p, “Volume” V and “Temperature” T are difficult to formulate. However, it turns out that it was worthwhile to select just these definitions of many possible related ones, because scientists were then able to formulate the theorem $p \cdot V = T$ (Boyle-Mariotte-Gay-Lussac). Finding these definitions seems easy in retrospect, but a glance at the history of science shows that it took centuries to differentiate meaningfully between impulse, force and kinetic energy, or, to give another example, between temperature and the quantity of heat.[2]

Accordingly, if we wish to research the dynamics of time use, we should not be content with arbitrary definitions of global properties of such a dynamic, but establish those which can be linked to theorems with empirical content. This means theorems that are not true by definition or a priori, but prove to be true by observation or a posteriori.

This paper proposes a first step in this direction. It suggests formalizing time use sequences through a Markov process. The diversity of time use can therefore be measured by the entropy of its attractor, and its stability by the norm of its second eigenvalue. Diversity and stability thus defined prove to have an empirical relationship, at least for the investigated data.

It is found that the higher the entropy of time use, the higher its stability.

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1 Exceptions known to the author are Grossmann (2007), Hufnagel (2004), Merz and Burgert (2004), Gille and Marbach (2004, 103 ff.), Wilson (1999).

2 See Falk (1990, 125 ff.).

It is clear that such a result can only be the starting point for building a genuine theoretical framework for the investigation of time use data. However, it should constitute a viable foundation.

In the following analysis, a detailed derivation of the central result of this paper is provided. Possible applications of these initial results are discussed in the concluding section. The data used for the investigation are presented in Section 2. Section 3 reports previous research, preliminary heuristic findings and looks for interdisciplinary elements which could be considered in further research. The analysis also explains and justifies why the author decided to use a Markov model. The assumptions and implications of the model are described in considerable detail. The fourth section presents the empirical results yielded by the Markov framework. Section 5 contains a discussion of the findings and the implications for further research.

2 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)[3]. We use the 95% Scientific Use File which has been available from the Statistisches Bundesamt since 2005. The sample size is approximately 5,500 households, comprising about 14,500 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 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 per day. 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 the Activity Group Number 31 “preparing meals”. Again, Activity Group Number 31 is subsumed under Activity Field 3 “housekeeping”.

[3] See, for example, Kahle (2004) on the design of the 2001/2002 Time Use Survey. Some initial research on this data by a pioneering group of social scientists was published by the Statistisches Bundesamt (2004).

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 for three days per person, and usually includes two working days.

This following investigation by the author is essentially explorative in nature. Trying to use all the information included the SUF at once, would have been prohibitively complex. Therefore, a sub-sample was selected, based on the following criteria.

Only single-person households are used for the investigation. This is to avoid investigating influences from the activities of several household members.

It is necessary to document time use for two subsequent working days. This allows us to regress the activities performed during a certain hour of one day on the activities of the same hour the day before.

Single people ("singles") who regularly perform paid work are excluded from the study. Considering the answers of paid workers, one can see that they mostly fill in an 8-hour block of time with only one activity: 11= "paid work". In comparison to non-employed individuals, their time use becomes very monolithic or indeed monotonous. Because we are interested in non-trivial reasons for "monotony" and the diversity of time use, regularly employed people are excluded from the study.

Applying these criteria, we obtain a sample of 426 single people. For these individuals, we have information on what they did on two subsequent working days during each ten-minute interval of each day. Accordingly, we have 2×144×426= 122,688 observations of time use. Each of these observations can assume one of 272 values, the number of activities documented by the SUF. Some of these activities rarely emerge, and others do so very frequently. Because we have to estimate these frequencies later in the investigation, we must ensure that there are sufficient observations of each activity to secure a reasonable level of significance of the estimated frequencies. Therefore, the activities are aggregated into 18 activity groups which are listed in Table 1.

3 A Markov model for time-use sequences

By means of the data described in the above section, we can pose the heuristic question of whether it is possible to predict the activities that a person will perform within a certain time interval. In order to deal with this issue, the author has proposed a Boolean grid model (Hufnagel, 2000).

Table 1
Activity groups used in this investigation

Group	Includes activity No.*)	Group	Includes activity No.	Group	Includes activity No.
1. Sleeping	010-012	*7. Textile care*	330-339	*13. Recreation*	531-532
2. Eating	020-021	*8. Craftmanship and gardening*	340-359	*14. Sports*	610-651
3. Personal care	030-039	*9. Shopping*	360-389	*15. Hobby*	700-729 840-849
4. Paid work and education	100-249	*10. Voluntary work*	400-449	*16. Reading*	800-819
5. Preparing meals	310-319	*11. Social contacts*	510-519	*17. Watching TV*	820-822
6. Cleaning	320-329	*12. Cultural activi-ties*	520-529	*18. Travelling time*	900-993

* For a detailed description of these activities, see the handbook from the SUF of the Statistisches Bundesamt.
Source: Own illustration.

In this model, the activity conducted during a certain time interval depends on:

1. the activities carried out in the time intervals prior to the observed one
2. the activities of other household members
3. natural, social and economic restrictions
4. socio-economic and socio-demographic characteristics, attitudes and norms of the household members.

When the author used Boolean regressions to concretize his Boolean grid model, he found that the number of observations is too small to obtain significant estimates.

A less demanding approach was subsequently attempted, estimating Probit regressions. At first glance, the results seemed promising: hit rates and ψ-R^2s often greater than 90% could be obtained. However, these results turned out to be useless for the purpose of predicting and simulating household behaviour. This will be explained in more detail, because this failure has important implications.

Assume a 0/1-dummy-variable y_t^s. Imagine, for example, that y_t^s indicates whether person number s ($s \in \{1,\ldots,S\}$) is sleeping during time interval t or not. y_t^s should depend on the activities performed immediately before (0/1 dummies as well), the length of time these activities took and the squares of the variables, the length of time which the activities had not been conducted in the past, and the squares of the variables (all metric). Furthermore, y_t^s should depend on the time of day and on the social, economic and psychological characteristics of the investigated person.

Because y_t^s is dichotomous and we assume an interdependency of many qualitative, ordinal and metric regressors x_i (i=1,…,n), it is best to work with a Probit [4] model:

(1) $\tilde{y}_t^h = a_0 + a_1 \cdot x_1^s + ... + a_n \cdot x_n^s + \varepsilon^h$

(2) $y_t^s = 1 \ \ for\ \tilde{y}_t^s \geq 0 \quad and \quad y_t^s = 0 \ \ for\ \tilde{y}_t^s < 0$

(3) ε~N(0,1).

Now, suppose the coefficients a_i (i=0,…,n) have been estimated.[5] Let $x_1^s,...,x_n^s$ be the observed values for a certain member of the sample. We can then use the Probit-model for two different forms of prediction (e.g. Woolridge, 2006, 582 ff.):

A) We predict $y_t^s = 1 \quad if \quad a_0 + a_1 \cdot x_1^s + ... + a_n^s \geq 0 \quad and \quad y_t = 0 \ otherwise.$

B) We predict the probability that $y_t^s = 1$, to be $\Phi(a_0 + a_1 \cdot x_1^s + ... + a_n \cdot x_n^s)$.[6]

It was found that only the second interpretation of the Probit-estimates was useful for dealing with our time budget data. This is clear if one examines Figure 1, which shows the result of a Probit-estimation for a sample of singles. The ordinate indicates the predicted probabilities $\Phi(a_0 + a_1x_1 + …..+a_nx_n)$. Among the regressors, x_i are a dummy that indicates whether the person had been sleeping during the previous time interval or not, a variable that measures how long the person has been sleeping without interruption in the past 24 hours and the square of this variable. Finally, the time of day is among the regressors and this variable is indicated on the abscissa. At the bottom of Figure 1, we see a cluster of observations that behave as might be expected. The probability of sleeping is low during the day and higher at night. At the top of the plot, there is a cluster of observations with very high probabilities for sleeping, even during the day. The reason for this cluster is that the Probit-procedure indicates that it is very likely that someone will continue sleeping when he has slept during the last ten minutes, even in bright daylight.

Now imagine that we attempt to simulate a single's behaviour on the basis of such a Probit-estimation. We start with a person who is sleeping at four in the morning. Then, the cross applying to this person will fall in the upper cluster in Figure 1, Φ will be about 0.95. Consequently, according to the above Rule A, we would predict "sleeping" for the next time interval. Again, the observation would be in the upper cluster and, continuing this process, we would predict sleeping for the entire day. To conclude, trying to simulate a single's behaviour on the basis of Probit-estimates and the above prediction Rule A, would lead us into a quite unreal world.

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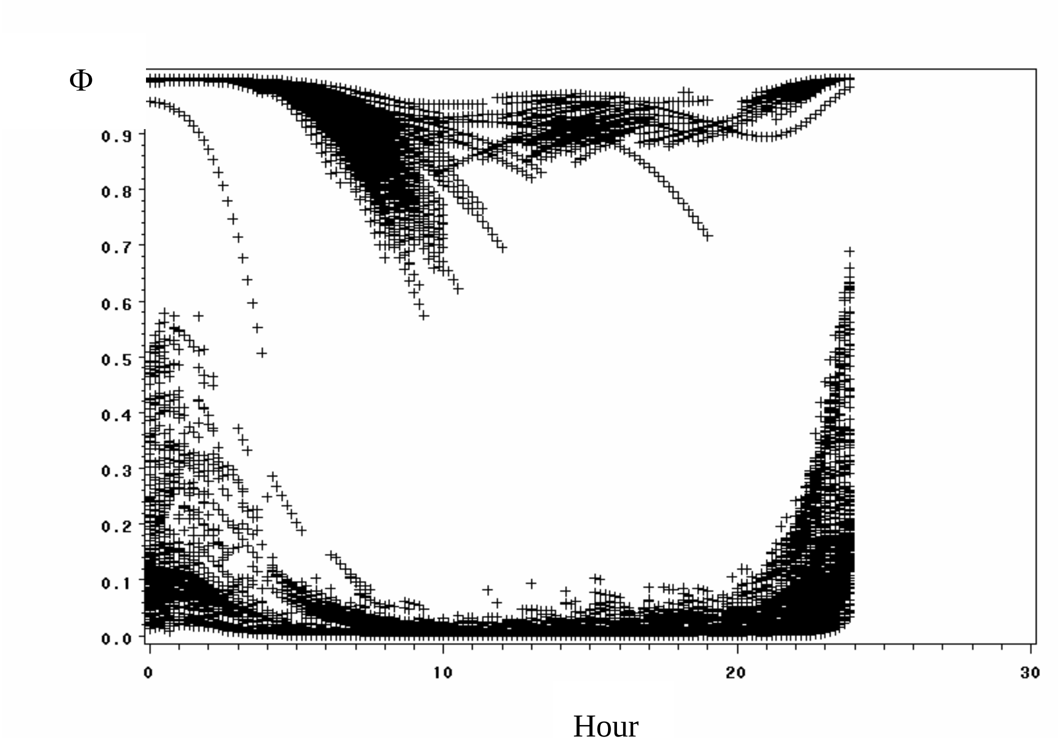
4 Clearly, a Logit or anything similar would do as well in the context of this paper.

5 Assume that non-significant regressors have been deleted.

6 Φ denotes the cumulative distribution function of the standard normal.

Figure 1
Predicted probabilities for the activity of sleeping



Φ=Probability for the activity of sleeping; Hour= time of day.
Source: Own illustration, based on German Time Use Survey 2001/2002.

One way out of this dilemma, however, is to use the above prediction Rule B. Let us start with a person sleeping at 8 o'clock in the morning. We predict that she will sleep during the next time interval with a probability of about 90%. If we continue this process for the next 4 hours, we will obtain a probability of $0.90^{4\times 6}$ = 8% that this person will still be sleeping at noon. This seems a much more realistic result than that yielded with predictions through Rule A.

To summarize: there are not enough observations in the SUF to estimate a complex model of time use behaviour. We can successfully reduce complexity by using Probit instead of Boolean regressions. However, we must then accept that we cannot predict which activity will be conducted, but only the probabilities with which they will be conducted. Hence, with the data and methods on hand, the central object of our analysis must be vectors

(4) $$x^{\langle t\rangle} = \left(x_1^{\langle t\rangle}, ..., x_n^{\langle t\rangle}\right)^T$$

where $x_i^{\langle t\rangle}$ yields the probability that Activity Number i will be performed in time interval Number t. From heuristic investigations based on Probit estimations, the insight was gained that the probabilities $x_i^{\langle t\rangle}$ generally and consistently depend on the following regressors:

a) the activity conducted in the time interval immediately before the current one
b) the time of day
c) some socioeconomic and socio-demographic characteristics.

Thus, together with the insight that only the probabilities $x_i^{\langle t\rangle}$ of the activities being performed can constitute the object of analysis, the following approach is suggested

(5) $$x^{\langle t+1\rangle} = A(t,s)\cdot x^{\langle t\rangle}$$

with a n×n matrix A. The element a_{ij} of the matrix A indicates the probability that the i^{th} activity will be conducted in time interval t+1 given, that the j^{th} activity had been conducted in the time interval t, i.e. in the interval before. These transition probabilities depend on the time of day, and hence finally on t, and possibly on the socioeconomic characteristics described by a vector s. Therefore, in Equation (5), we denote the transition matrix exactly by A(t,s).

Next, it is assumed, for working days, that the matrix A depends on the time of day, but not on the day of the week. Formally, we express this as:

(6) A(t,s) = A(t+144,s)

From Equation (5), we have

(7) $$x^{\langle t+144\rangle} = M(t,s)\cdot x^{\langle t\rangle}$$

with

(8) $$M(t,s) = \prod_{\tau=0}^{143} A(t+\tau,s)\,.$$

From Assumption (6), we know that there are 144 distinct matrices M(t,s) (t=1,…,144). We now assume formally that there were only working days and no interruptions in the form of Saturdays and Sundays. Then, each of these matrices M(t,s) would constitute a Markov-process by

(9) $$x^{\langle t+d\cdot 144\rangle} = M(t,s)^d\cdot x^{\langle t\rangle} \qquad d=1,2,3,\dots\,.$$

We consider a single Markov-process for a given t, characterized by a matrix M with only non-negative elements. M has n eigenvalues λ_i and eigenvectors u_i.

The eigenvectors can be selected as real and for the norms of the eigenvalues, the following holds

$$1=\lambda_1 \geq \|\lambda_2\| \geq \dots \geq \|\lambda_n\| \geq 0\,.$$

If $\|\lambda_2\|<1$, the eigenvector u_1 is the only attractor of Iteration (9). This means it does not matter which distribution of time-use frequencies a person starts with, because it will finally end with the distribution u_1. In other words, the ultimate result will always be the same frequency distribution. The iteration approaches u_1 more quickly, the lower the norm of λ_2. We can therefore interpret the vector u_1 as an indicator of typical time use and the norm of λ_2 as a measure of the stability of time-use behaviour. Given this interpretation, it is of great interest to estimate the values of u_1 and of λ_2, even if, in reality, a sequence of working days is interrupted by weekend. The attractor shows the typical time use which would be achieved if there were no forced or random deviations, and λ_2 shows how fast such "disarrangements" will be smoothed out in the iteration.

To conclude, we try to estimate the matrices M(t,s). We can then evaluate their eigenvalues and eigenvectors. These allow us to learn something about typical time use and its stability.

Finally, we must deal with some details of the estimation of the matrices M(t,s). For a given t, we have to count the absolute frequencies N_{ij}, indicating in how many cases activity j is followed by activity i exactly 24 hours later. From this information, we derive the absolute frequencies $N_{.j} = \sum_{i=1}^{n} N_{ij}$. We can estimate the element m_{ij} of the matrix M(t,s) by

(10) $$\hat{m}_{ij} = \frac{N_{ij}}{N_{.j}}.$$

Through Bernoulli's law, we have

(11) $$\Pr ob\left(\left|\hat{m}_{ij} - m_{ij}\right| \le \varepsilon\right) \ge 1 - \eta \qquad \text{if} \quad N_{.j} \ge \frac{1}{4 \cdot \varepsilon^2 \cdot \eta}.$$

Therefore, even if we request very modest values for ε and η as e.g. ε=0.1 and η=0.1, it should hold that

(12) $N_{.j} > 250$.

Considering Request (12), one might consider it necessary to include as many people as possible in the estimation of the matrices M(t,s). However, these matrices might depend on the vector of characteristics s and therefore, the respondents included should be as homogenous as possible with respect to socioeconomic characteristics. Accordingly, the number of respondents used to estimate the matrices M must be kept fairly small. Nevertheless, it is possible to increase the number of observations. For this purpose, we do not consider all 272 activities given in the Time Budget Survey, but aggregate them into those 18 Activity Groups given in Table 1. Further on, we assume that the matrices M(t,s) are the same, if the time intervals t occur at the same hour of the day h. Thus, the task simplifies to an estimation of 24 18×18-matrices M(h,s), h = 1 … 24. It remains a problem that some activity groups occur rather infrequently. Therefore, for some j and some h and h' (h,h'$\in\{1,\dots 24\}$), further assumptions of the form

(13) $m_{ij}(h,s) = m_{ij}(h',s)$

had to be made. For which activity groups j, and hours h, assumptions of the form (13) were made, is depicted in Table 2. The selection was also made by looking at the kind of activity on hand, as well by securing counts of more than about 400 for estimating the transition probabilities m_{ij}.

Table 2
Numbers of counts per hour and activity*

Activity group No.	Hour of the day																							
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3
1	2488	2241	1611	771	441		442					343							904	1837	2308	2460	2510	2517
2	502				607			621		411		543			386	345	383							
3	433			384	473				558									637						
4	502				660	799	894	907	694	802	874	805	621	418	562			256						
5	397						1029		407		311				425									
6	127				342		959																	
7	357												430											
8	651												591											
9	21				318		716			414			571											
10	489									533					340									310
11	422									478				453		450		342						
12	797																							
13	386											392												
14	456											626												
15	794														635	636								
16	525								576						486				414					
17	311											389			253	624	1062	1050	527	276				
18	390				465		461		390		520		635		441		301							

* Connected cells show for which hours of the day the same transition probability has been assumed. The numbers in the cells show upon how many observations the estimates of the transition probabilities are based.
Source: Own illustration, based on German Time Use Survey 2001/2002.

With respect to the possible dependency of the matrices M(h,s) on the vector s, we first use the sample of 426 single people described in the introduction. This means that we assume initially that the matrices M(h) are identical for all singles belonging to this sample.[7] The number of observations which determines each estimate $\hat{m}_{ij}(h)$ with respect to Equation (11) is also given in Table 2.

Given all these steps, we are able to estimate the matrices M(h), and then evaluate their attractors u_1 and second eigenvalues λ_2. The results are described in the next section.

7 In a further step, we test whether the M(h) assume different values if the sample of 426 single people is split up into sub-samples that are characterised by elements of the vector s, such as age, sex, or income. The results are mentioned at the end of Section 4.

4 Empirical results

Due to space limitations, it is not possible to show all estimated Markov matrices M(h) in Figure 2, but rather their attractors. λ_2=1 does not hold for any of the estimated matrices. Accordingly, the attractors are unique. They give a quite credible and accurate picture of a typical working day. The highest probability is obtained during the late evening and night-time by sleeping. During the morning, travelling time, paid work, and education predominate, whereas in the late afternoon and early evening, many people seem to be watching TV. Figure 3 shows Cramer's V for the cross tables that one needs in order to subsequently derive the Markov matrices according to Equation (10). The measures of contingency have a large magnitude and are different from zero to a significant degree, providing evidence that the estimated matrices involve nontrivial information.

Subsequently, the entropies of the attractors were evaluated.[8] They are shown in Figure 4 together with the norms of the second eigenvalues. The entropy of an attractor provides a measure of the diversity of time use. The higher the entropy, the less monotonic (consistent) the selection of activities. On the other hand, the norm of the second eigenvalue is a measure of the stability of time use. The lower $\|\lambda_2\|$, the faster the vectors $x^{<t>}$ will approach the attractors u_1(h). Therefore, the smaller the norm of the second eigenvalue, the greater degree of stability.

Given these considerations, we can see from Figure 4 that the higher the entropy, the lower the value of $\|\lambda_2\|$. Hence, the more diverse the time use, the greater its stability. This relationship holds with respect to varying the time of day. In Figure 5, we can see that it holds more generally. Figure 5 was generated as follows. For each member of our sample of 426 singles, we can evaluate the entropy i of individual time use during the two observed working days.[9]

We divide our sample into two sub-samples:

ILOW: 217 persons with entropy of individual time use $i<2$.

IHIGH: 209 persons with entropy of individual time use $i\geq 2$.

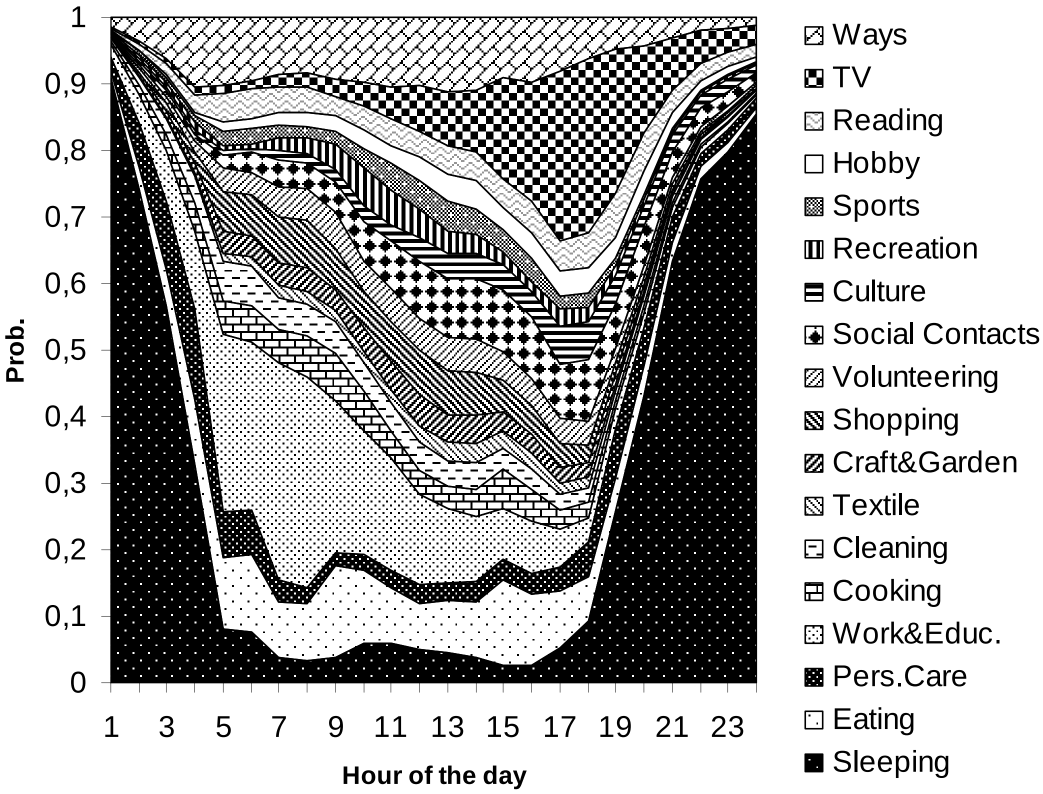
For each sub-sample, Markov matrices were estimated, eigenvalues and eigenvectors and the entropies of the attractors were computed. Our concern is again with respect to the relation-

8 Let $u_1(h) = ({}_1u, \ldots, {}_{18}u)$ be the first eigenvector of the matrix M(h). We then evaluate $i(h) = \sum_{j=1}^{18} - {}_j u \cdot \ln({}_j u)$ and denote it by "entropy of the attractor u_1 (h)".

9 For a given person, the observed relative frequency of Activity Group j during the two observed working days shall be denoted by p_j. We set $i = \sum_{j=1}^{18} - p_j \cdot \ln(p_j)$ and denote i by "entropy of individual time use" of this given person.

ship of the norm of the second eigenvalue and the entropy of the attractor. The result is shown in Figure 5.

Figure 2
Attractors of the Markov matrices M(h), for all singles (n=426)



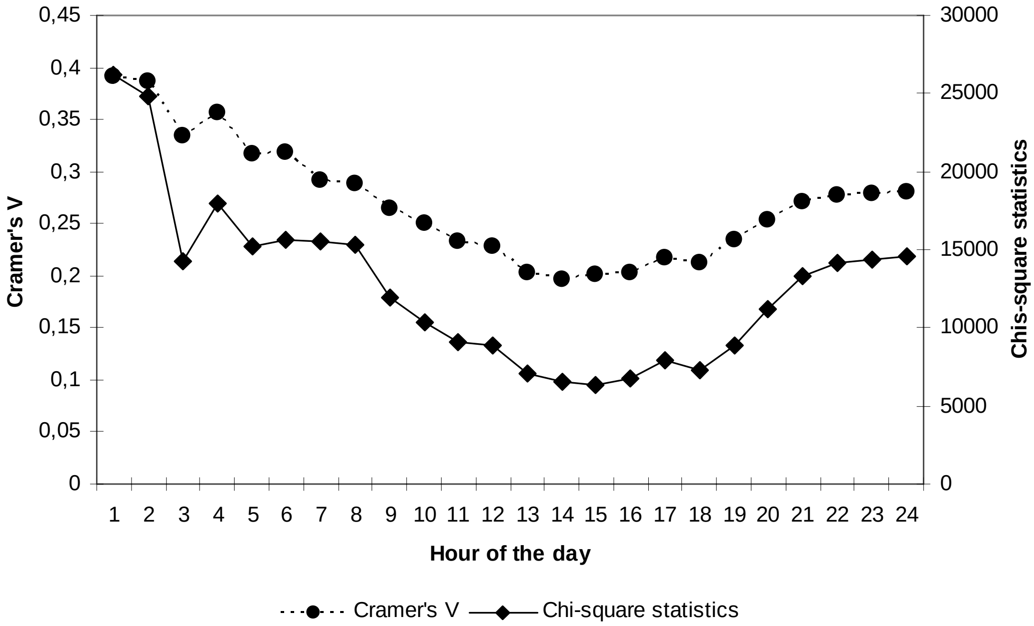
The probability of each activity group is shown as length relative to the ordinate for each hour of the day.
Source: Own illustration, based on German Time Use Survey 2001/2002.

The attractor of the sub-sample with lower *individual* entropy has a lower entropy than the attractor of the sub-sample with higher *individual* entropies.

The norms of the second eigenvalues for the sub-sample with lower individual entropy are greater than the norms of the second eigenvalues for the sub-sample with higher individual entropies. These results are not equally convincing for all hours of the day. Therefore, 90% confidence intervals were computed for $\|\lambda_2\|$.[10] These are shown in Figure 6. At least between 5 o'clock in the morning and 4 o'clock in the afternoon, we can say that $\|\lambda_2\|$ is significantly greater for the sub-sample with low entropy.

[10] The method is described in Oberhofer and Kmenta (1973).

Figure 3
Cramer's V and χ^2-statistics of the Markov matrices by hour of day



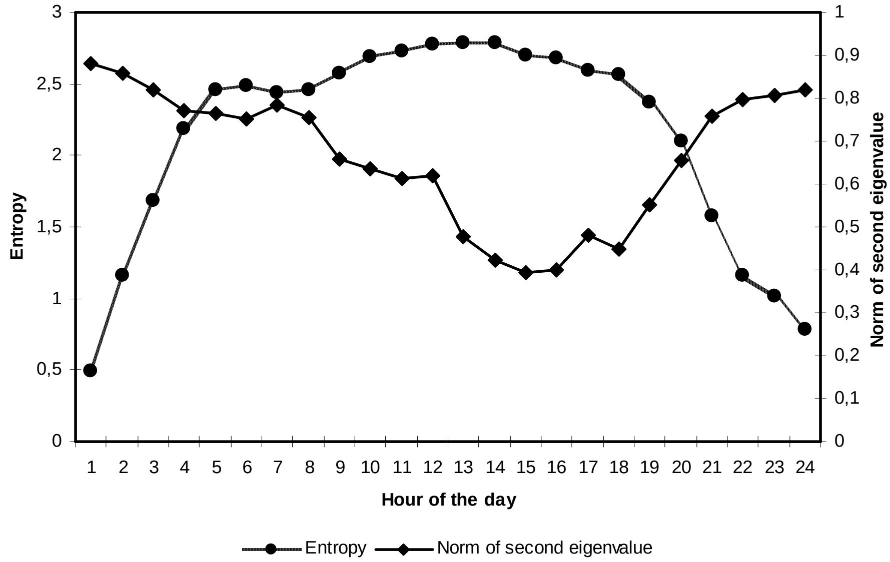
Cramer's V and χ^2 are evaluated for the cross tables, which are the basis for calculating Markov matrices according to Equation (10).
Source: Own illustration, based on German Time Use Survey 2001/2002.

Given these restrictions, one can summarize that the greater the entropy of time use, the greater the degree of stability. This result holds when the time of day is varied and if the sample is divided into two sub-samples, i.e. when the vector of personal characteristics s, is varied with respect to entropy in individual time use.

It remains necessary to report that other variations of s, such as with respect to age, income, or sex, did not produce any significant differences in the stability of the attractors of the subgroups defined in these terms.

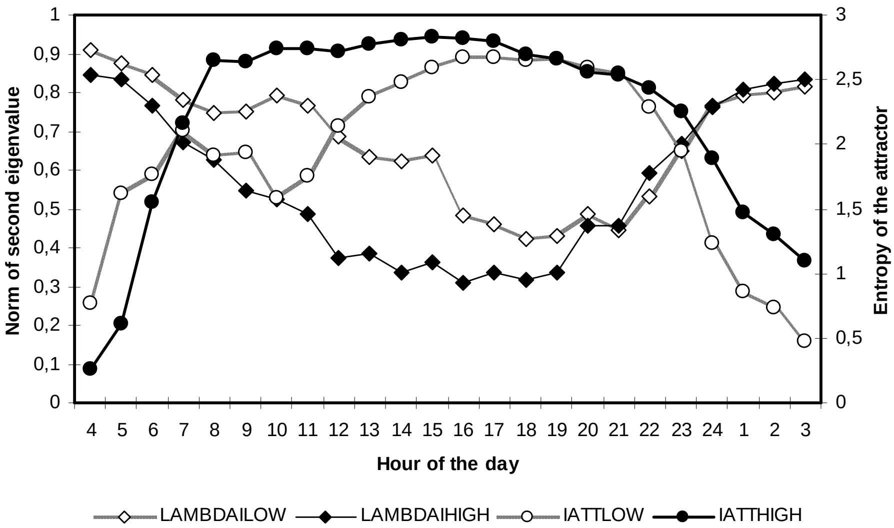
Finally, it is important to point out that our finding that high entropy is related to high stability, is not a priori. Indeed, it is easy to give some counter-examples of matrices that connect an attractor with high entropy with a high norm of the second eigenvalue. Thus, our observation that high entropy is related to high stability, is a "real" empirical finding, which could not have been deduced a priori from the model. In the following section, some possible consequences of the observed regularity, are discussed.

Figure 4
Entropy and stability of the attractors for all singles (n=426)



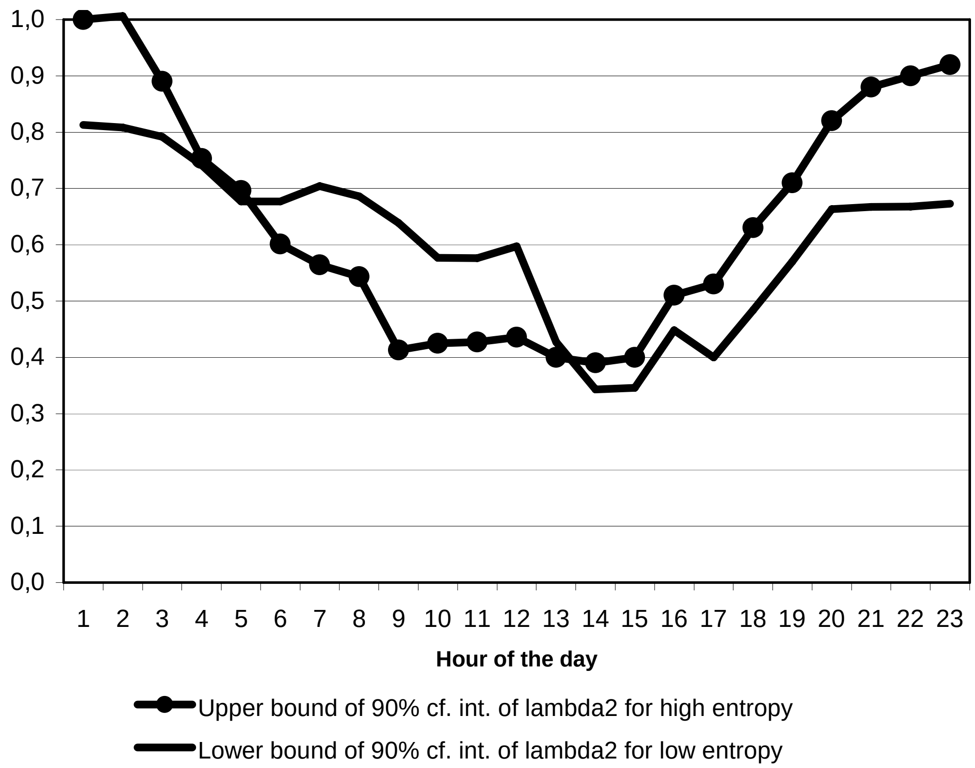
Source: Own illustration, based on German Time Use Survey 2001/2002.

Figure 5
Norm of second eigenvalue and entropy for sub-samples with low and high individual entropy



Source: Own illustration, based on German Time Use Survey 2001/2002.

Figure 6
90% asymmetric confidence intervals for λ_{2high} and λ_{2low}



Source: Own illustration, based on German Time Use Survey 2001/2002.

5 Conclusions

That flexibility ensures stability will not surprise anyone who knows the basics of systems theory. Nevertheless, this investigation provides a specific example of this theorem in the field of household science.

The results seem interesting and useful enough to look for generalizations. Firstly, it is worth investigating whether the observed regularity can also be found in other data sets. Extensions at the theoretical level can then be made. Models for households consisting of several individuals should be formalized and the iteration process include greater time lags and eventually non-linear relationships.

However, this paper certainly provides a useful introduction and starting point for such investigations. The fundamental preliminary insights are:

1. With the present data and methods, the central object of analysis should be vectors depicting probabilities of time use and connected by transition matrices.

2. These objects have further properties, such as entropy, stability and determination.
3. There are meaningful empirical relationships between these properties.
4. These properties are only weakly associated with the usual socio-economic and demographic characteristics. Thus, new dimensions of socio-economic research are appropriate objects of investigation.

These seem to be rather abstract results of basic research. Assuming that further empirical evidence will be obtained to bolster and extend these findings, practical consequences will surely emerge in due course.

We are used to judging our behaviour and the behaviour of others. In the broadest context, drug abuse, addiction, criminal or selfish behaviour, running risks of many kinds should be reduced and pollution avoided. Corpulent people should eat less, anorexic people should eat more, and for both, more exercise and sport is recommended. It is possible to add a long list of merit or demerit goods and activities. (see Musgrave and Musgrave 1984, 78). We will constrain ourselves to activities. The frequency of merit activities ought to be increased and that of demerit ones, decreased. This is the field of didactics, which uses educational advertising, training and other methods for this purpose. The author is well aware that Markov-matrices as presented are a very simple behavioural model, but let us accept them for the moment at least as the starting point for more elaborate ones and think along these lines. Changing behaviour would mean changing the attractor of time use. And this again would mean changing the transmitting matrix M. Whether this is achieved by information, arguments or training may remain open for the present considerations. The mapping from matrices to attractors is not isomorphic, so for a given attractor, there are, in general, many matrices M as inverse images. Among these matrices, one would prefer the more stable ones, if the attractor represents desirable behaviour. It is a result of this paper, however, that empirically stability is associated with higher entropy.

Accordingly, the positive relationship between diversity in time use and its stability could have implications for teaching Home Economics and such related fields as Public Health or Financial Literacy. It might not be sufficient merely to implement behaviour that is generally thought to be adequate and appropriate. In order to stabilize appropriate behaviour, it is necessary to acquire competency in reacting flexibly to disturbances, or, viewed from another perspective, we should tolerate variant behaviour, because it includes the benefit of giving stability to the sequencing of our everyday activities.

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electronic ***International Journal of Time Use Research***
2008, Vol. 5, No. 1, 43-64.

Alone at home

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Abstract

Recently there has been much public discussion about children spending long afternoons alone at home. It has been claimed that spending a lot of time alone makes children vulnerable to many kinds of risk behaviour, such as smoking, use of alcohol and drugs, depression and poor school performance. Concerns have also been voiced about children's unsupervised television watching, playing of computer games and surfing on the Internet. Yet, do we actually know how long the times are that children do spend alone at home and what do they do during that time? The purpose of this paper is to study how much time youngsters in Finland spend alone at home, who are the youngsters who are alone and what do they do when they are alone. The research data are data relating to households from the 1999–2000 Time Use Survey of Statistics Finland. The data cover the shared days of families with children on which all family members aged 10 or over kept a time use diary. The respondents recorded into the diaries at 10-minute accuracy whether they were alone or together with children aged under 10 belonging to the same household, other members of the household, or with other people they knew. Besides the data concerning being alone or together with somebody, the paper also exploits diary information on whether other members of the household were at home at the time in question. The scope of the study is limited to school students aged from 10 to 18. The material contains data on 191 schooldays and 229 days off school.

JEL-Codes: D13, J13

Keywords: Intra-family time use, "with whom" context

A preliminary version of this paper has been published in Finnish in Pääkkönen, H. (ed.) (2005). It was also presented at the 2005 IATUR Conference in Halifax. I would like to thank Pirjo Hyytiäinen for help in creating the data files. I also thank Kari Djerf, Liisa Rantalaiho, Hannele Sauli, Paavo Väisänen, and two anonymous referees for their useful comments.

1 Introduction

Recently there has been much public discussion about children's lonely afternoons at home. It has been said that spending a lot of time alone exposes children and young people to various kinds of risk behaviour, such as smoking, drinking and drug abuse, depression and poor school performance. The risk limit has been found to be daily loneliness of over two hours. There has also been concern about children's unsupervised TV watching, computer game playing and Internet surfing (e.g. Pulkkinen, 2002, 29; Hochschild, 1997, 10–11, 221–229; Suoninen, 2004, 51–53). Is it known, though, how long children actually are at home alone and what do they do during that time?

Children in Finland usually start school at the age of seven. It has been socially acceptable that even the youngest schoolchildren can spend time alone at home after school and there is no legislation preventing this. Children's parents usually go to work. It has been very usual since the 1960s for mothers to go to work. Mothers and fathers in Finland generally work full-time (Hulkko, 2007). Children receive a free, hot meal at school and families' living environments have generally been safe in Finland (e.g. Strandell and Forsberg, 2005; Pulkkinen and Launonen, 2005). Nevertheless, around the mid-1990s, public debate arose in Finland about the lonely afternoons of small schoolchildren. Indeed, in consequence of the debate, legislation entered into force as of the beginning of 2004 giving municipal authorities the possibility to provide state-subsidised morning and afternoon activities for children at the first and second grade of school and obliges municipalities to provide morning and afternoon care for children with special needs at any grade of school (Pulkkinen et al., 2006).

A few studies have been conducted in Finland into how the very smallest schoolchildren spend their afternoons. Spending time alone in the mornings and afternoons without the company of adults was studied in connection with the Integrated School Day trial among children attending school grades one to nine in four localities in different parts of Finland in 2002–2005. The study was funded by the Finnish National Fund for Research and Development (SITRA) and conducted by the University of Jyväskylä. The project was devising a school-centred operating model with a restructured school day inclusive of provision of hobby activities as part of it (Pulkkinen and Launonen, 2005). According to the study results, 42% of schoolchildren attending grades one to nine spent time alone without any adults present during at least one morning and 62% on at least some afternoon during the survey week in 2005. The majority of children did not spend more than one hour alone in mornings. In the afternoons, the length of the time alone did not exceed two hours with most of the children. The proportion of children spending time alone diminished during the Integrated School Day trial (Pulkkinen and Launonen, 2005, 94–101). The study also identified possible risk pupils, who were those spending more than 10 hours per week alone or with friends and with no regular hobbies. In the course of the study from 2003 to 2004, the number of such risk pupils fell from 77 to 23 (Pulkkinen and Launonen, 2005, 111).

A study of the National Research Centre for Welfare and Health, STAKES, examined how children under the age of 10 of employed parents spent their afternoons. According to this study the commonest place where schoolchildren spend their afternoons is their own home. The children of nearly one-half of the respondents had been alone at home after the school day during the past six months either often or always. Only one-fifth of the respondents said that their child had never been alone at home (Lammi-Taskula, 2004, 59–60). The main focus of this study was on parents' experiences relating to organised afternoon activity, not on possible risks experienced by children.

A study funded by the Academy of Finland used qualitative methods to examine descriptions of 8-year-old children of their afternoons in a large Finnish town (N=32). The children spent their afternoons mostly at home, sometimes alone, sometimes with their own parents or with some other adult person. Some spent their afternoons with an older sibling. Very few of the children were completely alone at home for long time periods. The children's descriptions emphasised being alone as more of a positive than a negative experience: spending time alone was not always regarded as nice but was occasionally perceived as necessary and as a desired state (Strandell and Forsberg, 2005; Forsberg and Strandell, 2006).

The Finnish studies referred to above concern only a few localities. Thus far nationally representative studies specifically on the aloneness of schoolchildren have not been done in Finland. The data on aloneness and its duration are based on estimates obtained by interviews in the studies by Pulkkinen and Launonen (2005) as well as Lammi-Taskula (2004). Additionally, the latter study did not ask the schoolchildren themselves about their aloneness, but instead directed the questions at their parents. Strandell and Forsberg (2005) applied in their study not only interviews but also other qualitative research methods, such as diary forms.

The objective of this article is to find out how much time young people spend at home completely alone and what they do when they are alone. Unlike in previous Finnish studies, the data are based on national data. In addition, the data have been recorded by the children themselves in time use diaries. The use of the household data makes it possible to use, for the first time, also the diaries of other members of the family. Previously aloneness among schoolchildren has been studied with the Finnish Time Use Survey without separating being all alone from being alone e.g. in one's own room while other members of the family may be at home, and being alone at home has not been studied separately (Pääkkönen, 2006).

The article first examines how much time children spend at home on the whole and at what time they are at home. Next we will see how much and at what time schoolchildren are at home by themselves or in the company of others. We will then examine what kinds of schoolchildren are alone at home. Finally, the article studies what children do when all alone and how much of their activities they do alone or with others.

2 Data

2.1 Individual and household data

The research data were the individual and household data from the 1999–2000 Time Use Survey of Statistics Finland. The data were collected between 1 March 1999 and 12 March 2000 by household in accordance with the recommendation of Eurostat, the Statistical Office of the European Communities. Finland's previous Time Use Surveys have been conducted on individual samples. All household members aged ten or over were interviewed and diaries were left for them to fill in. Household members kept a diary on two same days drawn by lot in advance, of which one was a weekday and the other a weekend day.

The respondents wrote in the diary in their own words at the accuracy of ten minutes what they did primarily and possibly simultaneously. In addition, the time spent together with family members and other friends was recorded in the diary. The location of activity was determined in connection with coding. Statistical interviewers collected the data. The primary and secondary activities were coded into 185 categories, from which tabulation classifications with different accuracy were formed. The data were coded and stored at Statistics Finland. Appendix contains a diary.

The diary was returned by 56% of the households and 52% of the persons. The response rates were average by European standards, but clearly lower than in Statistics Finland's previous individual-based surveys (for more about household and person non-response, see Väisänen, 2002; 2005).

The individual data for the Time Use Survey include 10,561 survey days. A diary was kept at least on one day by 5,332 persons from 2,623 different households. All accepted days were collected to the individual data, regardless of whether or not all the household members kept a diary on both days. The household data include all those households with at least one common survey day for all members aged 10 or over. The data contain 4,420 household days from 2,240 different households.

In this article, the time spent at home is first examined on the basis of the individual data. In this case only the location data is used from the diaries, in addition to the main activity data. The household data are used later when analysing the aloneness of schoolchildren. Included are the common days of families with children when all the family members aged 10 or over have kept a diary. In this case both the being together ("with whom") data recorded by the respondent and the location data on all members of the household are used.

The respondents recorded in their diaries during waking hours at the accuracy of ten minutes whether they were alone, with children aged under ten belonging to their own household, with other household members (mother, father, siblings aged at least ten), or with friends (see the diary in the Appendix). The "with whom" data are, however, not available for the whole year.

To speed up the coding, the “with whom” data was checked and coded only for seven months from March to July and from November to December 1999.

The lower age limit of the Time Use Survey was 10 years. Hence the subjects examined are limited to schoolchildren aged 10 to 18. The youngest schoolchildren, that is, children aged 7 to 9 are excluded from this examination. Consequently, the schoolchildren in this study are slightly older than those included in earlier Finnish studies (Pulkkinen and Launonen, 2005; Lammi-Taskula, 2004; Strandell and Forsberg, 2005). These data represent the whole country, but do not include the youngest schoolchildren. The students included are students from comprehensive school (aged 10 to 16), upper secondary school and vocational school or college (aged 16 to 18). As time is used differently on schooldays and days off, they are studied separately. Summer holidays are not included in days off. In all, the household data contain information on 191 schooldays and on 229 days off. In the broader individual data the number of schooldays is 514 and that of days off 600.[1]

2.2 Constructing variables for being alone and being together

In this article, being alone at a given point in time is defined by using the data recorded by the respondent him/herself on “with whom” time was spent and in what location. In addition, household data are utilised by using the location data from the diaries of other household members older than 10 years of age to check if they were at home simultaneously with the respondents.

Time spent together (“with whom”) recorded in the time use diaries means not only doing things together, but also being in the company of someone else. Being alone can also refer to retiring to one’s own room, even if there were other persons present at home.

Being alone and being together at home are defined in the article as follows:

1. Being all alone when no other household members are at home,
2. Being alone “on one’s own” when there are only siblings at home,
3. Being together only with friends,
4. Being alone “on one’s own” when the mother or father are also at home,
5. Being together with family members (also with friends in addition to family members).

The connection between aloneness and risk behaviour varies in the categories of being alone thus defined. Spending time completely alone may generate loneliness or boredom if no activity is on offer. Watching X-rated videos, playing violent computer games or surfing on adult Internet pages become possible being alone and without supervision. On the other hand, being

[1] The individual data also contain the months for which information on being together was not coded. By comparing the individual and household data from the same months we can determine the attrition due to missing diaries of some household members and missing “with whom” information in the accepted diaries. 60% (420 days in the household data) of the temporally identically defined (total of 701 days in individual data during the same months) population are included when being together is examined.

alone also gives the possibility for a needed period of rest after the school day. For many, the opportunity to spend time alone keeping oneself to oneself is only possible in the afternoons (Strandell and Forsberg, 2005). Just being with siblings or friends has its own risks, such as increased risk of smoking or drug abuse. On the other hand, spending time with friends without the supervision of parents is a normal part of young people's development from childhood to adulthood. The chance of risks is the lowest when the parents are at home (cf. Osgood et al., 2005).

3 Time spent at home

First we look at how much time children spend at home in general and what they do during that time. The examination is done on the basis of individual data concerning the school year. In all, schoolchildren are at home 14 to 15 hours on schooldays and around 17 hours on days off (Table 1).

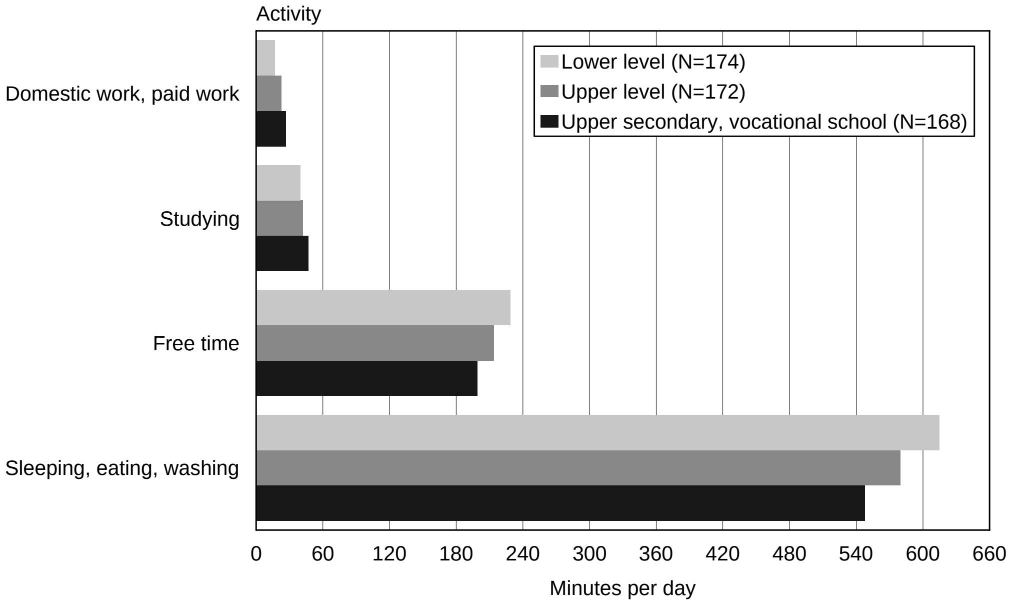
Table 1
Time spent by schoolchildren at home by school level and gender on schooldays and days off, minutes per day (standard errors in parenthesis)[2]

	Minutes per day											
	Schooldays						Days off					
	All		Boys		Girls		All		Boys		Girls	
	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)
All	869.9	(10.1)	879.3	(14.5)	860.9	(13.2)	1016.8	(22.8)	1023.6	(30.0)	1010.9	(33.7)
Lower level of comprehensive school (aged 10 to 13)	906.9	(17.7)	932.9	(21.9)	879.3	(27.6)	985.6	(38.1)	991.5	(49.8)	980.4	(56.6)
Upper level of comprehensive school (aged 14 to 16)	863.8	(13.5)	876.6	(20.2)	854.0	(18.1)	1029.8	(36.6)	1029.1	(42.0)	1030.3	(55.6)
Upper secondary school, vocational school (aged 16 to 18)	826.6	(18.4)	808.7	(30.0)	845.8	(19.3)	1051.3	(29.4)	1064.9	(41.2)	1037.1	(42.1)
Diary days (whole school year)	514		250		264		600		283		317	

Source: Time Use Survey, Statistics Finland, 1999–2000.

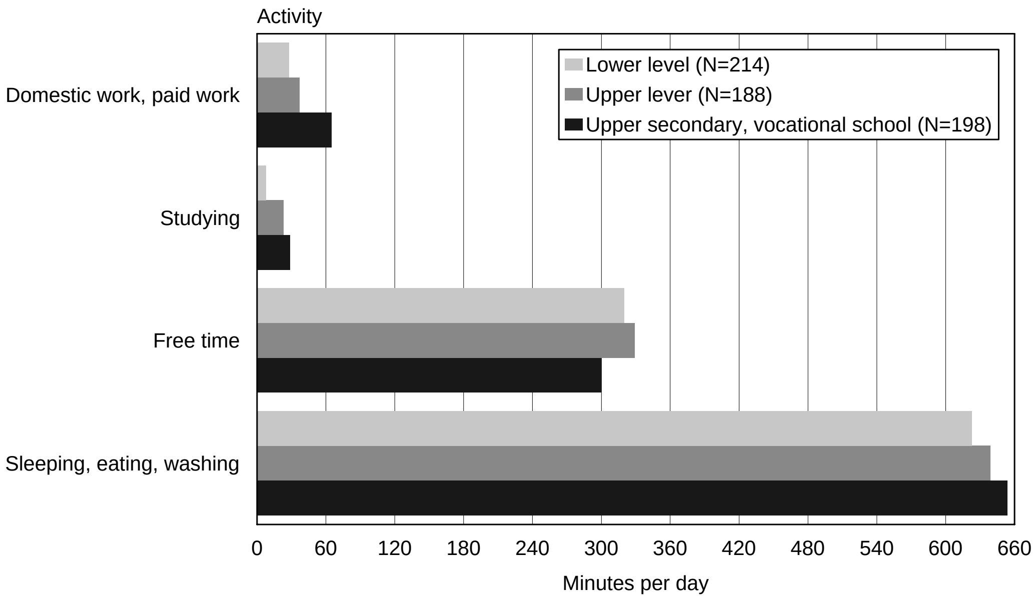
2 In this article, the standard errors of the means have been calculated with the SURVEYMEANS procedure of SAS 9 software while taking the sampling design into consideration. There are two types of intra-class correlation of the diaries: between the household members and between each individual's two diaries. The statistical tests of this article are adjusted for those design complexities. Due to the small volume of data, original strata could not be utilised. Thus the tests were slightly conservative. For the same reason we also used a 10% significance level (on the sampling design of the survey see Väisänen, 2002; 2005).

Figure 1
Time use of schoolchildren at home on schooldays, minutes per day



Source: Time Use Survey, Statistics Finland, 1999–2000.

Figure 2
Time use of schoolchildren at home on days off, minutes per day



Source: Time Use Survey, Statistics Finland, 1999–2000.

Comprehensive school students aged 10 to 13 are more at home on schooldays than older students. On days off, the differences between students of different ages in the lengths of time they are at home are not statistically significant.

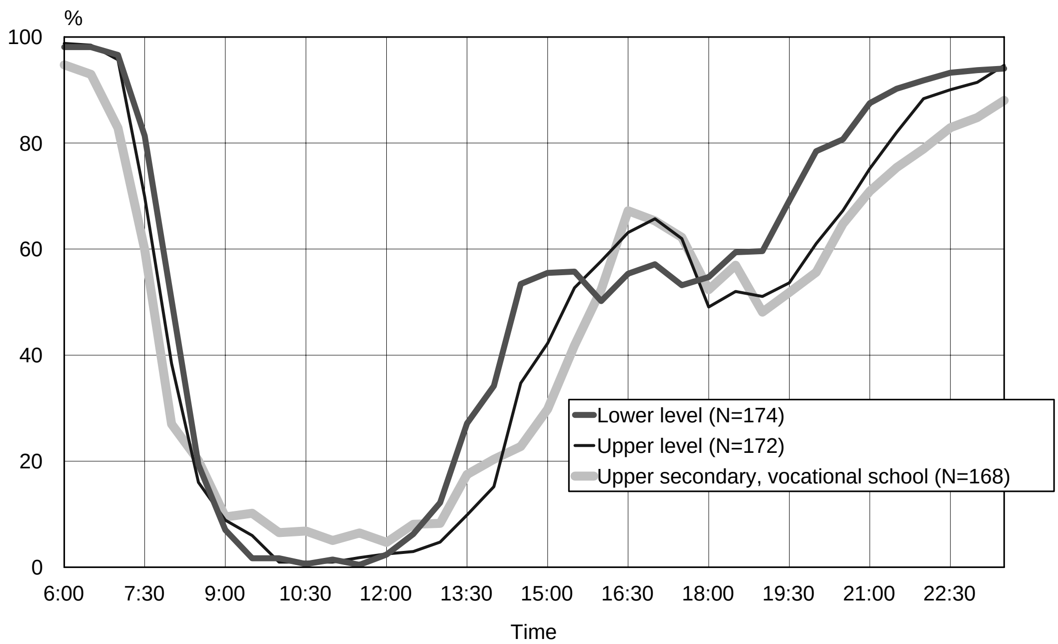
Two-thirds of the time spent at home is used for sleeping and other personal needs. There is a large difference between schooldays and days off school in the duration of sleep. Sleep is “caught up” on days off school. At the lower level of comprehensive school, the difference in the time used for sleeping on schooldays and days off is around one hour. At the upper secondary level it has already grown to two hours (see Pääkkönen (2006, p. 431)).

On schooldays around 40 minutes are spent on homework. On days off studying takes up over 20 minutes per day at the upper level of comprehensive school, upper secondary school and vocational school. Those at the lower level of comprehensive school (aged 10 to 13) can spend their weekends mostly free from homework. On schooldays one-quarter of the time at home is free time and on days off nearly one-third (Figures 1 and 2).

4 At what time at home?

At what time are children at home? On schooldays the timetables of schools determine when children are at home. Schooldays begin early in Finland. Figure 3 shows that the time of going to school in the morning is almost the same, but it follows the inverse order of age so that upper secondary school and vocational school students leave for school first and those at the lower level of comprehensive school are the last to go. By 8 am over one-half of schoolchildren have left home (see also Pääkkönen and Niemi, 2002, 19–21).

Figure 3
Proportions of schoolchildren at home by time on schooldays, per cent



Source: Time Use Survey, Statistics Finland, 1999–2000.

In the afternoon, the youngest schoolchildren come home first. Among comprehensive school students aged 10 to 13, one-half have returned home by 2.30 pm. Those studying at the upper level of comprehensive school (aged 14 to 16) come home one hour later. Upper secondary school and vocational school students aged 16 to 18 arrive at home last, one-half of them being at home by 4 pm.

The proportion of those away from home on schooldays grows again, except for the youngest schoolchildren, between 5 and 8 pm, when they do sports and meet friends. Comprehensive school students watch the most TV at around 8 pm, whereas older schoolchildren do so a few hours later (Pääkkönen and Niemi, 2002, 21).

Upper secondary school and vocational school students are absent from home later in the evening than younger schoolchildren. However, on schooldays around 90% of comprehensive school students and nearly 80% of those in upper secondary school are at home by 10 pm.

5 Being alone at home on schooldays and days off

5.1 Timing of being alone

Schoolchildren spend more than one-half of the day at home. How much of this time are they all alone? Next we will first examine the timing of being alone on schooldays and days off (Figures 4 and 5). The examination is restricted to afternoons and evenings. Being alone is studied separately at given points in time during the afternoon and evening. The figures only reveal the proportions of those being alone at each specific point in time. The same schoolchildren are not alone for the whole evening.

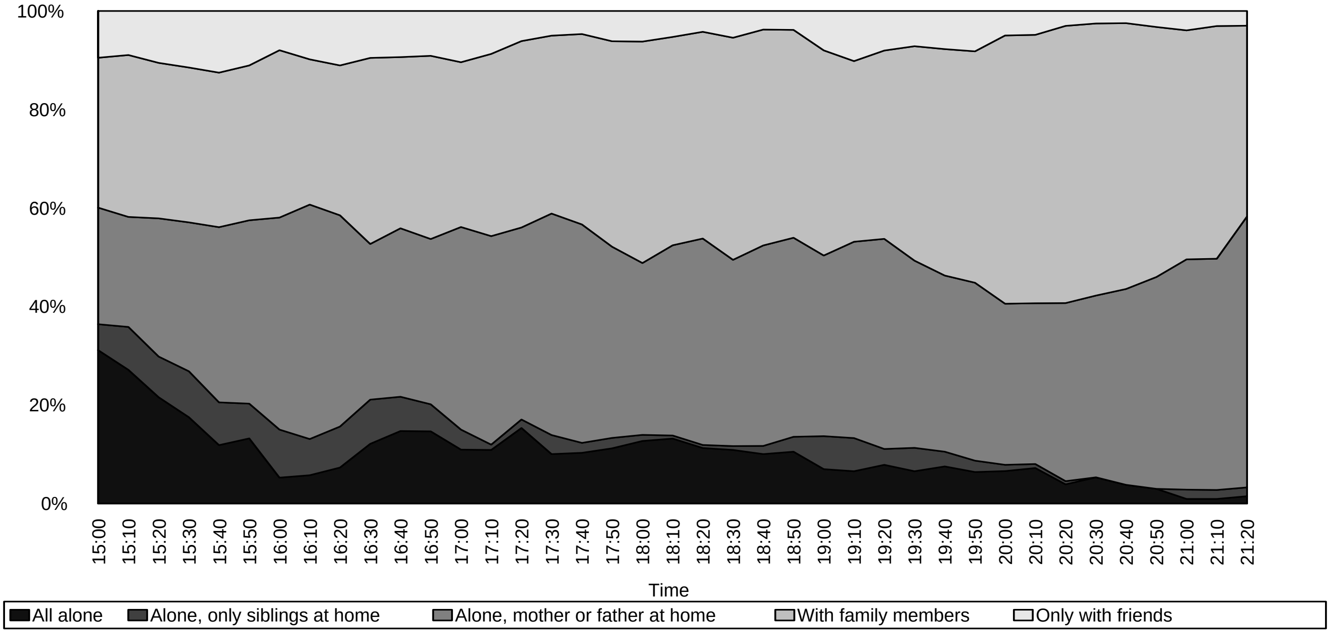
The proportion of schoolchildren alone at home is at its highest in the afternoon right after they come back from school. At 3 pm nearly one-third of schoolchildren are at home on their own. After that parents start to come home and the proportion of those all alone decreases. After 4.30 pm a good one-tenth of schoolchildren are at home alone at each studied moment until 7 pm, after which the proportion falls evenly.

Until around 5 pm one-tenth of schoolchildren are at home on their own, e.g. in their own rooms so that only other siblings are at home. Later during the evening at each studied moment, nearly one-half of schoolchildren spend time at home on their own so that their mother or father is at home.

At least one-third of schoolchildren are in the company of their family members at each point in time between the afternoon and evening. Most time is spent with family members between 8 and 9 pm.

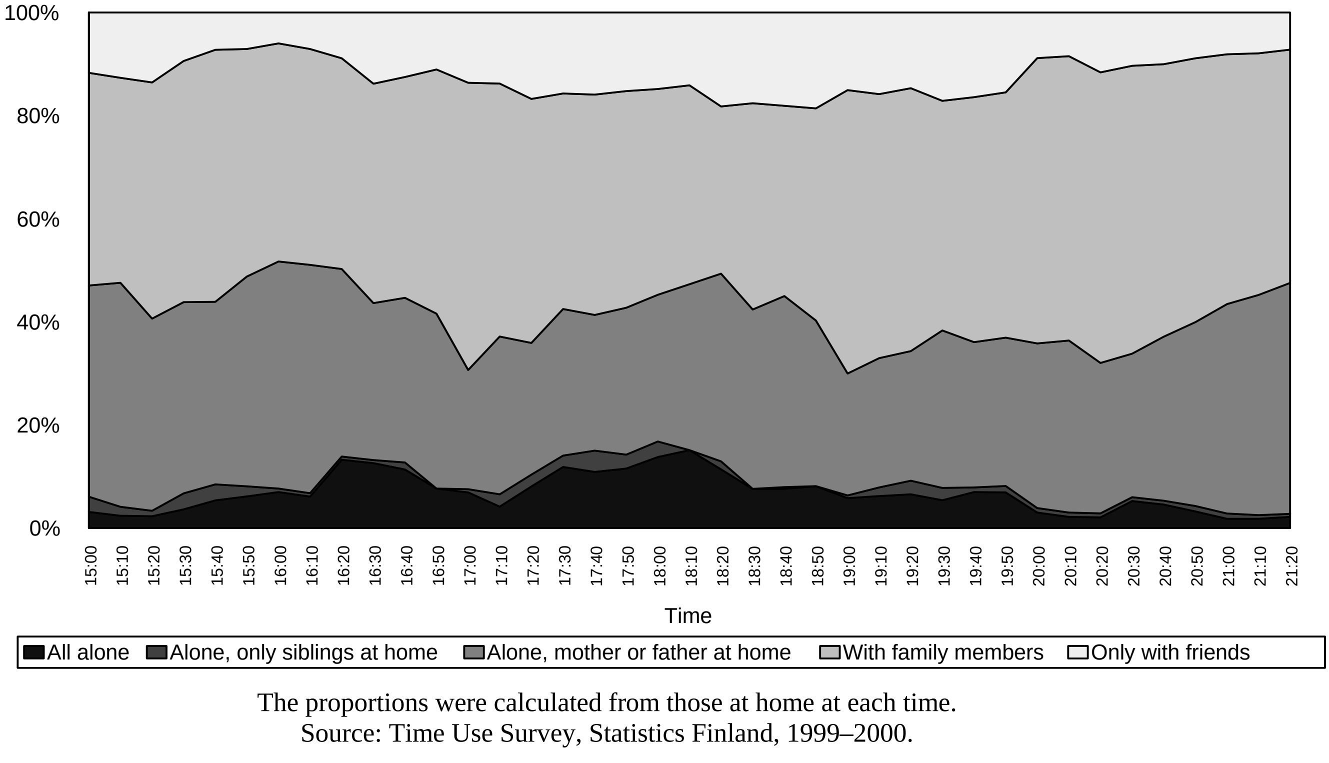
Time use at home is more sociable on days off than on schooldays. On days off being alone is most common in early evening at around 6 pm, when 15% of schoolchildren are on their own. Around one-half of them spend time with other family members at each examined moment during the afternoon and evening. On days off more time is spent at home with friends than on schooldays. During the early evening, hours about 15% have a friend visiting them.

Figure 4
Time spent alone and together at home by schoolchildren on schooldays by time between 3 and 9.30 pm



The proportions were calculated from those at home at each time.
Source: Time Use Survey, Statistics Finland, 1999–2000.

Figure 5
Time spent alone and together at home by schoolchildren on days off by time between 3 and 9.30 pm



The proportions were calculated from those at home at each time.
Source: Time Use Survey, Statistics Finland, 1999–2000.

5.2 Length of time alone

How long are they at home all alone without anyone else present? On an average schoolday around one-half of schoolchildren were not at all alone at home, one-fifth were alone for under one hour and one-sixth from one to two hours. Every tenth had been alone for at least two hours. Daily aloneness of over two hours has been found to be the limit which, if exceeded, raises the risk of problem behaviour (Pulkkinen, 2002, 29, 150).

On an average day off, over two-thirds were not alone at home at all. Similarly to schooldays, a good one-tenth had then been alone for at least two hours, too.

Schoolchildren spent an average of 38 minutes alone at home on schooldays, which represents 4% of the total time spent at home (Tables 2 and 3). This average includes all schoolchildren. However, those who were at home alone, spent nearly one-and-a-half hours alone (1 hour and 20 minutes). On days off the corresponding figures were 46 minutes and 2.5 hours. Fewer children were alone at home on days off than on schooldays (31% vs. 48%), but their aloneness lasted longer on days off than on schooldays (the significance of the difference is $p<0.05$).[3]

In addition to being alone, schoolchildren spent unsupervised time with siblings and friends. The lengths of time spent at home with siblings but without parents were 17 minutes on schooldays and 16 minutes on days off. Around 20 minutes was spent at home with friends on schooldays. On weekends the time spent with friends doubled. All in all, schoolchildren spent around one-tenth of the time they were at home without the company of their parents (Table 3).

Schoolchildren spent around 2.5 hours of their time at home with family members on schooldays and about three hours on days off. Tables 2 and 3 show that the vast majority of time at home is spent alone so that at least one parent is at home. This also includes time used for sleeping. The rest of the time is time spent alone in ones' own room, for example.

5.3 What kinds of schoolchildren are alone at home?

According to the averages in Table 2, boys were at home on their own on schooldays more than girls were. Boys spent double the time alone compared to girls. On days off there was no statistically significant difference in the aloneness of girls and boys. Because of the limited data, no statistically significant difference between boys and girls was found in the proportions of those exceeding the two-hour risk limit.

In addition to the above descriptive analysis, being alone at home was modelled with logit models by using gender, as well as age, existence of siblings[4] (yes/no), number of parents,

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[3] These averages underestimate somewhat the time spent alone, because around ten minutes of the time spent at home was not specified due to insufficient information on time spent together. It is probable that some of this time was spent all alone.

[4] The regressor has been constructed with the help of data on the size of the household and number of parents. In addition to siblings, the "yes" class may include also other members of the household.

mother's and father's employment, type of area (urban/scattered settlement area) and household income (quintiles 1–3/4–5) as the regressors.

Table 2
Time spent by schoolchildren at home according to being together and gender on schooldays and days off, minutes per day (standard errors in parenthesis)

	Minutes per day											
	Schooldays						Days off					
	All		Boys		Girls		All		Boys		Girls	
	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)
All alone, nobody else at home	38.2	(5.3)	49.5	(9.0)	24.9	(5.1)	46.3	(11.3)	58.3	(17.6)	32.0	(12.9)
Alone, only siblings at home	17.3	(3.1)	21.0	(4.3)	12.8	(3.2)	15.9	(3.8)	16.5	(5.1)	15.2	(5.3)
Only with friends	22.8	(4.1)	21.3	(6.1)	24.7	(5.8)	50.1	(11.2)	42.7	(11.5)	58.9	(20.1)
Alone, mother or father at home	639.9	(16.7)	639.0	(23.4)	640.9	(22.5)	633.2	(29.4)	629.0	(38.2)	638.4	(43.5)
With family members	147.0	(11.9)	158.1	(16.2)	133.9	(15.3)	178.2	(13.4)	186.4	(19.9)	168.3	(17.0)
Diary days	191		102		89		229		120		109	

Source: Time Use Survey, Statistics Finland, 1999–2000.

Table 3
Percentage distribution of time spent by schoolchildren at home according to being together and gender on schooldays and days off, per cent

	Schooldays			Days off		
	All	Boys	Girls	All	Boys	Girls
All alone, nobody else at home	4	6	3	5	6	4
Alone, only siblings at home	2	2	2	2	2	2
Only with friends	3	2	3	5	5	6
Alone, mother or father at home	74	71	76	69	67	70
With family members	17	18	16	19	20	18
Total (%)	100	99	100	100	100	100
Diary days	191	102	89	229	120	109

Source: Times Use Survey, Statistics Finland, 1999–2000.

The dependent variables were (1) aloneness in general (0= not alone, 1= all alone at least 10 minutes) as well as (2) being alone for at least 60 minutes (0= not alone, 1= all alone at least 60 minutes). The models were estimated separately for schooldays and days off[5]. It would have been interesting to model also the factors influencing being alone for at least 120 min-

5 The estimation was produced using the SURVEYLOGISTIC procedure of SAS 9 software, which takes the survey sampling design into consideration, see footnote 2.

utes. The number of such cases in the data was, however, so small (19 schooldays and 19 days off) that this variable could not be used in modelling.

The parameter estimates of the models and their standard errors are presented in Tables 4 and 5. The odds ratio estimates and the corresponding 90% Wald confidence intervals are presented in Tables 6 and 7. The confidence interval expresses the range of the odds ratio among the population. Due to the small volume of data, a 10% significance level was chosen (see footnote 2). The odds ratio is obtained by exponentianing the value of the parameter estimate associated with the factor. For each regressor the value of the parameter estimate of the category (last category of the variable) selected as the reference category is 0, and the value of the corresponding odds ratio estimate is 1. If the odds ratio estimate of the variable's category is greater than 1, the category's odds of being alone at home are greater than that of the reference category, when other regressors are kept constant. Correspondingly, if the odds ratio estimate of the category is smaller than 1, the category's odds of being alone at home are smaller than those of the reference category. However, if the 90% confidence limits contain the value 1, no conclusion can be made about being alone based on these data (Liao, 1994; SAS Institute Inc. 2004).

When the dependent variable was being alone for at least 10 minutes, the only statistically significant regressors on schooldays were gender, age, siblings and number of parents (Table 4). On days off the significant regressors were age, siblings and mother's employment. When explaining being alone for at least 60 minutes on schooldays, gender, siblings and number of parents were significant regressors (Table 5). On days off, only age and siblings were significant regressors. In the broad model, which included all regressors, also gender was significant (Model 2 in Table 5).

According to the results, on schooldays the odds for boys to be alone at home were more than twice as high as for girls, given age, siblings, family type and mother's employment status. On days off the estimated difference between boys and girls was not statistically significant at the 0.10 level. Young schoolchildren (aged 10 to 14) were less likely to be alone than their seniors (aged 15 to 18) on both schooldays and days off. As could be expected, the existence of siblings significantly lowered the odds of being alone both on schooldays and days off. On schooldays children of one-parent families were alone more often than children of two-parent families, whereas on days off the difference was no longer statistically significant. Mother's employment has a significant impact on being alone only on days off. Even though Table 6 seems to indicate that a child of an employed mother has higher odds of being alone on schooldays than a child of a non-employed mother, the result is not statistically significant ($p=0.13$). On days off a child of an employed mother had lower odds of being alone than a child of a non-employed mother. It is, however, difficult to interpret the impact. Schoolchildren's days off include also weekends. As the mother will, in general, have a day off then as well, the variable shows the impact of also other factors than employment.

Table 4
Logit models of being all alone (at least 10 minutes) at home on schooldays and days off, parameter estimates

	Model 1				Model 2			
	Schooldays		**Days off**		**Schooldays**		**Days off**	
	Est.	Std. Err.	Est.	Std. Err.	Est.	Std. Err.	Est.	Std. Err.
Intercept	-0.04	0.65	1.10 *	0.62	0.49	0.87	0.71	0.83
Sex (Boy=1)	0.79 **	0.38	0.30	0.36	0.81 **	0.40	0.32	0.36
10 to 14 years (Reference: 15 to 18 years)	-0.60 *	0.35	-1.10 ***	0.35	-0.61 *	0.37	-1.11 ***	0.35
Siblings (Yes=1)	-1.23 ***	0.44	-0.91 **	0.39	-1.21 ***	0.44	-0.91 **	0.39
One-parent family	0.83 *	0.49	-0.12	0.49	0.43	0.61	-0.08	0.66
Mother employed	0.79	0.52	-1.03 **	0.47	0.73	0.54	-0.96 *	0.50
Father employed[1]					-0.53	0.49	0.45	0.56
Rural (Reference: Urban)					-0.24	0.53	-0.88 *	0.52
Household income: Quintiles 1–3 (Reference: Quintiles 4–5)					-0.11	0.50	0.62	0.50
Likelihood Ratio:								
Chi-Square	12707.47		6658.37		13456.04		7930.88	
DF	5		5		8		8	
N	191		229		191		229	

[1] The reference (father employed = 0) includes those without a father in the family.
Note: *** Statistically significant at the 0.01 level, ** at the 0.05 level, and * at the 0.10 level.
Source: Time Use Survey, Statistics Finland, 1999-2000.

When modelling, the impact of variables explaining being alone for at least 60 minutes were broadly similar than those presented above. The effect of age was, however, no longer significant on schooldays. Mother’s employment did not have a significant impact to being alone for at least 60 minutes on schooldays or days off. Age and mother’s employment did, however, interact so that on days off only the 15 to 18-year-old children of employed mothers were more likely to be alone for at least 60 minutes than the children of non-employed mothers. By contrast, the 10 to 14-year-old children of non-employed mothers were more likely to be alone than those of employed mothers.[6]

Father’s employment did not have a significant impact on aloneness after controlling for number of parents and mother’s employment. The variable category "Father non-employed" also contained the children without a father in the family.

[6] The model (not shown) included as regressors gender, siblings, number of parents and the interaction of age and mother’s employment.

Table 5
Logit models of being all alone at least one hour at home on schooldays and days off, parameter estimates

	Model 1								Model 2							
	Schooldays				Days off				Schooldays				Days off			
	Est.		Std. Err.		Est.		Std. Err.		Est.		Std. Err.		Est.		Std. Err.	
Intercept	-1.67	**	0.71		-0.38		0.74		-1.79	*	1.05		-0.17		0.86	
Sex (Boy=1)	0.98	**	0.48		0.76		0.50		0.91	*	0.49		0.97	**	0.04	
10 to 14 years (Reference: 15 to 18 years)	-0.52		0.41		-0.99	**	0.44		-0.52		0.44		-0.94	**	0.04	
Siblings (Yes=1)	-0.95	**	0.47		-1.06	**	0.43		-0.99	**	0.48		-1.03	**	0.02	
One-parent family	1.23	**	0.51		0.16		0.58		1.45	*	0.85		-0.64		0.43	
Mother employed	0.87		0.66		-0.58		0.60		0.81		0.71		-0.38		0.57	
Father employed[1]									0.47		0.70		-0.58		0.38	
Rural (Reference: Urban)									-0.91		0.72		-1.49	*	0.07	
Household income: Quintiles 1–3 (Reference: Quintiles 4–5)									0.02		0.69		0.70		0.26	
Likelihood Ratio:																
Chi-Square	10988.92				5414.57				12355.37				7542.93			
DF	5				5				8				8			
N	191				229				191				229			

[1] The reference (father employed = 0) includes those without a father in the family.
Note: *** Statistically significant at the 0.01 level, ** at the 0.05 level, and * at the 0.10 level.
Source: Time Use Survey, Statistics Finland, 1999-2000.

Table 6
Being all alone at home on schooldays and days off, odds ratio estimates

	Schooldays			Days off		
	Odds Ratio	Lower 90 % Limit	Upper 90 % Limit	Odds Ratio	Lower 90 % Limit	Upper 90 % Limit
Boys vs Girls	2.21	1.18	4.11	1.35	0.75	2.42
Aged 10 to 14 vs Aged 15 to 18	0.55	0.31	0.97	0.33	0.19	0.59
Siblings vs No siblings	0.29	0.14	0.60	0.40	0.21	0.76
One-parent family vs Two-parent family	2.29	1.03	5.08	0.89	0.40	1.98
Mother employed vs Mother not employed	2.21	0.94	5.17	0.36	0.17	0.77

Source: Times Use Survey, Statistics Finland, 1999–2000.

Table 7
Being all alone at least one hour at home on schooldays and days off, odds ratio estimates

	Schooldays			Days off		
	Odds Ratio	Lower 90 % Limit	Upper 90 % Limit	Odds Ratio	Lower 90 % Limit	Upper 90 % Limit
Boys vs Girls	2.66	1.21	5.86	2.15	0.94	4.90
Aged 10 to 14 vs Aged 15 to 18	0.59	0.30	1.16	0.37	0.18	0.76
Siblings vs No siblings	0.39	0.18	0.83	0.35	0.17	0.70
One-parent family vs Two-parent family	3.42	1.48	7.92	1.17	0.45	3.04
Mother employed vs Mother not employed	2.39	0.81	7.03	0.56	0.21	1.52

Source: Times Use Survey, Statistics Finland, 1999–2000.

Likewise, type of area and household income had no significance on aloneness on schooldays. These variables have been excluded from the final models (Model 1 in Tables 4 and 5). The type of area variable was, however, significant in the broad model concerning days off, which included all regressors. It indicated that schoolchildren living in urban areas were more likely to be alone at home on days off than those living in rural areas (Model 2 in Tables 4 and 5).

6 What is done when alone?

Next we will examine what schoolchildren do when there is nobody else at home. The examination includes only those who were alone at home during schooldays and days off. The data are thus based on quite a small number of respondents (diary days 154). The results are only indicative and the examination is limited to waking hours.

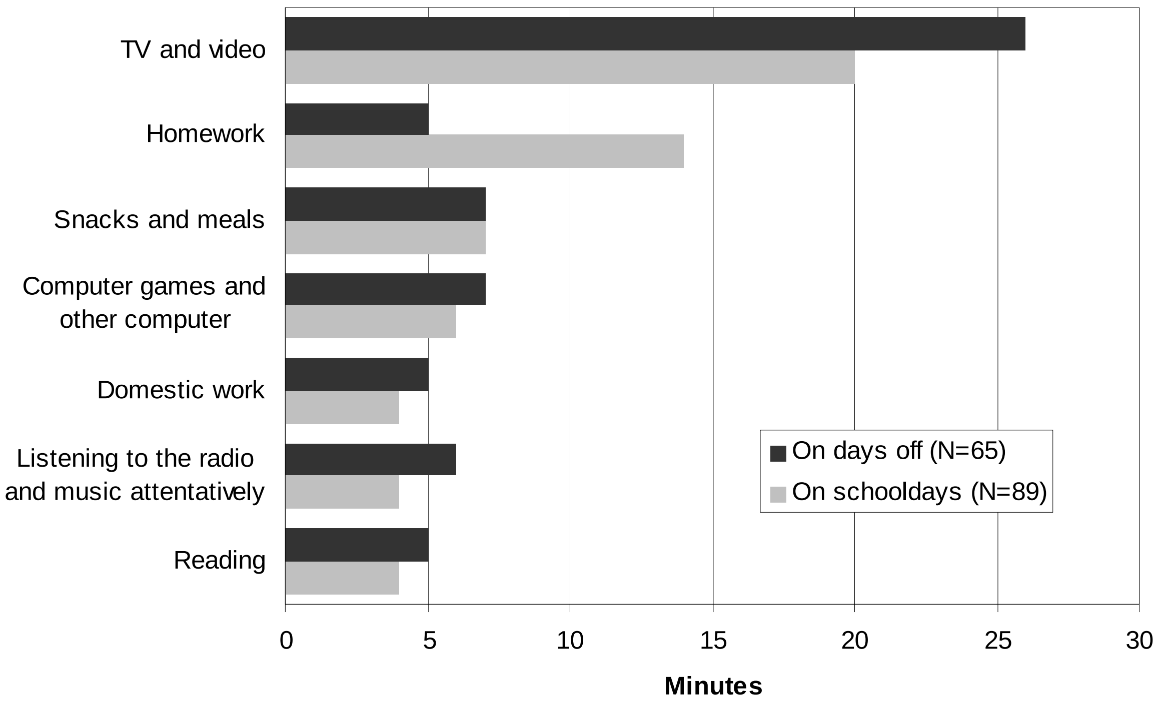
Clearly the most common activity when alone was watching TV (Figure 6). On schooldays 20 minutes (a good one-quarter) and on days off 26 minutes (over one-third) of all time spent at home alone was made up of TV watching. Watching TV is in general the most common leisure activity among schoolchildren in Finland (Pääkkönen and Niemi, 2002, 25). When tired after a schoolday, it is easy to switch on the TV. According to a survey on young people from Central Finland, young people regarded television and video as the most important ways of filling empty moments (Luukka et al., 2001, 41; Suoninen, 2004, 81–82).

Still, only a good one-third of all children who were alone had watched TV, and only a few (5%) spent the entire time alone by watching TV. Watching TV took up a higher proportion of the time spent alone from those who spent more than 60 minutes alone (32%) than from those who spent less time alone (17%). No difference was found to exist between boys and girls and schoolchildren of different ages in how much time was dedicated to watching TV.[7]

Children also did homework, especially on schooldays. Homework took nearly 15 minutes (one-fifth) of all time spent alone. By comparison, only one-tenth of the time alone was spent at the computer. This includes playing with video game consoles as well. Other clearly minor activities were domestic work, listening to the radio and music, reading and washing oneself and getting dressed. These activities are largely the same that emerged in the study of Pulkkinen and Launonen (2005, 101).

Of the different kinds of risk behaviour, the data examined here included information only on the use of alcohol. Alcohol use was not mentioned in a single diary, although according to the interview data of the Time Use Survey, 50% of boys between the ages of 15 and 18 reported that they drink alcohol at least once a month. The corresponding proportion among girls of the same age was 29%. It is fair to assume that alcohol drinking takes place mainly outside the home in the company of friends.

Figure 6
Schoolchildren's most common activities alone at home during waking hours on schooldays and days off, minutes



Source: Time Use Survey, Statistics Finland, 1999–2000.

7 Due to the limited data, these figures include both schooldays and days off. The figures refer to the waking hours.

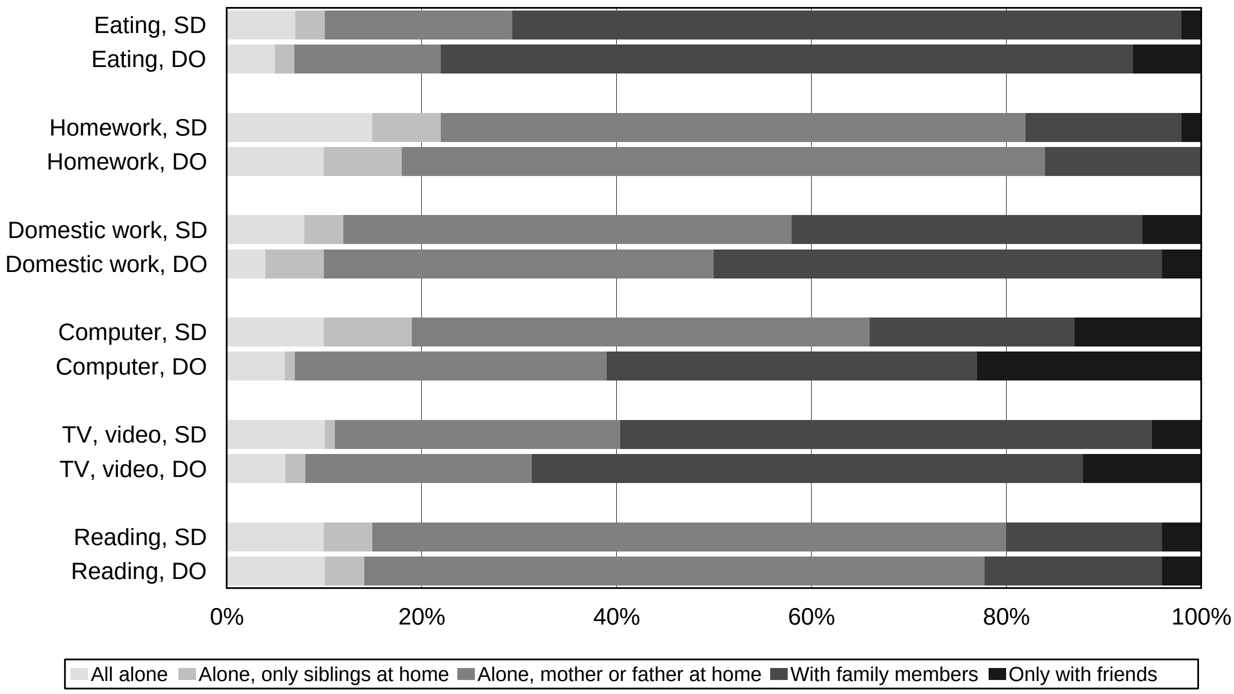
7 Alone or together?

Above we examined what is done when at home alone. Next we will see how much of their different activities schoolchildren did at home alone and how much together with others. Figure 7 presents a distribution of the time used for each activity by category of aloneness. The examination is limited to primary activities. Possible simultaneous activities were disregarded.

Taking meals and watching the TV were the most family-centred activities among schoolchildren (cf. Livingstone and Bovill, 1999, Ch.10, 3). Having meals at home mainly takes place together with family members, which means around 70 % of all eating time. Even when eating alone, there are usually other family members at home. Thus, schoolchildren's eating has not as yet become individualised.

The TV is also watched mostly with other family members. Although TV watching dominates the time spent alone at home, only very little of all TV watching is done completely alone. TV is watched together with friends especially at weekends.

Figure 7
Schoolchildren's time use at home according to time spent together on schooldays (SD) and days off (DO), per cent



N=420: schooldays=191; days off=229.
Source: Time Use Survey, Statistics Finland, 1999–2000.

One-quarter of TV watching takes place alone when other family members are at home. Many schoolchildren also have the possibility to watch the TV in their own room. The Time Use Survey did not ask about the location of the TV set(s) in the home. According to the TV

Household Survey, we do, however, know that during the survey period 1999–2000 around every tenth household had a TV set in the children's bedroom as well (Mass Media, 2002, 148). More than half of the young people, 62% of boys and 57% of girls, aged 13 to 19 in Central Finland had a TV in their own room in 1999 (Luukka et al., 2001, 48).

Over one-half of the total time is spent at the computer with family members or friends on days off, one-third on schooldays. Of all leisure use of the home computer, only under one-tenth takes place all alone. The results thus support the view that the use of the media is socialising rather than isolating from other people (see also Livingstone and Bovill, 1999, Ch.4, 7; Suoninen, 2004, 89–93).

In families, in addition to the TV, also the computer is often placed in children's room. Nearly one-half of the boys and one-fourth of the girls aged 13 to 19 in Central Finland had a computer in their own room in 1999 (Luukka et al., 2001, 80). According to a British survey, children with a TV or computer in their own room also use them more than others do (Livingstone and Bovill, 1999, Ch.4, 20–21).

Homework is done mainly alone, but mostly when either of the parents is at home. One-sixth of the time spent on homework was reported to happen with family members. Although homework was not done together all the time, advice could be asked from family members when needed.

Music and the radio are also mainly listened to alone. Reading is mostly done alone in peace and quiet. Washing oneself and getting dressed are naturally private activities. Schoolchildren go to the sauna mainly with their family members; two-thirds of the sauna time at weekends is spent together with family members.

Domestic work is done quite often with family members, a good one-third on schooldays and nearly one-half at weekends. Cleaning and arranging are household chores most often done by schoolchildren at home.

8 Conclusions

On the basis of the Time Use Survey it appears that despite all fears, schoolchildren's aloneness is not that widespread. Schoolchildren spend a relatively small portion of their day alone at home. Most of the schoolchildren aged 10 to 18 were not at all alone at home during the survey day. One-tenth of schoolchildren spent at least two hours alone at home, which is the perceived limit for risk behaviour. The number of children belonging to the risk group of children alone for more than two hours was so small that the composition of the group could not be examined in more detail. An earlier Finnish study (Pulkkinen and Launonen, 2005) did not identify a large group of schoolchildren in the risk group either.

According to the results, boys spend more time on their own than girls on schooldays. The odds for boys to be alone at home were more than twice as high as for girls. The youngest schoolchildren were less likely to be alone than their seniors. Only children were more likely to be at home alone than children with siblings. The children of single parents are also more likely than other children to spend time alone during schooldays.

Mother’s or father’s employment had no significant impact on the aloneness of children on schooldays. This is probably influenced by the fact that in Finland both parents generally work full-time. Household income did not have an independent impact on the aloneness of schoolchildren. Similarly, the likelihood of being alone on schooldays did not differ between rural and urban areas.

TV is watched most often when alone at home. However, only a few schoolchildren spent their entire time alone by watching TV.

Only one-tenth of the time alone is spent in front of the computer. Since the survey period, computers and Internet access have become more common in Finnish homes, so the time spent alone may now be more computer-centred than around the millennium. During the recent years, different instant messaging services, such as the Messenger, have become popular among young people. In addition to email and playing computer games, using such messaging services belongs to the most common uses of the Internet (Pääkkönen, 2007). Even when the computer is used alone, the ways of using it are becoming increasingly social.

The risks relating to unsupervised use of the television and computer arise more from contents than from the amount of time used for them. Because of the explosive growth in the supply of television programmes brought on by cable, satellite and digital broadcasting, decisions concerning their contents are no longer made at the national level. Likewise, the nature of the Internet is global. However, parents do, to a certain degree, have at their disposal technical means for preventing access to undesirable channels or web pages. Regardless of this, it is difficult to monitor the contents of Internet pages popular among young people.

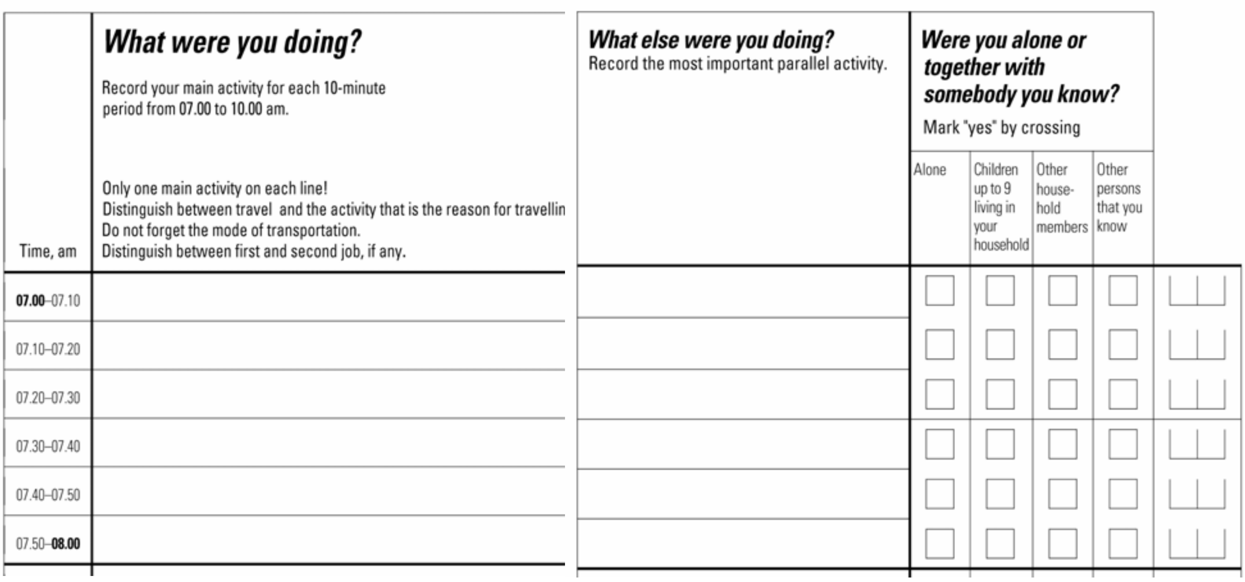
Schoolchildren’s most family-centred activities at home were having meals and TV watching. Over two-thirds of the time spent on meals takes place in the company of family members. Even if other family members were not eating at the same table, they are still at home. Despite much debate, families’ eating habits have thus not yet individualised. Listening to music, homework and reading mostly take place on one’s own.

This article has examined only staying alone at home. However the time spent at home is not the most prone to risks. Children spend time without their parents outside their homes as well, alone or with their friends, which may also expose them to risk behaviour. Some US studies have observed that the afternoon hours from 3 to 6 pm between the end of the school day and the family dinner pose the highest risk to young people. The highest numbers of young people are arrested and many teenage pregnancies are started between these hours (Larson, 1998; Osgood et al., 2005). This is also the time period during which Finnish children most often are at home alone.

The main means adopted in Finland for the prevention of schoolchildren’s aloneness is municipally organised morning and afternoon activity. At the moment the related legislation concerns pupils attending grades one and two of the comprehensive school. These children are younger than the schoolchildren included in this study. Demands have been made to extend to activity also to pupils attending grades three to nine (Ombudsman for Children et al., 2006). On the other hand, the Integrated School Day project has also aroused criticism. Strandell and Forsberg (2005) are of the opinion that the project redefines free time as learning. Increasing areas of children's environment are specified as learning environments and activities in them as learning or learning-like activities. "(T)he foundation of children's after-school activities is relocated in the public sphere; childhood thus becomes removed from the realm of home and family" (Strandell and Forsberg, 2005, 623).

Appendix

Diary



Time, am	**What were you doing?** Record your main activity for each 10-minute period from 07.00 to 10.00 am. Only one main activity on each line! Distinguish between travel and the activity that is the reason for travellin Do not forget the mode of transportation. Distinguish between first and second job, if any.	**What else were you doing?** Record the most important parallel activity.	**Were you alone or together with somebody you know?** Mark "yes" by crossing: Alone	Children up to 9 living in your household	Other house-hold members	Other persons that you know
07.00–07.10						
07.10–07.20						
07.20–07.30						
07.30–07.40						
07.40–07.50						
07.50–**08.00**						

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electronic **International Journal of Time Use Research**
2008, Vol. 5, No. 1, 65-89.

Time for play – An exploratory analysis of the changing consumption contexts of digital games

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Abstract

This study posits that Internet technologies are relaxing the coupling constraints required for the consumption of digital games, resulting in entirely different modes of consumption than has been the norm for the past thirty years. The data collection and analysis found that players of traditional console-based games tend to play for several hours at a time while at a home during evenings and on weekends, the traditional scenario associated with leisure activities. Players of the latest breed of online browser-based digital games, on the other hand, tend to play them for only a few minutes at a time, and at many times throughout the day as a diversionary filler activity between other daily activities. Because they utilize simple and readily available Internet technologies, online browser-based games have facilitated the penetration of digital games into new spaces, including the workplace and school, reflecting a growing trend in modern society.

JEL-Codes: C89, D70, J22, Z19

Keywords: Digital games, online browser-based games, time use, uses and gratifications

1 Introduction

Interactive digital games have penetrated deeply into modern popular culture, becoming a prevalent form of entertainment among children and adults alike. Digital game producers put a great deal of effort into creating, marketing, and distributing these games, and players respond by investing large sums of time and money in consuming them. However, despite the growing significance of this medium in the lives of a large segment of the population, little effort has gone into the examination of the changing consumption contexts of different forms of digital games that are arising due to the growing ubiquity of game playing technologies.

Digital games[1] are not a new phenomenon, but the Internet is greatly expanding their reach beyond what was possible during the first thirty years of their existence. They have suddenly evolved from an activity that possessed stereotypical leisure-related time and space requirements into an activity that can be enjoyed in a wide variety of places and time periods. Anecdotal evidence suggests that they are now being played in schoolrooms and workspaces, rather than only in the living room after work. This blurring of the separation between the once dichotomous realms of work and home is part of a growing trend in modern society that needs to be more clearly illuminated so that we can better understand its impact on us as individuals, as well as on us as a society.

The purpose of this study is to determine if there are differences between the typical times and places in which traditional console-based digital games (e.g. games played using Microsoft's Xbox® or Sony's PlayStation®) and the more recent breed of online browser-based games are consumed (see Appendix A for a brief overview these technologies). Based on the conjecture that widespread availability of Internet-capable technology enables game playing anytime and anywhere that such technology is present, it is believed that online browser-based games are easing the coupling constraint[2] that once restricted consumption of digital games, thus allowing them to be played in many additional times and spaces as compared with earlier forms of digital games. This study also presents a new method of gathering time use data regarding the consumption of an Internet-based activity that is typically consumed sporadically throughout the day and for short periods of time, a task for which many pre-existing time use methodologies are inadequate. This study is relevant to researchers interested in the role of Internet technolo-

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[1] A digital game is a computer-controlled game that players interact with and that typically uses a video display of some type as the primary feedback device. This includes arcade games, computer games, console games, cellular phone games, PDA games, as well as games played on other proprietary handheld devices and set top boxes. The term "digital game" is being used in this paper because it is broader in scope and connotation than the colloquial "video game".

[2] A coupling constraint is a restriction on one's ability to engage in an activity consequent to the need for requisite objects (e.g. equipment, devices, etc.), space, and time. For example, one can only engage in the sport of ice skating if one has ice skates, ice to skate on, and the time to engage in the activity. If one does not have ice skates and cannot acquire them, or there is no readily available ice to skate on, or the individual is busy doing something else such as working or sleeping, then the coupling constraint has not been met – not all of the necessary "ingredients" are available, and so the activity cannot occur.

gies and the manner in which they alter the consumption contexts of activities that can be conducted both online and offline, and to anyone that seeks to conduct similar time use studies related to these media.

This study uses two different time use survey methods to gather data from a population of digital game players concerning the context in which traditional console style video games and Internet-accessible browser-based games are played. These data are then compared and analyzed to reveal the differences in the times and spaces in which these two different forms of digital games are consumed. The first hypothesis of this study is that online browser-based games are being consumed at many different times throughout the day and week, whereas traditional console-based games are played most heavily during typical leisure times (evenings and weekends). The second hypothesis is that browser-based games are being consumed in many different places than console-based games, which are believed to be restricted to typical leisure spaces.

2 Literature review

Digital games have grown significantly since their birth in the 1960's, becoming an important component of mainstream popular culture (Kerr, 2006; Malliet and de Meyer, 2005). The digital gaming medium has reached almost every demographic segment and become nearly as pervasive as television and radio. In fact, the Entertainment Software Association (2005, 2007) reports that 67% of the heads of America's households play digital games of one type or another, and the average player spends approximately seven hours per week engaging in this form of entertainment. The quantity of time being spent consuming these games becomes quite large when considered in the aggregate. For example, Microsoft reports that gamers logged a total of 1.5 billion hours of play time using the Xbox® gaming console's online gaming network during the first sixteen months after its introduction (TeamXbox, 2006). That equates to about 65 million days or 200000 years spent playing games online - and this is just the amount of time spent using Microsoft's network, which is one of many.

Evidence of the growing popularity of digital gaming can also be seen in the industry's sales figures - the software portion of the US gaming industry alone is bringing in over seven billion dollars per year in revenue (Entertainment Software Association, 2007; Interactive Digital Software Association, 2003; Research Alert, 2005). This has brought the industry to a level comparable to many of the older, more traditionally popular media such as newspapers ($11 billion in 2004), magazines ($13 billion), and recorded music ($12.7 billion) (Research Alert, 2005). These numbers are indicative of the inclusion of digital gaming into mainstream culture. However, despite their significant role in the lives of much of the population, there has been very little exploration of the times and spaces in which digital games are consumed, and how that is changing consequent to modern technologies.

The basic tenets of time geography, first introduced by Hägerstrand (1970), are that all human activities take place in a physical location, and that all activities take time to complete. This represents the simple truth that, in order to engage in a specified activity, an individual must be at a specified place where the necessary conditions for the activity are present for a specified period of time. Thus, not all activities can be engaged in at any given moment because of the "coupling constraints" wherein time, space, and the individual must all meet the necessary conditions for the intended activity. For example, console-based digital games generally require the player to be at home (or the home of another) where the console and television to which it is connected are housed, and to have several hours of free time to spend engaging in the activity. The influence these sorts of restrictions have on the activities of a population is one of the major concerns of time use research, as is the manner in which individuals cope with these constraints as they carry out their daily lives (Ellegård & Cooper, 2004; Huisman & Forer, 2005).

A major constraint on the activities of many individuals is their work schedule. Classical notions in time use research consider time spent at work to be time that cannot be spent on other activities such as household chores, personal care, and leisure pursuits (Arndt, 1981; Gronau, 1977; Hornik, 1982; Juster & Stafford, 1991). In the classic view, work and leisure are dichotomous, largely because the workplace and leisure spaces present constraints in terms of time, location, and accessibility of resources. We cannot be in both spaces at once, nor can we have all of the resources that we need in order to engage in both activities at the same time. As stated by Huisman and Forer (2005, p.3), "Essentially, these fixed activities [such as paid work] impose constraints upon an individual's activity pattern. Rather than focusing on observed behaviour, Time-Geography has sought to define the physical (spatial and temporal) constraints which restrict the choice of alternatives open to the individual. This describes what is physically possible or accessible within certain time constraints."

Early time use theory such as that by Becker (1965) and Voss (1967) brought attention to the importance of studying time spent engaging in non-work activities in addition to the more commonly studied work activities, and laid down the definitions and fundamental framework still in use in time use research today. The proliferation of the Internet offers a challenge to some of these fundamental conceptualizations of work versus leisure. Research has begun to focus on the role of Internet technology in the erosion of the clear divisions between work spaces and leisure spaces, such as in the manner that paid-work related activities are migrating into the home (Kaufman-Scarborough, 2006), and how they are changing when and where university students carry out the business of their education (Forer & Huisman, 2000). However, little research has addressed the growing movement of leisure activities into new spaces, such as the workplace. Many non-work activities (both leisure and nondiscretionary activities[3]) that previously could not be carried on at work are now quickly and easily dovetailed into a daily work routine because they can be carried out online, such as shopping, reading the news, play-

[3] Nondiscretionary activities are typically defined as activities that one feels obligated to engage in, but for which the individual is not paid (Voss, 1967). Examples include doing household chores (laundry, washing dishes), cooking, and sleeping.

ing digital games, paying bills, watching the highlight reel from a recent sporting event, and even online dating. While digital games are the specific interest of this study, they represent but one of a plethora of online activities that are available to anyone, anywhere that they have access to an Internet-capable computer. The increasing time being spent in such activities while at work has ramifications for the individual's utility function (e.g. more time for leisure activities in total, and receiving wages for the time spent engaging in them) as well as for the firm's productivity (e.g. paying workers for time spent in leisure pursuits, and potentially less productive workers). This study examines the impact of Internet gaming technologies that represent a potential relaxing of the "coupling constraint" that used to restrict the play of digital games to leisure spaces, and reveals that this technology is leading to them being played while at work. Online game playing is one of many online activities that are bringing into question our fundamental notions of how to draw the line between work and leisure activities, and how to measure these activities now that the line is much less clear.

2.1 Lack of contextual data on game consumption

Studies have been conducted that reveal some of the motivation behind the consumption of digital games and the demographics of the people that play them (cf. Lucas, Greenberg, and Lachlan, 2006; Nielsen//NetRatings, 2004). However, our knowledge of the times and spaces within which they are played is somewhat lacking. Where information on when people play does exist, it is typically either too vague to have relevance, or it is very specific and lacking generalizability. An example of the former comes from the American Time Use Survey, which collects data on how much time people spend playing games. However, the coding of this type of activity lumps digital game playing into the same category with such varied pursuits as "playing cards," "working jigsaw puzzles," and "spinning dreidels" (US Bureau of Labor Statistics, 2004). Examples of the latter come from Nick Yee's Daedalus Project (Yee, 2004) and the PlayOn research group (Yee, 2006). Yee's research has produced rich and detailed data on how much time people spend playing Massively Multiplayer Online Role Playing Games (a.k.a. MMORPGs), but this type of data is much too specific (a single genre of computer-based multiplayer gaming) to be generalizable to other genres or gaming platforms. Additionally, the studies that have been done generally do not focus on when that play is occurring or in what contexts. Specific data on where and when the consumption of various forms of digital gaming occurs would aid in an understanding of how technological innovation in the gaming industry is changing the time geography of this leisure activity.

2.2 Online browser-based games

The market for digital games can be segmented based on many different criteria, the focus of this study being the method by which the digital gaming experience is delivered to, and/or consumed, by the consumer. A relatively new and rapidly growing method of such delivery comes via the Internet. The Pew Internet & American Life Project estimates that 71% of American adults (approximately 165-210 million individuals) currently have access to the Internet (Fallows, 2007), and that number is expected to continue to increase into the foreseeable future due to greater penetration of high bandwidth networks and wireless devices (Deloitte Research, 2004). This widespread availability of Internet-capable technology is providing ample opportunity for many individuals to participate in online game playing. According to a study by Nielsen//NetRatings (2004), one out of every three Americans that spent time online during May of 2004 played browser-based games at a gaming website.

The technology that facilitates online browser-based games is different from that which has facilitated digital gaming in the past, creating an entirely new degree of accessibility. The traditional digital game playing scenario involves dedicated hardware and/or software required to play the game (e.g. a Microsoft Xbox®, the game's software, and a television), which is generally designed to occupy a fixed location. Thus, consumption in this scenario occurs in the same fixed location over time, and at times when the location is accessible to the player (e.g. in a living room and during non-work hours when the individual is at home – a stereotypical leisure context).

In the case of the technology that facilitates online browser-based[4] games, the player occupies a fixed location housing a minimal amount of *non-dedicated* hardware (i.e. a computer) that grants accessibility through the Internet to a webserver at some remote location, which in turn houses and distributes the actual software that generates the digital experience. As an example, any person using a modern computer and an Internet connection may direct the computer's web browser to http://www.miniclip.com or http://www.pogo.com and click on their choice of a variety of free games. The game will then load into the player's browser and can be played for as short or long a time as desired. There is no downloading or installing of software needed. Once the Internet browser is closed, the game itself and all supporting files that may have been temporarily cached on the computer cease to exist (for all practical points and purposes).

In some respects, online browser-based games are a radical modification of previous forms of digital gaming. Games can be played from virtually any computer, any time, without any financial investment (i.e. many are supported by advertising and can be played for free), and without requiring the player to have any specialized technical proficiencies (i.e. they tend to be very simple to play). They can be sampled and played nearly at will, in the privacy and comfort of whatever environment the consumer chooses, and can be played from public computers. Anywhere that a person can find a computer with an Internet connection is now a potential location for consumption of a digital game. In addition to increased geographic availability, the browser-based games tend to be short and simple; they do not require a substantial time investment, which increases the temporal availability of digital games as well. Although a single, definitive reason for the popularity of online browser-based games is elusive, there is little

[4] A browser is a software program that is used to view and interact with various Internet resources available via the World Wide Web. Essentially, it is the program that allows one to view webpages. Popular examples of browsers include Netscape, Internet Explorer, Safari, and Mozilla Firefox. A browser-based game is a digital game that is accessed and played entirely through the use of a browser, typically without the need to download or install any additional software.

doubt as to the popularity of the medium, as summed up by the International Game Developer's Association (2006): "Without a doubt, more people from around the world play [browser-based] games than any other kind of video game."

3 Data

3.1 Phase one – Interception at time of use survey

The first method of data collection used in this study gathered information on the context in which a particular online browser-based game was being used. Simply gathering data on when people are playing does not tell us how they are fitting the play time into their daily routine. This data collection methodology was intended to reveal whether games distributed in this way really are being played in places other than the traditional "at home after work" scenario, and to what extent. The digital game used in this phase of the study was an online browser-based digital game that was created by the researcher called "War of Nations". The game is basically an interactive massively multiplayer turn based strategy game similar to the classic Milton Bradley board game titled Risk®, and was available free of charge on the Internet. This game was entirely authored, sponsored, and maintained by the researcher. It is part of a rapidly growing genre of games called "persistent worlds," in which the player must log in to the game regularly (via any computer that has an Internet connection) in order to maintain their strategic and tactical position within the gameworld[5]. As such, it affords the opportunity to study a relatively static population of game players that have integrated the activity into their daily lives. Games of this genre allow a player to log in, make their "moves" within the game space, and log out with only a few minutes of time commitment. While they are offline, the game continues, with other players logging in and making their moves, some of which may impact the offline players, who will then log in later to counter-move. This is a feature of many browser-based games that differentiates them from the typical console-based game, in which game play entirely ceases when the player pauses the game or turns off the console. Consequent to this on-going interaction with other players, loyalty to the game used in this study is fairly high – the mean number of days current players had spent playing the game at the time of this study was 192 days. Any player that is inactive for 14 days is automatically removed from the game, thus, the definition of a "player" is anyone that has actively participated in the game space continuously without any 2-week breaks in their participation. At the time of this study, the game had been online for two and a half years and had an average player base of approximately 150 players. For games of this genre, this population is fairly small; most games of this type boast player populations in the thousands. The entire adult (18 years of age or older) population of the game was used as a sampling frame for both phases of this study.

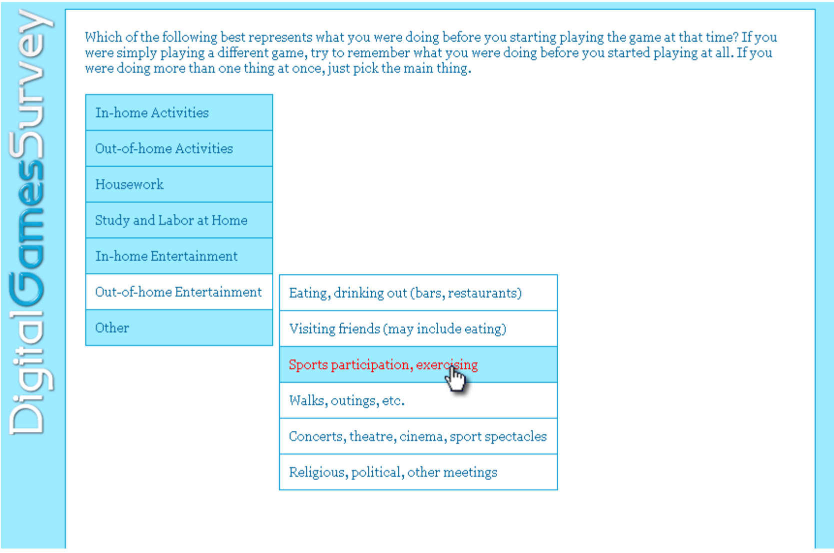
[5] A census of the "Multiplayer Online Games Directory" (http://www.mpogd.com) on November 12, 2005 found 1,023 similar entirely browser-based multiplayer games available on the Internet, many of which are also of the persistent world genre.

To collect the data, a random number generator presented players with a survey following approximately 10% of their logins to the game. 10% was an arbitrarily chosen number aimed at reducing the potential for respondent fatigue and keeping the response rate high throughout the study. Participation in the survey was rewarded with a “virtual” object that has value within the game. A potential limitation of this technique that should be mentioned is the simple fact that participating in a survey can alter the behavior of those that participate, particularly when an incentive is involved. However, the exact nature of that influence in this research project was not studied, and is unknown. The survey instrument asked the respondent to indicate which of 32 different activities most accurately represented the dominant activity they were engaged in prior to logging in to the game, and that which they intended to engage in after they finished playing. The choices available were based on a “light diary” design developed by Gershuny and Smith (1995) that covers broad categories of activities, but without going into so much detail that it becomes confusing or over-burdening for respondents. The 32 activities were grouped into seven categories and presented via a simple menu system, as depicted in Figure 1. This survey was left active on the game website for the period from March 2, 2006 until April 12, 2006. A total of 76 of the currently active players participated in the surveys (86% response rate), most of them more than once, resulting in 235 total usable completions (the mean number of responses per player was 3). In addition to the “context” questions, the survey instrument also recorded the time at which the player logged in to the game, and the time at which they logged out (i.e. the duration of the play experience). This time was recorded by a Javascript function that captured the time according to the clock on the player’s computer, eliminating any confusion about the time zone of the player versus the time zone of the webserver. Phase one’s methodology was employed to overcome common limitations inherent in recall-based time use data collection (see Mulligan, Schneider, & Wolfe [2005] for an overview of the problems inherent in many different types of time use instruments).

Online browser-based games are typically quick, simple to play, and easy to embed in a variety of other simultaneous activities - they represent the type of activities that recall-based surveys are especially bad at capturing. Studies have found that respondents are much more likely to accurately recall activities that are done on a regular schedule (such as a regularly scheduled gaming session with friends) than those which occur sporadically or infrequently (Blair & Burton, 1987; Havens & Schervish, 2001; Hu, Toh, & Lee, 2000; Juster, 1985; Sullivan, 2007). Also, events in which the respondent participates for longer periods of time (such as a three or four hour long Nintendo® session) are more likely to be accurately recalled than those that only last for a short period of time (such as playing an online game for a few minutes during a lunch break) (Hu, Toh, & Lee, 2000; Jarvis, 2003; Juster & Stafford, 1991).

The ability of Internet technology to record the details of the consumption event at the exact moment it is occurring offers an excellent method of capturing highly reliable data. This method was highly successful in this study, and is readily applicable to studies of any manner of Internet-based activities.

Figure 1
Illustration of the context data collection instrument



3.2 Phase two – survey of past players

The second phase of the study was intended to gather data on the consumption contexts of the traditional console and (non-browser-based) computer games. This took the form of an online survey that asked respondents to provide information on any digital game that they may have played over the previous 24 hours. This recall-style methodology was used because these other non-online, non-browser-based games are not played in a location where the player is readily accessible for surveying at the point of the consumption. However, anecdotal evidence suggests that the purposeful effort required to play games via these other methods makes them suitable for a recall-based survey. Requesting data from only the previous 24 hours was an attempt to enhance the accuracy of the data because time use research has suggested that accurate recall of an event is dependent on the amount of time that has elapsed since that event occurred (Doherty & Miller, 2000; Havens & Schervish, 2001).

The survey asked all of the same questions as the survey in phase one, with two notable exceptions. First, the participant was asked to provide the time at which they had started and finished playing a game (rather than having that data automatically recorded, as in phase one). Second, the respondent was asked to provide the type of game they played (e.g. console, computer, online, mobile) and the title of the game. This data was then used to categorize the respondent's consumption event into the appropriate category (traditional versus browser-based).

The sampling frame was composed of the same basic type of gamers as the previous phase. The email addresses of 4502 currently-inactive players of War of Nations (the same game used in phase one) were used as a mailing list. Batches of invitations to participate in the survey were emailed to approximately 200 potential respondents at a time, twice per day from March 16, 2006 to April 12, 2006. A batch was sent each morning and each evening every day of the week to try and elicit responses covering all times of the day and days of the week.

Approximately 9000 emails were sent, yielding 375 total visits to the survey website (4% response rate), but only 121 responses were usable due to incomplete data and underage respondents[6]. The low response rate for this survey (compared to that in phase one) is likely due to the lack of incentive to participate.

In addition to gathering data on the time, duration, and surrounding activities, the survey instruments collected simple demographic information: age, gender, occupational status, education level, and zip code. The vast majority of participants were residents of the USA – those residing outside of the US were excluded due to an inadequate number of observations to allow for analysis of differences between US and non-US players. Zip codes were used to look up the median per-capita income of residents in the individual's census tract, which was then used as a proxy for the individual's income. The results of this data collection can be seen in Table 1, which contains information from both phases of the study. Many of the players that were willing to respond to the questions dealing with the games being played failed to complete this demographic part of the survey, presumably because of concerns over their privacy. The demographic figures presented in Table 1 are representative of the types of respondents that reported playing each style of game in this study. The subjects in this study are predominantly young and male, coinciding with stereotypical views of digital game players in general.

Those with higher incomes (or higher family incomes) are more likely to be able to afford post-secondary education, and also to afford the expenses inherent in traditional digital games (i.e. a console and game software).

Another potential factor leading to the decision to play a browser-based game is the increased role expectations of older individuals. The stereotypical 30 year-old (as compared to a 21 year-old) is likely to be in a stage of the family life cycle (Wells & Gubar, 1966) in which they face a decrease in available leisure time due to the increased demands of their roles in career and family life (McGrath & Kelly, 1986).

Research by Kaufman, Lane, and Lindquist (1991) suggests that individuals with greater role expectations (i.e. more demanding roles in life that lead to greater pressure on available resources such as time, money, and energy) are more likely to engage in polychronic time use (doing more than one thing at a time). While the data collected in the current study are not able to specifically address the issue, the demographic profiles support the notion that older, potentially more time-deprived individuals are more likely to be playing browser-based games because they are more easily played simultaneously with (or dovetailed into) other required daily activities.

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6 The Institutional Review Board that oversees all US University-based research that uses human subjects requires a signature from the parent or guardian of an underage respondent before any survey data can be collected from those individuals. Within the framework of the current methodology, this requirement could not feasibly be met, so only adult respondents were used in the study.

Table 1
Demographic Profile of Respondents

	Traditional Games	Browser-based Games	US Population
Age			
Median	21	30	35
Gender			
Female	13%	6%	51%
Male	87%	94%	49%
Work Status			
Full-time Student	31%	19%	6%
Work Full-time	41%	56%	63%
Part-time work and/or Part-time student	16%	13%	
Homemaker	2%	3%	
Unemployed	10%	6%	34%
Retired	0%	3%	
Education			
Less than high school	8%	3%	9%
High School	31%	31%	32%
Some College	36%	41%	25%
Bachelor's degree	16%	22%	18%
More than Bachelor's	8%	3%	10%
Per-capita Income			
Median	$24,943	$18,773	$21,587
Sample Size (those reporting these data):	61	32	

US work status and education figures compiled from the US Bureau of Labor statistics (http://www.bls.gov/), the US census (http://www.census.gov/), and the National Center for Education Statistics (http://nces.ed.gov) are somewhat vague and include overlaps due to the data not being readily available in the same divisions used in this survey.

3.3 Limitations of the survey methodologies

The first major issue is the limited nature of the sample population. This study surveyed all present and past players of a particular online browser-based strategy game. As such, the results of this study are fairly conclusive as to the behavior of this specific population, but do not necessarily extend to the entire population of digital game players. Future studies may wish to use sampling plans that will include a wider range of player types. A related limitation is the genre of game employed for the data collection. There are many types of browser-based games available via the Internet, and the particular genre to which this game belongs is attractive to more serious gamers. There are a great many simpler games available that are played by less committed gamers, and the populations playing those games may behave differently than the population used in this study. A second issue involves the self-selected nature of the respondents. The respondents in phase one chose to respond (ostensibly) out of a desire for the incentive. Phase two respondents participated out of some sort of altruism. In both cases, the individuals that responded do not necessarily represent all of the gamers in the population, or in other populations.

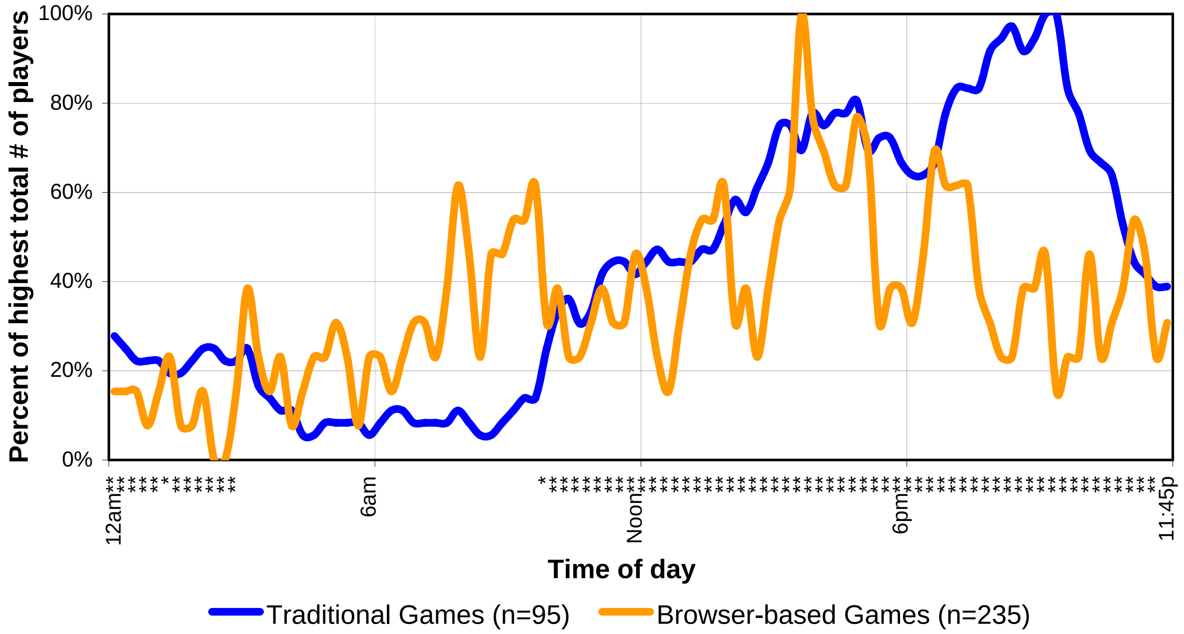
A final issue involves the large number of underage respondents in the sample population. Due to the extreme difficulty involved in obtaining written parental consent from these minors, slightly less than sixty percent of the sample population were excluded due to age issues. As a consequence, any conclusions made in this study are only reflective of the adult population of this community.

4 Results and analysis

4.1 Time of play

Figure 2 depicts the number of respondent players consuming "traditional" games and "browser-based" games at any given time (the data is based on 15 minute intervals and is the aggregate of all weekdays and weekend days). The x-axis of the figure provides reference times, but also indicates those time periods wherein the differences between the two forms of gaming are significant. Chi-squared tests (χ^2) of significance were used to examine whether or not the proportion of players reporting playing games of each type were the same during a given 15 minute time period. The time of day represents the local time of the player.

Figure 2
Time of play for traditional and browser-based games: Percent playing



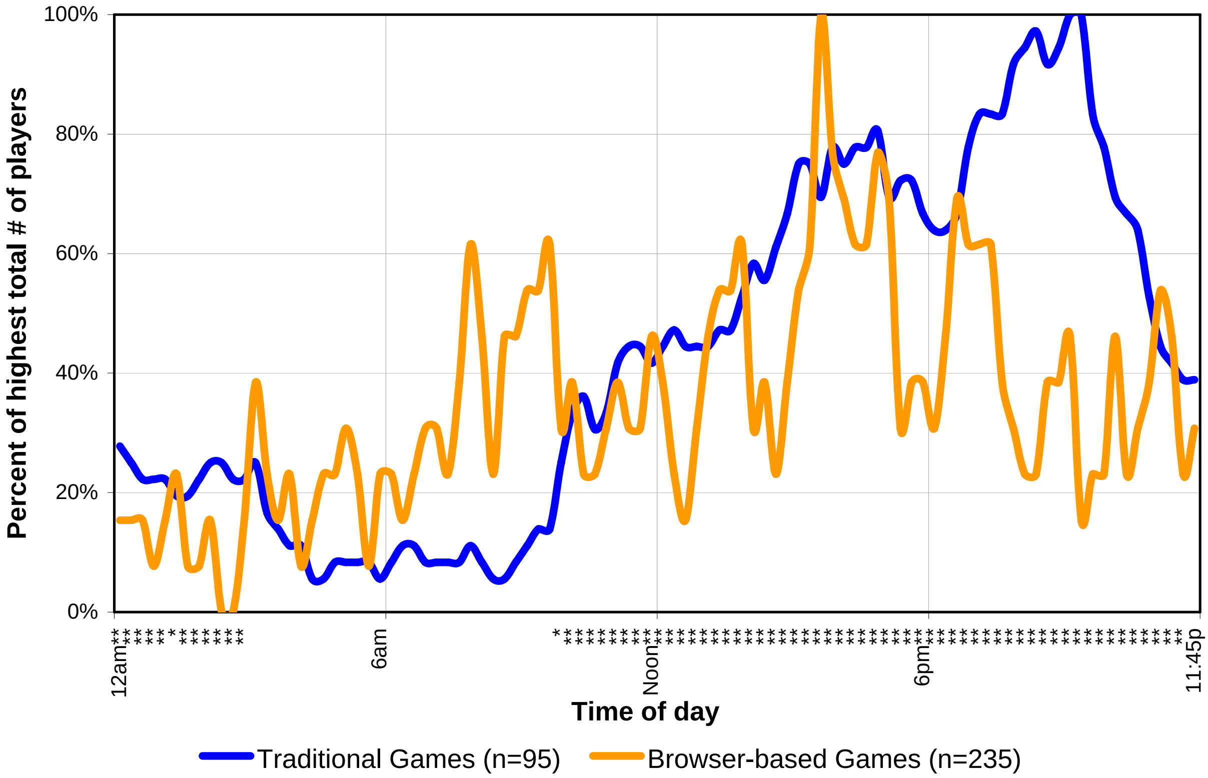
Statistical significance figures represent the significance between the traditional games data and the browser-based games data.
*/** Statistically significant difference between the types at a 95%/ 99% confidence level.
Source: Calculations based on own data.

Figure 2 displays a pattern that is reflective of the length of time that players tend to spend playing games of the different types. The median amount of time spent continuously playing a game classified as a "traditional game" was three and a half hours, while "browser-based games" were played for a median time of fifteen minutes (the smallest interval possible via the survey instrument).

Consequently, a player of the older style of games was more likely to have their play episode overlap with that of other players, leading to the higher percentages in the graph. Another depiction of the exact same data can be seen in Figure 3. Figure 3 attempts to plot the data on a more directly comparable scale.

Each line is plotted based on the proportion of players of each type of game that were playing in a given time period relative to the maximum number that were ever playing at once. This makes it easier to see when a player is likely to consume each type of game relative to the other. In this depiction of the data, a steady increase in the playing of traditional games occurs throughout the day, reaching its highest point in the evening, just after a lull around 6:00pm (presumably representing the evening mealtime). Browser-based games, on the other hand, begin to be played earlier in the day (the first major spike in usage occurs at 8:00am) and continue sporadically, reaching their peak around 3:45pm. A notable diversion between browser-based games and traditional games occurs around 8:00pm, when browser-based games are being consumed less, while the older types of games are consumed more. This is posited to be because consumption of traditional console games is restricted to, and more suitable during, those post-work leisure hours (i.e. when the coupling constraints of that form of digital game consumption are met). If a gamer knows that they can play a browser-based game anytime, even while at work or school, but can only play their Xbox® in the evenings while at home, then that consumption makes more logical sense during that time frame. Additionally, a family or peer group that has a similar work-leisure time use pattern will have the opportunity to play together during leisure times (Fisher & Layte, 2004). It therefore makes sense to use those time periods to engage in multiplayer console games that are designed to be played in the same room with a group of friends, rather than to play single-player online games that can just as easily be played while alone and/or away from home. Console gamers are going to utilize those scarce "pure leisure" hours doing things that can only be done during that time due to coupling constraints. Leisure activities that have more relaxed coupling constraints and that can be easily integrated into the workday may be perceived as providing less utility if consumed during this "pure leisure" time as compared to a leisure activity that can only be consumed during this time. Through this logic, Internet accessible leisure activities are slowly migrating into the workday, as evidenced by these results. The time of day during which people play games was also considered from the perspective of weekdays versus weekend days. Large-scale time use studies have indicated a clear distinction between rates of participation in classically defined leisure activities on weekends versus during the workweek. Essentially, Americans tend to spend nearly 27% more time engaged in leisure activity on weekend days (with variations across different categories of leisure pursuits) (Juster & Stafford, 1991; Robinson & Godbey, 1997).

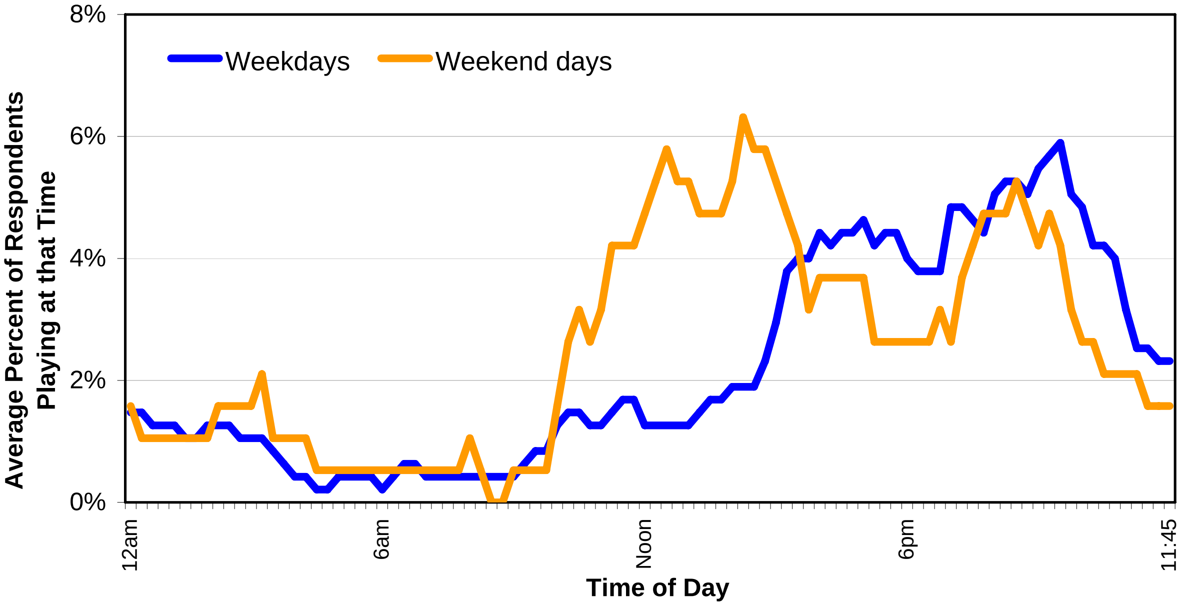
Figure 3
Time of play for traditional and browser-based games: Proportion playing



Statistical significance figures represent the significance the traditional games data and the browser-based games data.
*/** Statistically significant difference between the types at a 95%/ 99% confidence level
Source: Calculations based on own data.

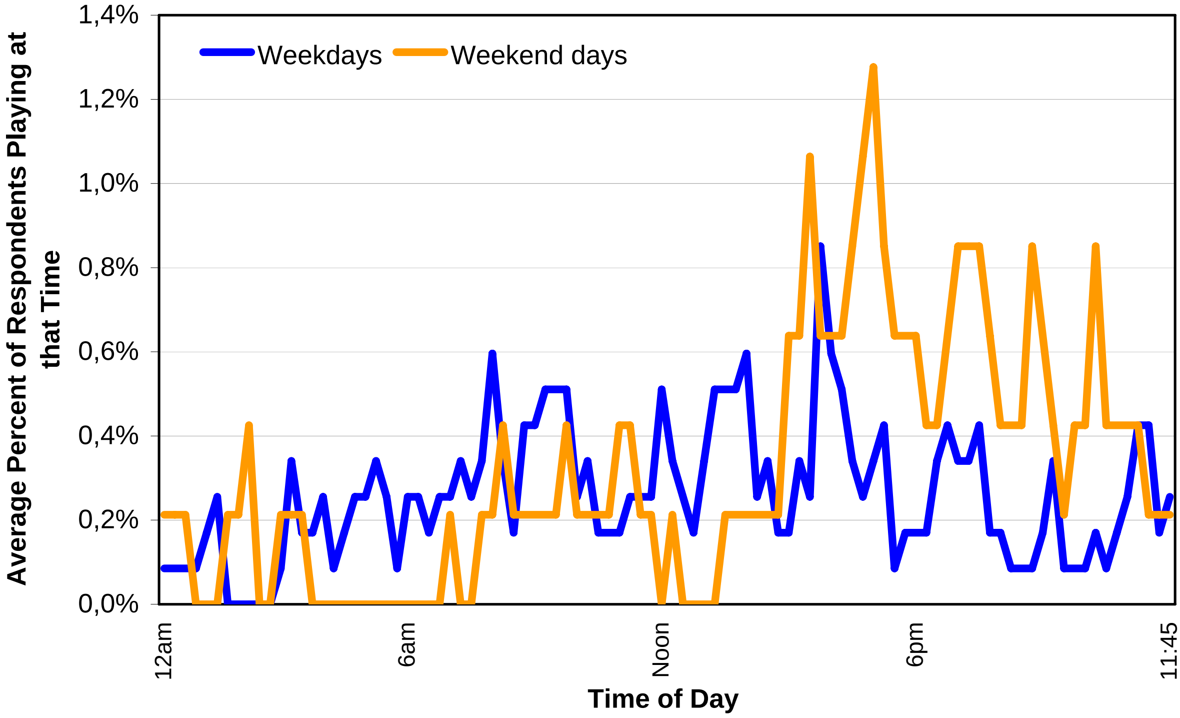
As such, we can expect digital games that are being consumed in the traditional manner in which leisure activities are consumed (i.e. during non-work hours and in non-work places) to exhibit a similar pattern. The data from this study clearly indicated just such a pattern of consumption for traditional games, but not for browser-based games (see Figures 4 and 5). While it is tempting to directly associate this weekday versus weekend pattern with the stereotypical work week (i.e. Monday-Friday are days spent working while Saturday and Sunday are days set aside for leisure), this study did not specifically inquire as to whether the participants adhered to such a schedule, and thus making that association is an assumption that cannot be strictly supported by the data presented in these graphs. A visual inspection of these graphs seems to hint that browser-based games are played almost equally across all days of the week, whereas traditional games exhibit the pattern expected of standard leisure activities – they are played most heavily in the evenings on weekdays but during both the day and evening on weekends. However, strong evidence was found *between* the different types of gaming. Analysis of the weekday data yielded results very similar to those displayed in the aggregated data (see Figure 6), indicating that traditional games are consumed much more actively in the afternoons and evenings than browser-based games. These graphs are suggestive of broad trends, but the small sample sizes of weekend play episodes are not able to provide conclusive statistical evidence.

Figure 4
Play of traditional games on weekdays and weekend days



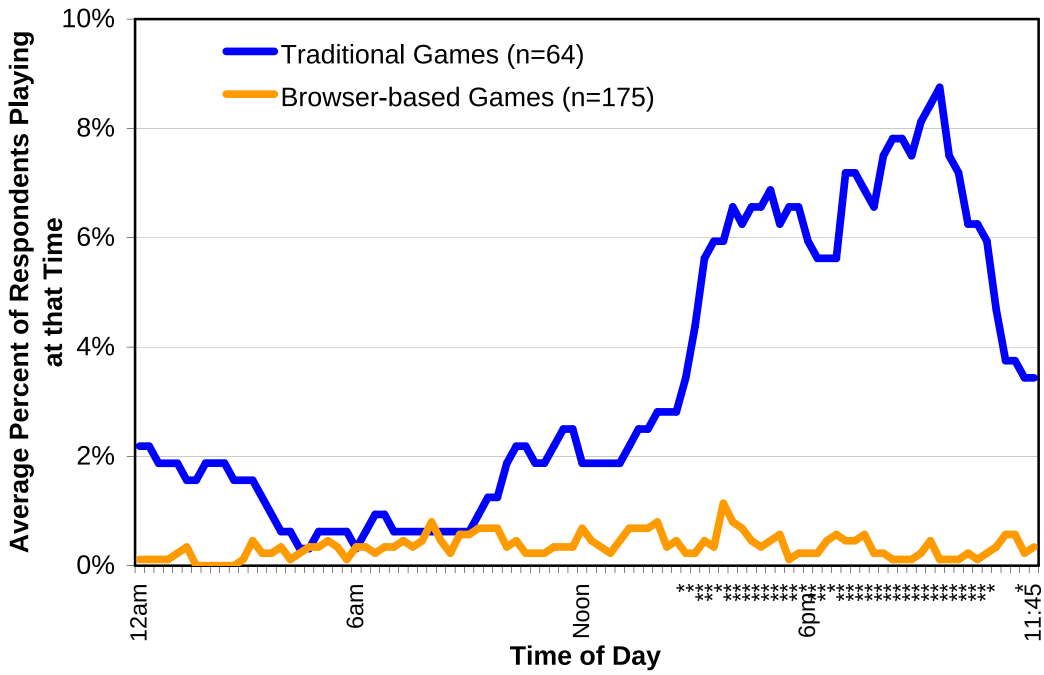
Percentages represent the average of all weekdays and all weekend days.
Chi-squared tests did not find any statistically significant differences between the data sets.
Source: Calculations based on own data.

Figure 5
Play of browser-based games on weekdays and weekend days



Percentages represent the average of all weekdays and all weekend days.
Chi-squared tests did not find any statistically significant differences between the data sets.
Source: Calculations based on own data.

Figure 6
Weekday play of traditional and browser-based games



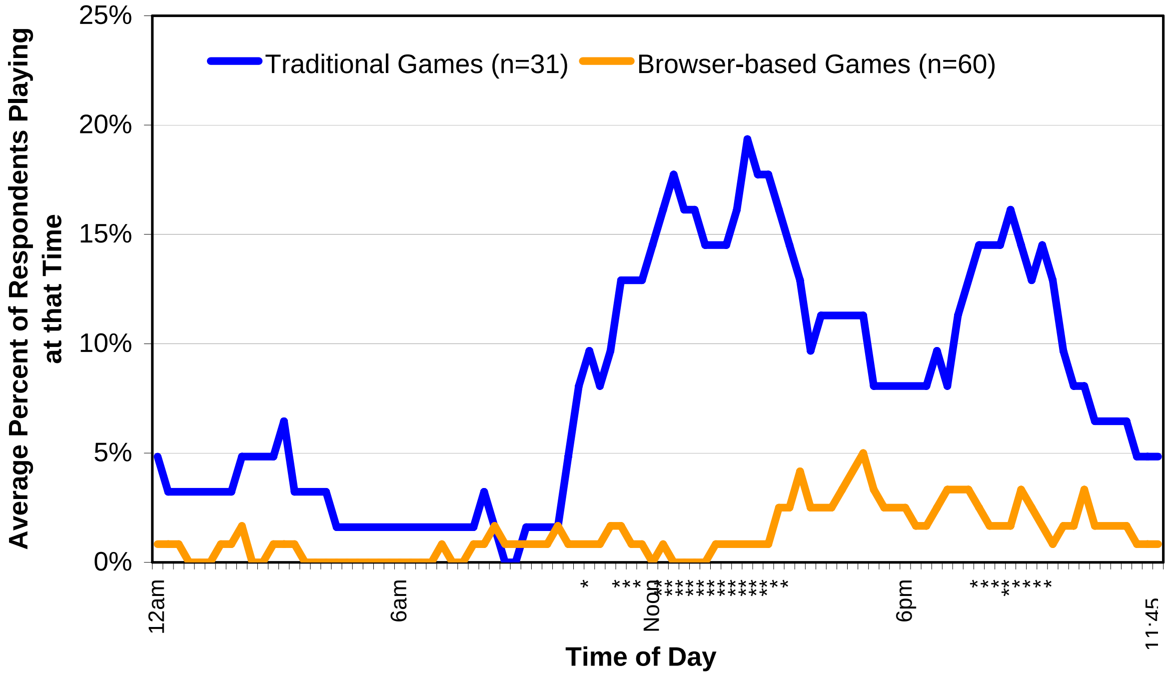
Percentages represent the average of all weekdays (Monday through Friday).
Source: Calculations based on own data.

The weekend differences depicted in Figure 7 indicate that traditional games are played more heavily both during the day and during the evening. Both of these observations support the notion that traditional leisure times (weekday evenings and all day on weekends) will preferentially be filled with consumption of activities that can only be consumed during those times. One of the objectives of this study is to determine whether browser-based games are played in different times than traditional digital games. The collected data support the conjecture that they are by revealing a trend toward playing browser-based games equally across all days of the week, whereas traditional games are consumed in a fashion similar to other stereotypical leisure activities.

4.2 Context of Play

The second major factor being considered in this study is the place, or context, in which the consumption of these games is occurring. Table 2 displays summary results. For the statistical analysis in Table 2, each activity category was considered independently of the others, as was the distinction between activities engaged in before versus after playing (Chi-squared tests of significance were used to examine the differences). In all cases, the null hypothesis was that an equal proportion of players of each style of game would be engaged in the activity in question. Those cases where this hypothesis could be rejected are indicated by asterisks.

Figure 7
Weekend play of traditional and browser-based games



Percentages represent the average of all weekend days (Saturday and Sunday).
Source: Own calculations based on own collected data.

Table 2 provides an indication of those activities where the play context of browser-based games is significantly different from traditional games. The first point is that browser-based games are less likely to be associated with meals at home. This is likely due to the fact that many players of these games play them in short, sporadic bursts throughout the day, while traditional digital games are played more often in the evening after supper until bedtime (traditional game players are significantly more likely to sleep after playing versus before). The amount of time spent in a single play episode (typically over 3 hours) tends to make these consumption experiences a major event, couched between other major daily events such as meals, work, and sleep. Browser-based games, on the other hand, seem to be filler activities that can be easily squeezed in between many other routine daily behaviors.

The second major point is that browser-based games are much more likely than traditional games to be played while at work. Many of the players of the more traditional games mentioned having been at work before playing, but none mentioned then going back to work. The same is true of education and classes outside the home. This fits with the notion that these players are going home at the end of the workday/schoolday and starting to play. While just as many of the browser-based play episodes followed work, a full 9% of the responses indicated that the respondent was then going to resume working. Work was significantly more likely to follow a browser-based play episode (χ^2=12.71, p<0.000), partially because of these "at work" players, and partly because of a large number of players playing before starting work (5% indicated sleep or commuting, presumably to the workplace, as the activity that preceded the play episode that was followed by work). This leads to the inductive inference that nearly 10% of online browser-based gameplay episodes are occurring while the player is at work.

Players of browser-based games are accessing them via the Internet. Therefore, it was expected that they would be associated with web browsing. However, they were no more likely to be preceded (χ^2=1.64, p=0.200) or followed (χ^2=0.68, p=0.407) by web browsing than traditional games. This suggests that the Internet was used at that point in time solely as a way to access the game. Respondents were not surfing around, then playing the game for a while before going back to other online activities. This supports the notion that the game was what the individual was seeking, and the Internet was simply the delivery vehicle, rather than the Internet being the destination and the game just one of many diversions consumed.

The finding that almost 10% of the participants are embedding browser-based game play into their workday strongly supports one of the ramifications of this study – these games are being played in places where traditional games are not, the workplace in particular. The accessibility of these games via the Internet has relaxed the coupling constraint previously inhibiting consumption of digital games in the workplace to the degree that playing during work hours and at the work place is common, at least among this population of gamers. In light of these results, it is important to recognize that digital games are just one of many activities that are benefiting from this relaxed coupling constraint.

The Internet has altered the consumption possibilities for a great many digital activities, both leisure (games, dating, chatting with friends) as well as nondiscretionary uses of time (paying bills, shopping, looking for a new job), allowing them to be engaged in during the workday. Generalizing further, it is clear that many activities that were previously bound to specific times and spaces can now be engaged in at many different times during the day, in many additional places, and can be broken up and spread out throughout the day to serve as filler activities between those traditional activities that have not benefited from such an abstraction (e.g. washing dishes, playing soccer).

A final observation from Table 2 is that browser-based games are significantly more likely to be followed by participation in sports or exercise (χ^2=7.16, p=0.007), but all of the models are equally likely to be preceded by such activities (χ^2=0.04, p=0.843). This would appear to be a consequence of the fact that browser-based gameplay occurs throughout the day, while the older models tend to be played later in the day, leading up to bedtime. This finding does *not* suggest that browser-based gamers are more physically active, but that consumption of these types of games is more likely to occur earlier in the day, for shorter spans of time, and to serve as a time-filler between other activities (such as while waiting to meet with friends for a sporting event).

Table 2
Activities before and after the play episode

		Activity Prior to Play in %		Activity Following Play in %	
	Distribution Model:	Traditional	Browser-based	Traditional	Browser-based
In-home activities	Sleep, rest	15	20	30	23
	Washing, dressing, personal care	2	2	1	2
	Food prep & clean up	7	1**	2	0
	Eating at home	7	5	10	3*
	Care of own children & play	3	2	1	3
	Helping other household members	0	0	1	2
Out-of-home activities	Travel, commuting	0	6*	1	2
	Paid work	11	12	2	16**
	Attending classes and ed. outside of home	7	7	2	4
	Breaks and meals at work or study	0	2	2	0
	Shopping	0	0	0	0
	Professional appointments (doctor, dentist)	1	1	1	1
	Helping people outside home, charities	0	0	0	0
Housework	Cleaning house, tidying	7	1**	2	1
	Clothes washing, ironing, sewing, etc.	1	0	0	1
	Maintenance, odd jobs, DIY	1	0	0	0
	Gardening, pet care	0	0	0	0
Study and Labor at home	Studying at home	8	5	3	7
	Paid work at home	0	1	0	1
In-home entertain-ment	TV, radio	3	9	12	6
	Talking, telephone calls, email, online IM	3	0*	2	2
	Reading	0	2	2	3
	Web browsing	2	5	3	5
	Other hobbies	3	1	3	1
Out-of-home entertainment	Eating, drinking out (bars, restaurants)	0	3	3	2
	Visiting friends (may include eating)	4	3	0	2
	Sports participation, exercising	4	4	0	7**
	Walks, outings, etc.	0	0	1	0
	Concerts, theatre, cinema, sport specta-cles	0	0	2	1
	Religious, political, other meetings	0	1	0	0
Other	Doing nothing	3	0*	0	1
	Other, not elsewhere specified	8	3	11	3**
	Sample Size	92	258	92	258

* Statistically significant difference between the types of games at a 95% confidence level.
** Statistically significant difference between the types of games at a 99% confidence level or above.
Source: Calculations based on own data.

5 Conclusions and Implications

The results of the data analysis supported the hypotheses and primary conjecture of this study. Online browser-based games are consumed at many different times throughout the day and days of the week, while the more traditional console-based games are played much more heavily in the afternoons and evenings. These older forms of digital gaming are still restricted by the classical coupling constraints, and tend to be associated with classically defined leisure times and spaces. Online browser-based games, on the other hand, are consumed in some places where the other forms of games are not, most notably while at work and at school, and the consumption episodes tend to be much shorter (fifteen minutes or less versus more than three hours for the other types of games). Aside from being an illustration of the impact of the Internet on traditional notions of time geography, this relaxing of the coupling constraints on digital game playing also represents a phenomenon that feeds into the lifestyle of the growing class of time-constrained consumers that are actively pursuing a large variety of short-duration activities with which to fill their scarce free time (Sullivan, 2007). Any activity that can be performed via the Internet, whether it be leisure, work, or chores, can now be broken up and engaged in at many different points during the day and week. This reality complicates any traditional time use study; future time use studies will require detailed analysis of all Internet activities engaged in during the day, no matter how short the duration, and separating work from leisure activities will require greater attention to exactly what is being done, rather than when or where.

An additional important purpose of this study was to test the "interception at time of consumption" survey methodology. Online behaviors are difficult to categorize and track. An individual can check their email, find information on a product they are interested in, make reservations for a hotel, and play a game all while carrying on instant messenger conversations with several people entirely within a time span of less than fifteen minutes. A typical quantitative time use survey that asks the individual what they did on the Internet during those fifteen minutes is going to have a hard time coming up with an accurate portrayal of the activities. Internet activities can be shorter in duration and more fluid than most popular research methodologies can accommodate. Setting up a survey that intercepted an individual at that exact moment when they engaged in the activity worked well for this study. The response rate was very high (significantly higher than the standard survey used in phase two), and the instrument was able to capture data about the context of the behavior that is probably much more accurate than would have been possible through a recall based survey or a diary. All in all, this methodology proved itself to be a very valuable tool for time use research related to online gaming behavior, and it is likely to be useful in all time use research that involves studying Internet use, or populations that use the Internet.

The results of this study are reflective of a general trend in modern American society. Consumers are spending more and more of their time interacting with, and through, Internet based technologies. This represents a cultural shift with far reaching consequences. A central tenet of time use research is that individuals have 1440 minutes per day to budget to the activities in which they wish to engage. How masses of individuals collectively choose to spend those minutes dictates the structure of our society and the marketplace. The fact that there are a limited number of minutes available means that time spent on a new activity is time not being spent on an old activity.

The manner in which players of online browser-based games fit the consumption into their day provides hints as to what activities those play episodes might be displacing. Traditional digital games that are played in traditional leisure times are most likely to be replacing time spent with other leisure activities, such as outdoor sports and hobbies. They are also likely to be replacing other entertainment media and may be contributing to the recent decline in television viewership (Broadcast Engineering, 2004; Hughes, 2005). Browser-based games played periodically throughout the day (and at work) for purposes of diversion, on the other hand, may possibly be replacing economically productive activities, or household chores. This brings up obvious questions of lost productivity in the workplace, something that becomes even more significant when we take into account the wide variety of other Internet-accessible activities that are equally likely to be consumed in a similar fashion.

The results of this study support the conjecture that the technology that distributes digital games is related to their method of consumption, but the nature of the present study does not support a causal link between that technology and the consumption tendencies. This was an exploratory study, and as such, it was limited in its scope and the conclusiveness of its findings should only be considered as suggestive. Given the results, however, more research into the online browser-based gaming phenomenon is certainly warranted. Topics might include:

- What is the role of gaming in the workplace? How, when, and why do workers fit these short play episodes into their day? What impact does it have on their productivity? What impact does it have on how they spend their leisure time?
- Are the people that play these games while at work different from other game players? Do they play at work because they are spending more time there?
- Are digital games just substitutes for alternative leisure activities, or are they displacing other, non-leisure activities as well?
- The data collected in this study came from a free online game - does paying for a browser-based game alter how it is consumed? Does that monetary expenditure lead to longer or more frequent consumption episodes (i.e. a motivated attempt to maximize utility)?

This paper collected some introductory statistics on the relationship between the technology involved in digital games and the consumption itself, suggesting a penetration of digital games into new times and spaces in our lives and daily routines. As Internet use continues to grow, and new technologies emerge to absorb our time, time use researchers are going to increasingly be called to examine this fluid and dynamic realm of human experience. This study has presented a methodology and case study of how such examinations might possibly be conducted.

Appendix

Overview of console- and browser-based games

The term "digital game" has come to refer to any type of computer-controlled game that players interact with and that (typically) uses a video display of some type as the primary feedback device. The term is being used by the burgeoning field of digital games studies as an umbrella term that encompasses many diverse types of games: arcade games, computer games, console games, mobile games, online games, etc. These varying forms of games have many differences which essentially distinguish them as individual mediums, rather than as one cohesive media. However, they all share a fundamental commonality: they are created, distributed, and consumed using digital technologies – hence the use of the catch-all term "digital games".

This study focuses on two different types of digital games that are easily distinguishable based on the differences in equipment needed to play a game: console-based games and browser-based games. Console gaming systems first emerged in the 1970's (Malliet & de Meyer, 2005), and typically consist of a small computer system designed specifically to play games that is connected to the user's television set and into which interchangeable game cartridge or compact discs are inserted. Popular examples include the Atari 2600, Nintendo® Entertainment System, Sony Playstation®, and Microsoft Xbox®. The base system (the computer hardware) typically costs in excess of US$100, and is required to play any games. Individual games are sold separately and are usually only playable on the console system for which they were designed (e.g. Xbox games can only be played using an Xbox console). Console-based games tend to have relatively advanced graphics and sophisticated game play. Traditionally, games for these systems are for one player or for two players only, and popular genres of games include racing, fighting, action, and sports.

Browser-based games, on the other hand, are played on a computer that has Internet access. There is no specific hardware required; any modern computer can be used to play these games. However, in order to play browser-based games, the computer must have access to the Internet and have the software necessary for browsing (e.g. Microsoft's Internet Explorer, which is generally included in every installation of the Windows operating system). Browser-based games are called "browser-based" because all of the software needed to play them is included in the browser. These games tend to use an advertising-based revenue model, wherein a game is provided free of charge to all players, with the understanding that they will have to endure occasional advertisements during the gameplay, typicallly in the form of a banner ad or an ad that appears while the player waits for the game to load. A player of such a game does not need to download or install any additional software in order to play. Games of this type tend to be very simple, easy to play, and have rather basic graphics. Many games are single player, but there are also multiplayer games in which anywhere from several players to hundreds of players are all interacting within the same gamespace. These multiplayer games are very different from the typical console-based game, in that a player can easily "pause" their participation in the game (by simply taking a break from their computer, or by actively leaving the game space by logging out) while the other players in the game space continue to play. The player can then return to the game later and find that the game space has changed due to the actions of the other players; console games typically do not have this feature – once the game is paused or turned off, all game play ceases until the player returns, or begins a new play episode. Puzzle and strategy games are popular single player genres, while roleplaying and card games are popular mutliplayer genres.

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electronic **International Journal of Time Use Research**
2008, Vol. 5, No. 1, 90-126.

Representative time use data and new harmonised calibration of the American Heritage Time Use Data (AHTUD) 1965-1999

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Abstract

Representative and reliable individual time use data, in connection with a proper set of socio-economic background variables, are essential elements for the empirical foundation and evaluation of existing and new theories in general and in particular for time use analyses. Within the international project Assessing Time Use Survey Datasets several potentially useful individual US time use heritage datasets have been identified for use in developing an historical series of non-market accounts. In order to evaluate the series of American Heritage Time Use Data (AHTUD) (1965, 1975, 1985, 1992-94, 1998-99) this paper analyses the representativeness of this data when using given weights and provides a new harmonised calibration of the AHTUD for sound time use analyses. Our calibration procedure with its ADJUST program package is theoretically founded on information theory, consistent with a simultaneous weighting including hierarchical data, ensures desired positive weights, and is well-suited and available for any time use data calibration of interest. We present the calibration approach and provide new harmonised weights for all AHTUD surveys based on a substantially driven calibration framework. To illustrate the various application possibilities of a calibration, we finally disentangle demographic vs. time use behavioural changes and developments by re-calibrating all five AHTUD surveys using 1965 population totals as a benchmark.

JEL-Codes: J22, J29, J11, Z0

Keywords: Representative time use data, calibration (adjustment re-weighting) of microdata, information theory, minimum information loss principle, American Heritage Time Use Data (AHTUD), ADJUST program package

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This paper is a part of the international project Assessing Time Use Survey Datasets supported by Yale University with Prof. Dr. Andrew S. Harvey (Project Head), Time Use Research Program (TURP), at St. Mary's University, Halifax, NS, Canada; Prof. Dr. Ignace Glorieux, Tempus Omnia Revelat (TOR), Faculty of Economic, Social and Political Sciences, Vrije Universiteit Brussel, Brussels, Belgium; Prof. Dr. Joachim Merz, Research Network on Time Use (RNTU), Research Institute on Professions (FFB), Department of Economics, Behavioural and Law Sciences, Leuphana University of Lüneburg, Lüneburg, Germany; and Klas Rydenstam, Statistics Sweden. This project is supported by Yale University and the Glaser Progress Foundation.

Many thanks to Diane Herz (Bureau of Labour Statistics, USA), and her colleagues for providing the CPS information and all their support. Besides our project partners we also wish to thank the participants of the IATUR 2005 Conference in Halifax for their helpful comments on an earlier version and Jonathan Gershuny and Kimberly Fisher from the Oxford Centre for Time Use Research for clarifying differences between our AHTUD and their further developments with the American Heritage Time Use Study (AHTUS).

1 Introduction

Representative and reliable individual time use data, in connection with a proper set of socio-economic background variables, are not only essential elements for the empirical foundation and evaluation of existing theories – in general and in particular for time use analyses – but also for the search for new empirical based hypotheses about individual behaviour in the household/ family context. Within the international project Assessing Time Use Survey Data-sets several potentially useful individual US time use heritage datasets have been identified for use in developing a historical series of non-market accounts. In order to evaluate the series of American Heritage Time Use Surveys (1965, 1975, 1985, 1992-94, 1998-99) this paper analyses the representativeness of this original data when using given weights and provides a new harmonised calibration of all five AHTUD files for sound time use analyses.

When using the given individual weights it will become evident that there will be a serious bias in all of these files concerning demographic population representation for characteristics which are of strategic importance for substantive time use research analyses. However, when using proper weights the enormously content rich diary data will be demographically representative. Our study provides such proper individual weights with a new harmonised AHTUD calibration which circumvents the biases by delivering adequate and comprehensive demographic calibration weights for all five incorporated US time use surveys as they were available for our project (further abbreviated as American Heritage Tine Use Data, AHTUD).

Our calibration procedure is theoretically founded on information theory (minimum information loss principle with its ADJUST program package), is consistent with a simultaneous weighting including hierarchical data (like personal and family/household data), ensures desired positive weights, and is well-suited and available for any time use data calibration of interest.

We present the calibration approach and provide new harmonised weights for all AHTUD surveys based on a substantially driven calibration framework for sound time use analyses. To illustrate the various application possibilities of a calibration, we finally disentangle demographic vs. time use behavioural changes and developments by re-calibrating all five AHTUD surveys using 1965 population totals as a benchmark.

This paper is divided as follows: We start with a brief description of the methodological background of our calibration procedure based on information theory, including a survey of alternative calibration procedures used by other surveys and microsimulation models (chapter 2). Particularities of time use diary adjustments are discussed in chapter 3 and a solution is shown – exemplified with the actual German Time Use Survey. In chapter 4, a substantively driven calibration framework for time use analyses is developed, sketching microeconomic labour supply of women within the household context, household production/ time allocation, multiple market and non-market analyses, as well as policy impacts of tax and transfer systems in the formal and informal economy. Chapter 5 provides the result of our new harmonised calibration of the five heritage files 1965, 1975, 1992-94, and 1998-99 and shows the former bias for important demographic characteristics when using the survey's given calibration weights which are erased by our new weightings. As an example for the various calibration possibilities we disentangle demographic vs. behavioural changes by re-calibrating in chapter 6 using the demographic totals from the earliest survey 1965 as the new demographic totals for all four younger files. We conclude with some recommendations for further time use analyses.

This study was undertaken as a part of an initial component of a larger project, launched in 2003, designed to identify historical American Time Use data and explore its potential for facilitating historical analysis in conjunction with the American Time Use Study launched the same year. The larger project was undertaken through the Time Use Research Program of Saint Mary's University for the "Yale Program on Nonmarket Accounts: A Project on Assessing Time Use Survey Datasets." Five historical datasets readily available when the project was launched, assembled as the American Historical Time Use Data Set (AHTUD) data set, provided the input to the analysis presented here. Subsequent work incorporating additional and improved data is now available as the American Heritage Time Use Study (AHTUS) data set developed by the Oxford Centre for Time Use Research[1]. They provide further edited respective data files, detailed documentation and further support when using the data files from their archive (www.timeuse.org/ahtus).

2 The adjustment/ calibration of microdata – theory, methods and ADJUST software

A calibration/ re-weighting of the AHTUD was necessary in particular for several reasons:

- First of all, we observed that the available AHTUD respective survey weights do not fit desired totals and thus show a substantial bias.

In addition, there are further requirements to be fulfilled for any sound time use analysis:

- Second, as far as we know, not all of the given weights of the different AHTUD files use an *inter*dependent calibration between different weighting characteristics. Thus, a consistent calibration, which simultaneously fulfils hierarchical information (e.g. household/ family and personal information), is not assured. It is necessary to remedy this.
- Third, due to the lack of documentation, it was not possible to get sufficient information about the respective calibration procedure and their relevant totals. In particular, it is not

[1] American Heritage Time Use Study, release 1 (May 2006). Created at the Centre for Time Use Research, United Kingdom, by Kimberly Fisher, Muriel Egerton and Jonathan Gershuny, with Nuno Torres and Andreas Pollmann, and contributions from Anne H. Gauthier and John Robinson. Created for Yale University with initial funding from the Glaser Progress Foundation and supplementary funding from the ESRC

obvious if the demographic information used consider substantial requirements, which are important for any sound time use research analysis. However, a theoretically founded and transparent adjustment procedure is needed and will be provided by our approach.

- Fourth, a comparable and harmonised demographic calibration scheme for all single heritage files is not available. However, such a scheme is desirable for identifying substantial time use behavioural changes over time, independent of further demographic developments.

Our new calibration will consider and fulfill the above requirements for the five AHTUD surveys. We will start with the calibration procedure itself, applying the content driven approach in the second step.

Adjustment need

To adjust/ calibrate microdata in general is to fit a sample (a survey) to prescribed and known aggregate totals (with synonyms such as control data, restrictions, margins, population totals). For each microunit of a (sample) microdata file a suitable weight is sought so that the weighted sum of all microunit characteristics will then sum up to their externally given aggregates. If a sample is totally random, representative data is easily achieved by multiplying each observation by its reciprocal value of the sampling proportion (e.g. by 100 for a 1% sample). However, due to quoted sampling, item and unit non-responses, collection and coding problems, merging problems, missing observations etc., almost all actual survey samples are ultimately not at random and need a proper re-weighting.

Adjustment components

There are three building blocks of an adjustment: the restrictions (totals) to be achieved ($\mathbf{r}$), the sample information matrix ($\mathbf{S}$), and the calibration theory and procedure itself.

The known population characteristics, derived e.g. from a census, provide the microdata frame as a vector $\mathbf{r}$ of the number of m *desired total values*. Appropriate aggregate statistics might deliver the single restrictions, which could be given as a multidimensional cross table. In general, the restrictions may originate from aggregate statistics, from other samples, or other models. In our application, the US Current Population Survey (CPS), an ongoing monthly household survey to provide demographic and labour force information, provides the totals to be achieved. Since the CPS is adjusted to the Census, the calibration will fit the Census data, too.

The *sample matrix S* consists of all microunits (number of n observations) of the sample such as persons, families, households, or firms which are described by the m various weighting characteristics of the survey participants. If, for example, these microunits are persons, they would be described by age, gender, employment and household/ family characteristics by household size, number of children etc.

The *calibration procedure* itself should incorporate available sampling information. To incorporate this sampling wisdom, the new weighting factors should be as near as possible to those prescribed weights. Formally speaking, *an objective function* should minimize the distance between the prescribed n weights $\mathbf{q}$ and the chosen new n weights $\mathbf{p}$ subject to achieving the desired totals $\mathbf{r}$.

Adjustment formal problem

Taking all three components together: the calibration problem is to find an n-vector $\mathbf{p}$ of calibration factors minimizing an objective function $Z(\mathbf{p}, \mathbf{q})$ – a function evaluating the distance between the new adjustment factors $\mathbf{p}$ to be computed and the available factors $\mathbf{q}$ – satisfying the m restrictions $\mathbf{r}$ when summing up the weighted characteristics.

(1) $Z(\mathbf{p}, \mathbf{q}) = \min!$ $\qquad s.t.\ \mathbf{Sp} = \mathbf{r}$

This adjustment problem is a simultaneous one where, for even a large number of characteristics (m), only a single weighting factor has to be computed for each microunit j (j=1,…,n) which after summing up, fulfills consistently all m hierarchical microdata totals (e.g. household, family and personal information) simultaneously.

The objective function minimizes the distance between new adjustment factors $\mathbf{p}$ and the given factors $\mathbf{q}$ in order to capture already available information and former corrections due to quoted sampling etc.[2] After calibration, a single absolute adjustment factor/weight for a sample microunit j represents pj total population microunits.

Alternative adjustment procedures

There are various procedures and functional forms in quantitative economics where an objective function $Z(\mathbf{p}, \mathbf{q})$ weights the distance of two (adjustment) factors. In general, procedures with quadratic (unweighted or weighted) and other objective functions (linear or nonlinear) are conceivable. Within the microsimulation context re-weighting is an essential tool: it is used as *static aging* to achieve an updated actual or future demographic structure (see e.g. Merz 1986).

A solution based on a quadratic and unweighted objective function is used within the German Sfb 3 microsimulation model by the former German SPES project and its successor, the Sonderforschungsbereich 3 (Sfb 3) 'Microanalytic Foundations of Social Policy' at the Universities of Frankfurt and Mannheim Germany (Galler, 1977; Galler and Wagner, 1986). Another example of an early US microsimulation model and its calibration is Hollenbeck 1976 who proposed a quadratic weighted objective function[3] for the adjustment of the microsimulation models of Mathematica Policy Research, Inc. (MPR) and The Policy Research Group, Inc.

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2 If such corrections are not given in advance (or as a simple microunit independent sampling ratio), q_j would be equal for each microunit j (j=1,...,n).

3 Different algorithms may solve a quadratic objective function within a quadraric programming approach, e.g. by Frank and Wolfe (1956), Hildreth (1957) or Houthakker (1960). These procedures often used in operations research, however, become relatively inconvenient for large adjustment problems, particularly for those with many microunits and many characteristics. A constrained quadratic loss function is also used for instance by Stone (1976) and extended by Byron (1978) in an input/output context to estimate large social account matrices.

A multivariate raking ratio estimator is used by Oh and Scheuren 1980 in their 1973 exact match study to fit several types of sample units (design, analysis and estimation units) (see their bibliography on raking) and in the Simulated Tax and Transfer System (STATS) US microsimulation model (Bridges and Johnston, 1976). The raking ratio estimation, reaching back to Deming and Stephan 1940, uses proportional factors in each iteration to fit the marginals of a multi-way table (see also 'iterative proportional fitting' in Bishop and Fienberg, 1975; and the log linear approach within contingency tables in Mosteller, 1968). The proportional iterative fitting approach shows similar results to our entropy approach. For a further handling of different approaches, like algorithms connected with input/output tables and procedures, see Wauschkuhn (1982) and Merz (1986, Chapt. 7). For further calibration estimation approaches in survey sampling see Deville and Särndal (1992). Särndal and Lundström (2005) and Estevao and Särndal (2006) more recently discussed the estimation in surveys with nonresponse respectively with complex auxiliary information. In contrast to these approaches, Merz (1983b) proposed a Kalman filtering procedure and optimal control theory for the adjustment/calibration task.

Different calibration software packages were recently developed by several statistical offices. CALMAR developed by INSEE (Le Guennec and Sautory, 2003) is a program macro within SAS following a proportional fitting approach, which e.g. is used within the NATSEM microsimulation models in Canberra (Australia). G-Calib 2 has been developed in the SPSS language by Statistics Belgium (Vanderhoeft, 2002). Bascula 4.0 is a development in the Delphi language by Statistics Netherlands (Nieuwenbroek and Boonstra, 2002) and can be used with Blaise. All the forgoing need a host program package and are not available standalone like our calibration package ADJUST discussed below.

Only in the ideal case of a real random sample can the well known Horvitz-Thompson estimator be easily applied as the inverse of the sampling ratio for all microunits.

Our adjustment solution: the adjustment of microdata by the Minimum Information Loss (MIL) principle

As seen above, there are many approaches to weight a sample. However, those procedures may produce negative or zero adjustment factors as within the quadratic approach. In addition, most of them are based on an arbitrarily chosen objective function to be minimized. Since non positive weights will further exclude microunits, only a procedure such as the following which provides only positive weights is appropriate. Another already mentioned prerequisite is to simultaneously take care of adequate weights according to personal and family/household characteristics in a hierarchical setting. Separate personal and household weights, as often used in survey weighting, does not ensure the simultaneous fit to the aggregate personal or household data.

In recent decades, information theory - well known in engineering sciences - has found some applications in economics. Theil's 1967 'information inaccuracy' is used, for instance, to judge the forecasting accuracy of econometric models (Merz, 1980). Measuring income inequality by an approach based on information theory is another example (Theil, 1972). More recently, the minimum information approach was used to estimate microeconomic allocation models (Theil, Finke and Flood, 1984; Finke and Theil, 1984).

Within information theory an extension of the entropy concept is the *information loss* (or gain) when a multinomial distribution $\mathbf{q} = (q_1,...,q_n)'$ is substituted by a similar distribution $\mathbf{p} = (p_1,...,p_n)'$

(2) $$I(\mathbf{p}:\mathbf{q}) = \sum_j p_j \log(1/q_j) - \sum_j p_j \log(1/p_j) = \sum_j p_j \log(p_j/q_j),$$

with $(p_j, q_j > 0),\ \sum_j p_j = \sum_j p_j = 1 \quad (j = 1,...,n).$

Within this concept, the information loss is evaluated as the expected information before, weighted by q_j, minus the expected information after substitution. For an axiomatic derivation of the connected maximum entropy principle or principle of minimum cross-entropy, see Shore and Johnson (1980), and Jaynes (1957) who first proposed entropy maximisation within engineering purposes.

With reference to the above information theory concept, the adjustment problem under the Minimum Information Loss (MIL) principle then is to minimize the objective function

(3a) $$Z(\mathbf{p},\mathbf{q}) = \min_{\mathbf{p}} \{\sum_j p_j \log(p_j / q_j)\}$$

(3b) $$s.t.\ \mathbf{Sp} = \mathbf{r}.$$

where p_j = new adjustment factor for a microunit (e.g. household) j (j=l,...,n); q_j = known adjustment factor for each microunit j, n=number of microunits, with $\mathbf{S}_{(m,n)} = [s_{ij}]$ sample information matrix (i=1,...,m; j=1,...,n), $\mathbf{r}_{(m)} = [r_i]$ vector of restrictions, m=number of restrictions. The MIL-objective function minimization subject to the simultaneous set of possible hierarchical restrictions fulfills the two main requirements of positive weights and simultaneous consideration of hierarchical data.

This adjustment problem yields a highly non-linear equation system out of the restricted Lagrangean approach. After solving for the m Lagrange multipliers λ_k (k=1,...,m) iteratively the new adjustment factors with the solution $\boldsymbol{\lambda}$ are given by

(4) $$p_j = \exp(\boldsymbol{\lambda}'\mathbf{s}^j - 1)$$

Once the non-linear equation system is solved, the new adjustment factors can be calculated relatively simply: the single given adjustment factor q_j is multiplied by a term which is determined by a linear combination of the respective microunit (e.g. household and personal) weighting characteristics ($\mathbf{s}^j$) and the Lagrange multipliers.[4] For a further in-depth discussion see Merz (1983a, 1985, 1994) and Merz and Stolze (2007).

Multiple usages of re-weighting a sample

The calibration of microdata can be used not only to adjust a specific sample to its totals given from another database. There are more and multiple usages of a re-weighting procedure such as for

- Achieving representative results for a given sample and its population
  - Descriptive microanalyses
  - Microeconometrics: weighted estimation
- Sensitivity analyses with alternative artificial totals and respective weightings
- Extrapolating/forecasting samples for an actual demographic situation
- Microsimulation context: static ageing (forecasting by re-weighting), weighting of simulation files

ADJUST software package

Our stand-alone program package ADJUST based on the MIL-principle fulfills the above requirements in an efficient manner for unlimited sample sizes using specific iteration dependent step lengths within a modified Newton-Raphson procedure (Merz and Stolze, 2007). ADJUST has been proven to be successful in many applications: e.g. for the adjustment of the recent German Time Budget Surveys, the Income and Consumption Survey and other surveys of the German Statistical Office or for a refined adjustment of the German Socio-Economic Panel; within the framework of a microsimulation analysis of financial and distributional impacts of the German Pension Reform; for a consistent adjustment for the microsimulation analysis of time allocation impacts in the formal and informal economy of the recent German tax reform. In addition, ADJUST has been successfully used in many academic, government and private enterprises and consulting firm applications. ADJUST is available via http://ffb.uni-lueneburg.de/adjust.

3 Choosing a content driven calibration framework for time use analyses

To increase the representativeness of a sample with respect to a content driven time use analysis a calibration should incorporate basic demographic variables which are connected with the time use question of interest. Certainly, it is not the final resulting variable which is

4 Usually the above adjustment factors are not formulated as probabilities respectively relative frequencies but rather in absolute terms. The absolute adjustment problem yields the same solution as in the relative case and is only different according to the interpretation with $p_j = p_jN$, $q_j = qN$ and $r_i = r_i N$ (N = number of all microunits in the total population).

calibrated, but its proper socio-demographic background. One example: To investigate time use patterns within the context of different household types (like household with and without children, single parents etc.), the demographic distribution of those household types should be representative (and be calibrated) for further specific household time use analyses of interest.

Dimensions of a content driven calibration framework

The aim is to find a calibration framework which allows valid demographic data to analyse time use behaviour based on different theoretical socioeconomic approaches. To find such a calibration kernel, we briefly discuss the importance, necessity and application of time use information in explaining behaviour for theoretically based empirical economic and social research, as well as for a targeted economic and social policy.

As a basis, we sketch the economic framework of activity linked time dimensions: the optimal allocation of goods and time with constrained goods and time resources. Within this framework, the microeconomic allocation model, the optimal labour supply, and the household production approach for a model of multiple market and non-market activities is of central importance. Individual time use data, in connection with a proper set of background variables, are essential for an empirical foundation and an evaluation of those theories ('new home economics'), as well as in the search for new empirical based hypotheses about individual behaviour in the household context.

Genuine applications of time budget data with appropriate background variables include:

- Labour supply of women within the household context – microeconomic analyses
- Household production/time allocation
- Multiple market and non-market time use activities – socioeconomic analyses
- Policy impacts of the tax and transfer system – time allocation effects in the formal and informal economy by microsimulation modeling.

These examples and central time use research areas will illustrate the need for and the spread of appropriate background variables and demographic calibration requirements.

3.1 Labour supply of women within the household context – the microeconomic approach

Within the well known microeconomic allocation model, an individual/household is maximising his/her/its utility based on the amounts of goods. Facing a restricted income, utility maximisation under the money constraint yields an optimal allocation of goods in a static or an intertemporal approach. Based on this microeconomic allocation model, the individual's paid working hours (labour supply) are incorporated into the preference optimization model via leisure (full time minus leisure determines the working hours). Thus, total time is divided into consumption time (leisure) and time for paid work to earn income. Then, maximising utility as a function of the market goods amounts and the consumption time subject to full income (all expenditures plus wage weighted consumption time equals non-labour income and wage weighted total time) yields the optimal allocation equations for the goods amounts as well for the working hours (labour supply).

Already within this classical approach socio-economic background variables are necessary to determine

- individual utility function dependent of the socioeconomic status
- individual wage, including the potential wage of nonworkers, which has been econometrically estimated by human capital and other socioeconomic variables
- non-labour income dependent of the socioeconomic status
- hours of paid work.

Within the last decade, empirically based labour supply research using advanced econometric methods has proven the importance not only of time use itself in paid work, but also the need for proper socioeconomic background variables with regard to the mentioned four microeconomic dimensions.

One very important research area is the increased labour market engagement of women, where the household context in particular (children, need for care, family dependent labour force participation) is important. In all the applications, either the household itself is seen as the economic agent or its members are the agents who might bargain about the consumption and time allocation decision [useful early literature includes the survey concerning labour supply by Killingsworth, 1983; concerning female labour supply by Killingsworth and Heckmann, 1986, Chiappori 1988; more recently Chiappori, Blundell, Magnac and Meghir 2007 as well as recent issues in scientific journals (e.g. Journal of Labour Economics)].

In brief: personal (adults and children) as well household demographics have to be representative for further analyses following this strand of time use research.

3.2 Household production/time allocation

With the 'new home economics' since the Nobel prize winner Becker (1965), and Lancaster (1966), Muth (1966), and Ironmonger (1972), the above mentioned microeconomic approach has been broadened by household production and the connected time allocation. The utility function is now based on the basic commodities which are produced by the household with its input of non-market time and market goods. Such commodities can be defined broadly (e.g. childcare, homework, and do-it-yourself work). Shadow prices can be assigned for the basic commodities via the dual approach, which have no market price per se. Dependent of the household technology, the shadow prices are dependent or independent of the household production output amount (Merz, 1989).

Within this approach, the optimal allocation problem is solved in three steps:

- Modeling the efficient household technology (duality between production and cost function)

- Modeling and calculation of the shadow price (price of the basic commodities, duality of cost function, and valued production)
- Utility maximised allocation with regard to output (with shadow prices) or with regard to input (with explicit functionalised market goods and the necessary time for the production).

In all three steps, an empirical sound model needs the appropriate personal and household sociodemographic background variables in addition to its specific further information.

3.3 Multiple market and non-market time use activities – socio-economic analyses

To explain and estimate a proper household production function with different commodities, different time inputs and their dependencies on the socioeconomic background are necessary. If this approach is expanded by multiple paid market activities (multiple labour supply) – possibly including tax and transfers – then a full multiple market and non-market time use activity model can be formulated which will overcome the traditional one-sided focus on paid work alone.

The theoretical modeling approach allows for the formulation of the impacts of changing model parameters (like the income and substitution effects of a price/wage change). However, only an empirically based estimation and explanation with proven socioeconomic hypotheses will finally quantify these effects and decide, for example, whether the income or the substitution effect will be dominant – an important result about incentives in explaining e.g. the final labour supply (see e.g. Merz, 1990).

To do this, detailed time use information on multiple activities is necessary. However, again, representative individual personal and household demographics are essential for a sound empirically based result.

3.4 Policy impacts of the tax and transfer system – time allocation effects on the formal and informal economy by microsimulation modeling

Explaining behaviour is the basis for a targeted economic and social policy. To analyse policy impacts of a tax and transfer system the microsimulation approach has been proven as a well suited instrument for such impact analyses on an individual/family/household level (Mitton, Sutherland and Weeks, 2000; Citro and Hanushek, 1999a,b; Harding ,1996; Merz, 1991a; Orcutt, Merz and Quinke, 1986).

In contrast to microsimulation analyses of typical cases, representative microsimulation approaches rely on representative samples. Microsimulation approaches based on representative samples with time use focus on market and non-market activities were used for instance by Merz (1996a) or Merz (1991b) and Merz and Wolff (1993) for German tax reform impacts on the formal and informal economy or Flood (1988) for Swedish tax reform impacts. Questions concerning incentives of a tax reform via changing time used for paid work within such a microsimulation frame need a solid demographic background of persons and households.

To summarise: for testing given time use models, finding new explanations and policy impact analyses of individual time use behaviour within the household/family context – based either on a microeconomic or further psychological, sociological etc. theory – appropriate sociodemographics are an ultimate requirement. To fulfill this requirement, the calibration procedure has to incorporate the discussed personal and household/family information to ensure a valid demographic frame which forms the basis for substantial research and content driven analyses.

4 The calibration of time use diary days

Time use diaries provide their information over one or more days. It is expected that one will observe different time use patterns on different days of a week, a month, a year etc. (like summer vs. winter, workdays vs. weekends, public holidays or not etc.). Usually time use diaries are asked for two or three days in principle by a random procedure to cover all days over a week and year. However and again, due to unit non-response/missing data, sampling failures etc. almost every time the final available sample is not an ideal random sample with respect to all periods/day types considered.

Thus, in addition to the demographic structure, the proper distribution of diary days itself (e.g. days over the week, weekend or the season of the survey) has to be considered in a calibration procedure as well.

For example, if we have a survey with two diary days of the respondents, the following daily adjustments could be used: 8/7th for normal workdays [Monday thru Thursday], 2/7th Fridays, 2/7th Saturdays and 2/7th Sundays adding up to 14/7th or 2 days.

These adjustment factors are similar to economic multipliers/inflators used in microsimulation modeling, which in principle could be used before, within, or after a simultaneous demographic re-weighting. If it is used before, then the previous given demographic adjustment factors are altered and the altered factors are part of the simultaneous approach, but only via the old weights in the distance function. If it is used after a simultaneous re-weighting, the direct interdependencies are lost. We therefore prefer to incorporate the diary days directly within the simultaneous re-weighting by catching the socio-economic *and* daily interdependencies in a comprehensive way.

5 Assessing and new calibration of the American Heritage Time Use Data (AHTUD)

The collection of time use data has been recently spurred by the desire to obtain data necessary for understanding the full productive inputs and outputs of societies. However, the validity, reliability and comparability dimensions of these data have only sporadically been addressed. As mentioned, valid and reliable individual time use data, in connection with a proper set of background variables, are essential elements of an empirical foundation and evaluation of existing theories, and for the search of new empirical-based hypotheses about individual time use behaviour in the household context .

Our international project *Assessing Time Use Survey Datasets* is an examination of critical aspects of the time-diary variables, codes, and background demographic data required to provide inputs to a non-market household account. Within this project several potentially useful individual US time use heritage datasets were identified for use in developing a historical series of non-market accounts (St. Croix and Harvey, 2005).[5] In order to evaluate the series of American Heritage Time Use Studies (AHTUD) (1965, 1975, 1985, 1992-94, 1998-99) the following analyses investigates the representativeness of this data and provides a new harmonised calibration for sound time use analyses.

American Heritage Time Use Data

The following studies were identified and are the subject of the present investigation:

- 1965: Multi-national study: United States
  Robinson, J.P. (1977), How Americans used time in 1965, Institute for Social Research, University of Michigan, Ann Arbor, Michigan
- 1975: Time use in economic and social accounts, 1975-1976: United States
  Juster, T.F., Hill, M.S., Stafford, F.P. and J. Eccles Parsons (1983). 1975-1981 Time Use Longitudinal Panel Study, Survey Research Center, Institute for Social Research, University of Michigan, Ann Arbor, Michigan
- 1985: Americans' use of time
  Robinson, J.P. (1985), Americans' use of time, Survey Research Center, College Park, MD: University of Maryland,
  1985c: Americans' use of time
  as above but created from mail episodes (see St. Croix and Harvey, 2005)
- 1992: EPA time use survey, 1992-1994: United States
  Triplett, T. (1995), Data collection methods report for estimating exposure to pollutants

5 For further data work on the American Heritage Time Use surveys and the resulting edited files see the mentioned activities of the Centre for Time Use Research (CTUS) at the University of Oxford and their American Heritage Time Use Study (AHTUS) at www.timeuse.org/ahtus.

through human activity pattern data, A national micro-behavioural approach, Survey Research Center, College Park, MD: University of Maryland

- 1998: Family interaction, social capital, and trends in time use, 1998-1999: United States Robinson, J.P., Bianchi, S.M.and S. Presser (1999), Family interaction, social capital, and trends in time use, 1998-1999, Survey Research Center, College Park, MD: University of Maryland

Details of each survey are listed in the Table 1. A comprehensive description and evaluation of these American time use studies is given in St. Croix and Harvey (2005).

Time use theory based and harmonised calibration for all AHTUD files

As our further results will show, the existing calibration within each separate AHTUD file delivers seriously biased calibration results. The developing of a new AHTUD calibration will improve subsequent research for four major reasons:

First, for substantial analyses it is important that fundamental socio-demographic variables meet the given aggregates of reliable demographic data such as the current population survey (CPS) or the Intercensal Population Estimates of the U.S. Census Bureau; thus, the existing calibration bias in each AHTUD has to be erased.

Second, for longitudinal comprehensive time use analyses with the entire set of AHTUD files it is important to have a harmonised calibration approach of each AHTUD file, both, with respect to the content of the aggregates to be achieved and the calibration procedure itself. Working with harmonised calibrated data will allow sensitivity analyses and disentangling demographic changes vs. time use behaviour changes.

Third, because of a non-random distribution of time use data itself (like diary days within a week) an appropriate calibration is required.

Fourth and overall, the new harmonised AHTUD calibration will be content driven, providing sound and representative further substantive analyses of individual time use behaviour.

Aggregate characteristics for the AHTUD files

Our selection of calibration variables and respective aggregates to be achieved follows the above discussed dimensions and requirements by considering the relevant U.S. population, the content driven socio-demographic background with personal and household/family characteristics and sampling features concerning the diary date distribution.

The sample size and the nature of each calibration algorithm limit the amount of multiple restrictions given limited number of observations in respective subgroups and the larger factor variance arising from many restrictions.

Last but not least, the data has to be available (and in a similar manner) in the sample files as well as in the CPS-files (providing totals) for all of the specified years. When dealing with five samples simultaneously, the selection of the optimal set of restrictions is difficult and may vary from one which would have been chosen for a single calibration. Finding a compromise among the desired detail of restrictions, practical requirements, and the availability of data in all sample-files is a challenging task.

Considering the mentioned limitations and eligible structural variables in the AHTUD files available for an adjustment to CPS key data, the following calibration/adjustment characteristics were chosen:

- Age (5-year-classes) crossed by gender
- Educational attainment
- Occupational status (full time/part time/unemployed, self-employed)
- Marital status (single/married/divorced/widowed)
- Number of children (below 18 years of age) living in household
- Day of the week (for a representative distribution of diary days)

These adjustment characteristics are the core of and in line with many other international time use calibration aggregates like the Dutch Time Use Study from 1997 (CBS, 1999)[6], the UK Time Use Study 2001,[7] or the German Time Use Survey 2001/2002 (Ehling and Bieber, 2003).[8] For a further discussion of appropriate adjustment characteristics also see Harvey, Elliott and Procos (1977).

The intercensal population estimates of the US Census Bureau[9] provides the population totals. Due to the size and structure of the sample, classes with a width of five years were used. As the samples do not cover persons younger than 18 years, the first age class represents only persons of 18 and 19 years. The educational attainment is available via the "school attainment" variable[10] in the current population survey. However, only people over 25 years of age are represented in these statistics, which must be considered when building the microdata-matrix from the AHTUD files. The occupational status can be covered with data from the Bureau of Labour Statistics[11] surveyed in the CPS. Unfortunately, the time series started three years too late, with the year 1968, so for the 1965 time use survey aggregate data of 1968 must be used.

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6 With calibration totals sex by age, marital status, social position, degree of urbanization, household composition, and that the day of the week occurs regularly often (Dutch Time Use Study 1997).

7 With two sets of population controls: age group [8-11, 12-15, 16-19, 20 (5) -74, 75 and over] by gender, and Government Office Regions plus Scotland, Wales, Northern Ireland.

8 With age by sex, social status, occupation by sex, household size, household type, community type, where all items are respective to the regional division by the 16 Bundesländer. Additionally the type of weekdays is considered.

9 U.S. Census Bureau. (n.d.a).; U.S. Census Bureau. (n.d.b); U.S. Census Bureau. (n.d.c).

10 U.S. Census Bureau. (2005).

11 The tables are created with the LABSTAT- Database using following codes: LNU02500000, LNU02600000, LNU05000000.

To build the aggregates for the marital status, Labstat data was used[12] again. The labour statistics only include people older than 16 years of age, but this restriction will not affect the aggregates for occupational-status or marital-status, and the AHTUD files do not include respondents younger than 16 years. The number of children living in the household corresponds to the information on “living arrangements of children under 18 years” provided by the CPS.[13] In this case as well, there was no information available for 1965, so numbers of 1968 had to be used.

To enhance the structural data by a representative distribution of diary days, the days of the week were taken into account. As public holidays[14] (see Appendix Table 1) will affect the time use-behaviour of the respondents, these were counted in a class together with the Sundays. Calibrating days, the aggregate to be achieved for a certain year is given by weekday margin = ((number of weekdays)/365)*total population size (N) and similar for Sundays and public holidays as sunday/public holiday margin = ((number of Sundays or public holidays)/365)*total population size (N). Appendix Table A2 for every year provides the number of weekdays and Sundays/public holidays only. To avoid linear dependency, one weekday – without loss of generality - has to be neglected. This reference is Saturday.

Table 2 finally shows all aggregates (restrictions) to be achieved for all five AHTUD files. The Appendix Table A2 connects these totals with the respective variables of the five AHTUD files.

Results: New harmonised calibration of the AHTUD files

The calibration procedure itself was computed with our software package ADJUST version 1.1.8, developed at the Research Institute on Professions (FFB) at the Leuphana University of Lüneburg, Germany (http://ffb.uni-lueneburg.de/adjust). Based on the above harmonised calibration characteristics of Tables 2 and A2 describing the restrictions (vector r with m=36 simultaneous characteristics) and the sample matrix S) the calibration based on the Minimum Information Loss (MIL) Principle finally provides the single adjustment weights for each microunit and for each AHTUD file.

As the restriction characteristics age and gender are exhaustive, one characteristic of each category had to be left out respectively to avoid linear dependencies. Unfortunately, no data on the marital status was collected in the 1992-94 survey, so this category could not be included in the calibration for that year. Whenever possible, available weights were used to initialise the calibration procedure. These former weights all summed up only to its sample size and have to be multiplied by a constant factor for the final overall population size.

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[12] For the years ’65 to ’85: EmplymtStatus by_Maritalstatus.pdf Bureau of Labour Statistics; Labour Force Statistics Derived from the Current Population Survey, 1948-87; Bulletin 2307; August 1988; for the years after 1992-1998 the LABSTAT-Database with following codes: LNU000149, LNU000314, LNU000150, LNU000315, LNU000151, LNU000316.

[13] U.S. Census Bureau. (2004).

[14] U.S. Code Title 5, part II, Subpart E, Chapter 61, Subchapter I, §6103.

Since only valid cases of entire availablilty can be used for the calibration, some cases could not be included in the calibration due to missing values. However, as our categories were selected carefully, only small numbers of those cases occurred in the different studies. In the 1965 data set, 2,014 valid cases were used for the calibration, and only 7 cases with missing values had to be dropped. In the 1975 data set, there were no missing values and all 2,406 cases could be used for the calibration. For the survey 10 years later, in 1985, 4,467 valid and 473 missing cases occurred. In the 1992-94 file 7,297 valid cases can be found and 217 missing. In the 1998-99 time use data file 1,142 valid and 9 missing cases were listed.

In addition to the missing cases, in two calibration procedures (for 1975 and 1998), restriction number 34 (College Graduate) had to be removed due to linear dependencies. For those two files the mentioned restriction was taken into the reference group of the category ‘school attainment’, as otherwise linear dependency would be given. The remaining characteristics are available for all five AHTUD files.

The 1975 file contains information about four waves of spouse’s and respondent’s time use. Our calibration considers the respondents and spouses both as individuals with a proper demographic representation, even the household characteristics (e.g. the number of children are respected properly). For comparison reasons we only calibrate wave one with correct diary days’ full year distribution. However, if all four waves together will be investigated, then the demographic adjustment out of wave one has to be adjusted by maximal[15] four times having the same person. Then, in addition, the calibration of the days of the week for a representative distribution of diary days from all four waves must be re-computed.

As the starting weights provided by the original heritage files reflect the possible quotas of the different sub samples and – as mentioned – sum up only to its sample size, we multiplied them by a constant factor to achieve the population size. These multiplied weights – further called old weights - are used to build the sample aggregates of the five heritage files before our new calibration.

Table 3 shows the differences of the respective actual population size to the aggregates before the new calibration of the five heritage files from 1965, 1975, 1985, 1992-94, 1998-99. The single differences are the relative deviation of the aggregates using the former (old) weights compared to the CPS population to be achieved. A negative value, say -15%, indicates an under-representation by 15% compared to the actual respective US population size when using the former weights. The respective under-representation or over-representation totally vanishes with our new calibration weights.

[15] Missing values will yield less than four waves’ information.

Table 1
American Heritage Time Use Data (AHTUD) under investigation

	United States, 1965-66	United States, 1975-76 (Wave 1)	United States, 1985	United States, 1992-94 EPA	United States, 1998-99
Sampling unit	Individual	Individual and spouse	Individual and household	Individual	Individual
Population not in sampling frame	Families where all members worked as farmers, residents of Hawaii and Alaska	Institutional population	Institutional population, households without telephones	Persons not living in private residences	Institutional population, households without telephones
Number of respondents	2,021 persons	2,406 persons (1,346 completed all four diaries)	4,940 persons (5,358 if diaries for individuals aged 12-17 are included)	9,386 persons (7,514 adults)	1,151 persons
Age of respondent	19 to 65 years of age	18+	12+	Any age	18+
Response rate	82% for Jackson sample; 74% for all other cities	72% responded to initial request; 44.9% completed all four diaries	51% mail-backs (3,340), 67% telephone interviews (1,210), 60% face to face interviews (808), 55.2% overall	63%	56%

Source: St. Croix and Harvey 2005.

Table 2
Aggregates to be achieved for the different AHTUD files

Category	Restriction number	Description	**1965**	**1975**	**1985**	**1993**	**1998**
Male # age	01	male, age 18-19	3.804.236	4.232.884	3.841.017	3.570.727	4.053.326
	02	male, age 20-24	6.899.289	9.838.857	10.670.549	9.506.702	9.040.112
	03	male, age 25-30	5.612.436	8.617.480	10.887.657	9.718.386	9.202.990
	04	male, age 31-34	5.517.566	7.017.543	10.019.185	11.069.951	9.922.383
	05	male, age 35-39	5.898.942	5.702.224	8.797.913	10.779.896	11.253.107
	06	male, age 40-44	6.058.104	5.496.967	6.964.647	9.550.162	10.886.210
	07	male, age 45-49	5.552.528	5.712.160	5.699.630	7.907.584	9.312.659
	08	male, age 50-54	5.101.484	5.737.247	5.253.668	6.274.160	7.734.322
	09	male, age 55-59	4.582.681	5.047.753	5.320.599	5.153.959	6.040.932
	10	male, age 60-64	3.583.081	4.368.044	5.053.423	4.781.116	4.884.251
	11	male, age 65-69	2.972.192	3.596.151	4.206.036	4.508.024	4.375.310
	12	male, age 70+	5.041.923	5.669.334	7.259.226	8.867.436	9.858.514
Female # age	13	female, age 18-19	3.672.040	4.063.067	3.730.063	3.401.195	3.852.206
	14	female, age 20-24	6.847.150	9.687.979	10.477.262	9.195.636	8.720.108
	15	female, age 25-30	5.727.774	8.662.876	10.854.516	9.698.740	9.295.932
	16	female, age 31-34	5.607.221	7.173.363	10.148.768	11.158.397	10.096.947
	17	female, age 35-39	6.121.742	5.931.446	9.041.560	10.909.318	11.364.160
	18	female, age 40-44	6.368.258	5.700.193	7.220.447	9.790.668	11.086.204
	19	female, age 45-49	5.827.607	6.072.202	5.959.224	8.205.987	9.668.866
	20	female, age 50-54	5.357.560	6.235.032	5.615.061	6.633.198	8.167.797

Table 2 (cont.)
Aggregates to be achieved for the different AHTUD files

Category	Restriction number	Description	**1965**	**1975**	**1985**	**1993**	**1998**
Female # age	21	female, age 55-59	4.922.336	5.598.004	5.889.797	5.598.891	6.539.782
	22	female, age 60-64	3.988.792	5.031.207	5.849.526	5.404.942	5.455.166
	23	female, age 65-69	3.578.099	4.536.199	5.189.190	5.501.735	5.171.407
	24	female, age 70+	6.859.179	8.894.611	11.937.666	14.076.548	15.040.033
Children	25	children < 18 years in HH	68.362.000*	64.317.000	60.784.000	65.053.000	68.419.000
Marital status	26	married	84.734.000	96.222.000	102.217.000	109.196.000	112.552.000
	27	single (never married)	31.945.000	33.682.000	44.042.000	49.334.000	53.939.000
Occupational status	28	full-time employed	65.216.000*	72.393.000	89.201.000	99.698.000	108.770.000
	29	part-time employed	11.148.000*	14.767.000	19.226.000	21.691.000	23.655.000
Educational attainment	30	none/ only elementary	34.045.000	25.545.000	19.893.000	15.127.000	12.782.000
	31	some high school	18.617.000	18.237.000	17.553.000	17.067.000	16.776.000
	32	high school grad.	31.703.000	42.353.000	54.866.000	57.589.000	58.174.000
	33	some college	9.139.000	14.518.000	23.405.000	37.451.000	42.506.000
	34	college grad. or more	9.742.000	16.244.000	27.808.000	35.590.000	41.973.000
Weekday	35	normal working day**	199	200	199	200	201
	36	Sunday or public holiday**	62	62	62	62	62

Data available for 1968 only. ** Occurrences as in the specified year. For calibration the person-days in the U.S. population represented by the sample will be used instead.
Source: Various US CPS information (see text); own arrangement.

Table 3
Calibration situation before the new harmonised calibration: Differences to the actual aggregates

Category	Restr. no.	Description	Differences to actual aggregates [%]					
			1965	1975	1985	1985c	1993	1998
Male # age	01	male, age 18-19	-69.9	-59.2	-19.4	-31.6	-72.5	-46.9
	02	male, age 20-24	25.8	-22.4	-7.4	-19.7	-73.2	-14.6
	03	male, age 25-30	31.3	-8.7	-14.8	-9.8	-59.4	22.8
	04	male, age 31-34	-14.2	-4.1	-6.1	-8.2	-59.8	2.5
	05	male, age 35-39	4.7	23.1	-8.4	4.5	-50.0	-12.2
	06	male, age 40-44	18.5	15.2	-6.2	-12.0	-36.3	-10.6
	07	male, age 45-49	17.1	-18.8	-19.5	-4.5	19.8	9.9
	08	male, age 50-54	11.7	-12.2	1.5	2.4	45.5	-3.4
	09	male, age 55-59	0.5	5.6	-10.3	-9.4	88.9	-7.3
	10	male, age 60-64	5.7	-20.3	8.8	-9.6	126.2	-1.0
	11	male, age 65-69	-67.7	37.5	-1.8	-6.3	110.6	28.3
	12	male, age 70+	-87.1	-31.8	30.5	53.4	25.3	-36.0
Female # age	13	female, age 18-19	-30.2	-9.2	-4.5	-1.0	-65.3	31.8
	14	female, age 20-24	43.0	-15.6	-5.8	-11.6	-50.8	-13.5
	15	female, age 25-30	17.8	4.3	-6.9	0.3	-48.0	-2.8
	16	female, age 31-34	29.8	10.0	13.9	3.6	-52.5	10.6
	17	female, age 35-39	15.5	15.1	16.2	13.5	-46.3	-1.6
	18	female, age 40-44	31.8	-4.6	-10.4	1.4	-14.1	18.4
	19	female, age 45-49	16.7	-8.8	14.6	18.6	17.4	-7.8
	20	female, age 50-54	30.7	-12.8	-1.6	7.0	74.1	-19.8
	21	female, age 55-59	13.0	-14.1	31.0	5.2	146.2	-13.4
	22	female, age 60-64	-2.4	7.9	-6.6	-9.1	143.6	-2.2
	23	female, age 65-69	-68.7	-0.1	-5.9	-19.2	100.1	-26.1
	24	female, age 70+	-86.7	-31.6	40.9	20.0	-18.2	-17.5
Children	25	children < 18 in HH	150.1	148.0	89.4	75.1	127.9	156.2
Marital status	26	married	9.8	18.0	7.4	8.5	n/a	6.5
	27	single (never married)	-36.6	-58.1	-23.9	-18.5	n/a	-30.6
Occupational status	28	full-time employed	13.5	7.9	22.8	4.0	9.3	9.3
	29	part-time employed	-40.2	-26.3	4.8	-12.8	-0.7	-6.4

Table 3 (cont.)
Calibration situation before the new harmonised calibration: Differences to the actual aggregates

Category	Restr. no.	Description	Differences to actual aggregates [%]					
			1965	1975	1985	1985c	1993	1998
Educational attainment	30	none/ only elementary	-19.5	-14.7	1.4	-42.8	-76.6	-27.8
	31	some high school	8.8	-0.4	4.5	-21.9	-28.0	4.4
	32	high school grad.	11.5	2.1	6.7	13.0	10.2	-2.6
	33	some college	-16.6	-6.3	-1.7	0.8	18.2	0.4
	34	college grad. or more	-33.9	n/a	-39.2	-15.2	41.9	n/a
Weekday	35	normal working day	2.0	9.3	5.5	7.1	6.6	2.1
	36	Sunday or public holiday	-18.5	11.5	-7.4	-33.6	14.9	-11.8
n			2014	2406	4560	2811	7297	1142

Note, for 1985 there were two files: 1985: Americans' Use of Time, Robinson, John P. (1985), 1985c: Americans' Use of Time but created from mail episodes (St. Croix and Harvey 2005).
Source: American Heritage Time Use Survey (AHTUD) files, own computations.

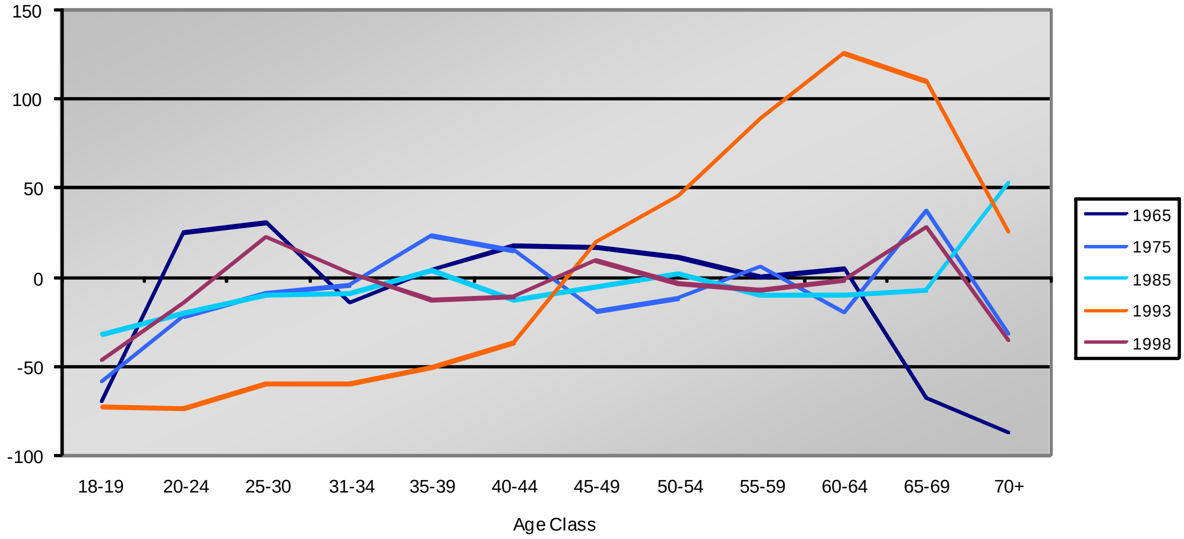
The overall result before calibration: The differences between the totals in the old survey weights and the respective actual population (representation bias) are remarkable. There is a serious socio-demographic bias when the former weights are used for calibration with respect to the chosen content driven calibration characteristics. This representation bias indeed is in need of a new calibration – such as ours – to eliminate these differences in order to achieve representative results for further substantive studies.

The following figures provide in-depth information about this representation bias with respect to different characteristics.

Figures 1 to 2 show the representation bias according to the old weights *for male and female age classes* and for all AHTUD files. It will be evident that younger and older persons, regardless of their gender, show the most differences in the desired actual totals. The 1993 Time Use Survey, in particular, is the time use study with the most calibration bias for peoples 50 years and older for males and females.

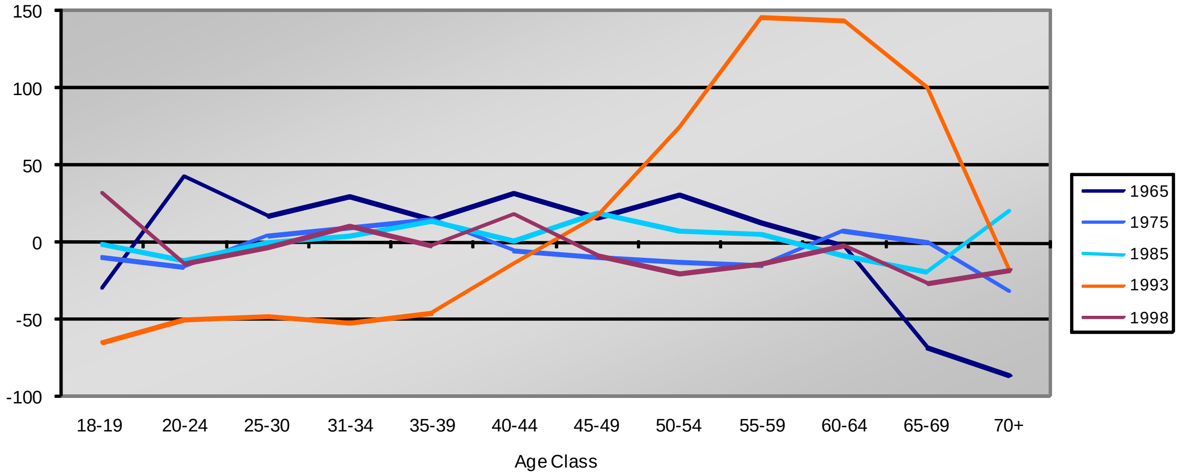
All AHTUD files seem to have a focus on *families* or at least on married couples: the respective old household/family weights fit the actual totals fairly well (Figure 3). Singles are under-represented (not 1993). All AHTUD surveys, however, show high over sampling rates for *children* living in the household/family, which in particular can produce misleading results in time use studies where children – and therefore the family composition – play an important role.

Figure 1
Representation of American Heritage Time Use Files 1965 – 1998/99 - Over- and underrepresentation compared to actual totals in %: Males by age classes



Source: American Heritage Time Use Files 1965 – 1998/99, own computation.

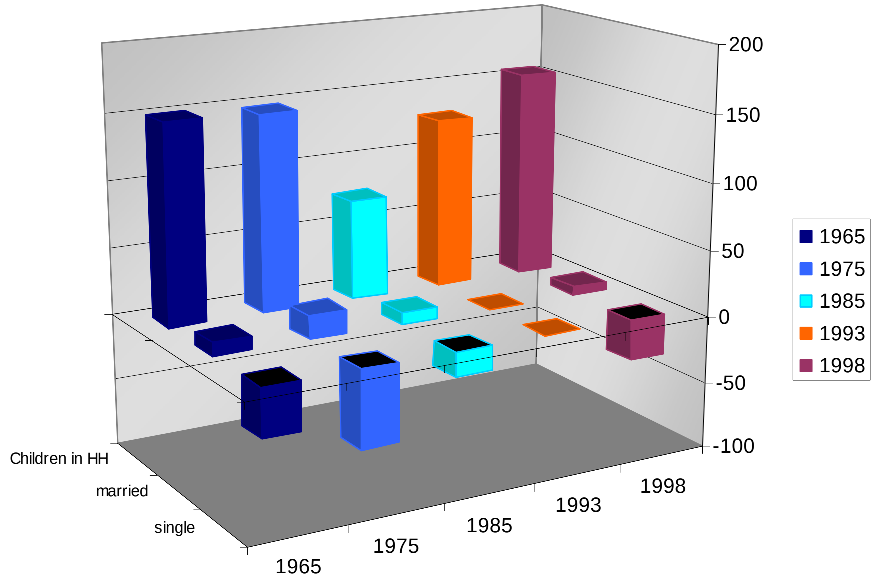
Figure 2
Representation of American Heritage Time Use Files 1965 – 1998/99 - Over- and under-representation compared to desired totals in %: Females by age classes



Source: American Heritage Time Use Files 1965 – 1998/99, own computation.

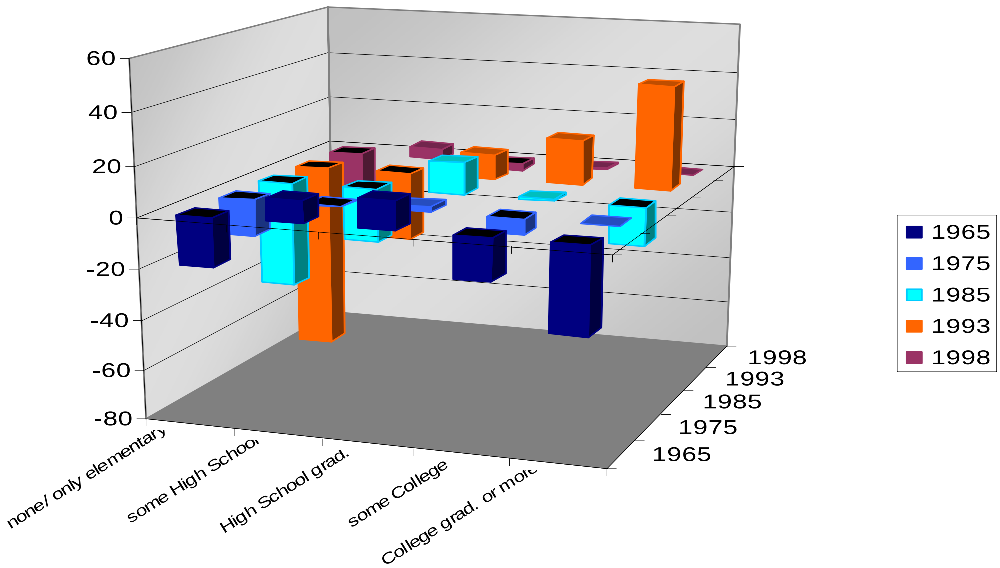
According to *educational attainment* the representation bias is most evident in the 1965 survey with underrepresentation in a lower and upper educational attainment (Figure 4). Additionally, strong effects are within the 1993 time use survey, with an underrepresentation in a lower education, resulting in an obvious overrepresentation of higher educated persons.

Figure 3
Representation of American Heritage Time Use Files 1965 – 1998/99 - Over- and under-representation compared to desired totals in %: Family status



Source: American Heritage Time Use Files 1965 – 1998/99, own computation.

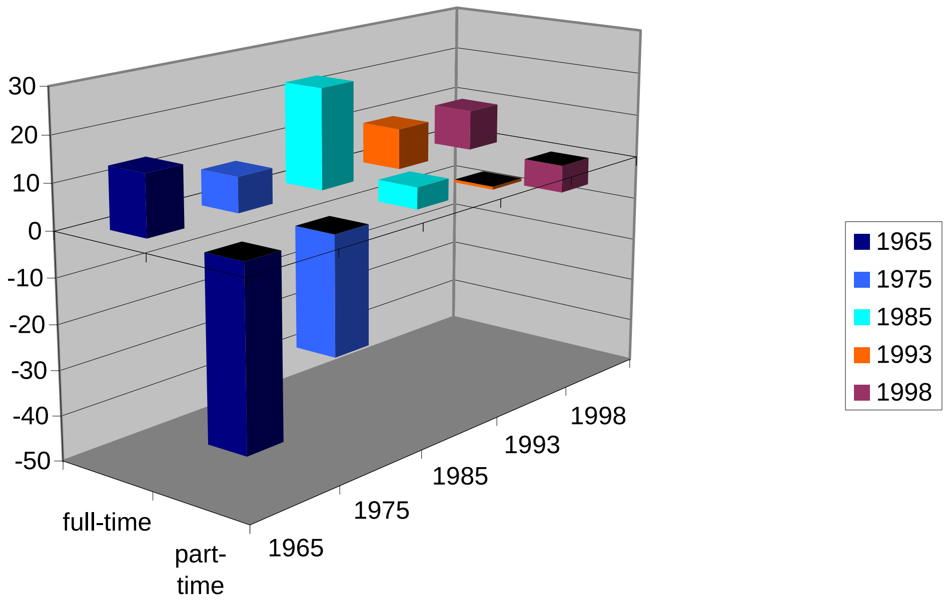
Figure 4
Representation of American Heritage Time Use Files 1965 – 1998/99 - Over- and under-representation compared to actual totals in %: Educational attainment



Source: American Heritage Time Use Files 1965 – 1998/99, own computation.

With regard to the *occupational status* in particular for part-time employment and within the early AHTUD files, in particular, underrepresentation will be evident (Figure 5). Since the occupational status is important for any income and paid work situation, the old weights again result in a biased situation.

Figure 5
Representation of American Heritage Time Use Files 1965 – 1998/99 - Over- and underrepresentation compared to actual totals in %: Occupational Status



Source: American Heritage Time Use Files 1965 – 1998/99, own computation.

The variations concerning the weekdays are interesting; the consideration of the public holidays in the 1998-file causes an overrepresentation of 3.4% for the working days and an under-representation of -17.4% for the Sundays and public holidays. It is likely that this heritage file was quoted only to the calendar distribution of the weekdays not considering the public holidays, while the 1975 and 1993-files slightly oversample the Sundays and public holidays. However, these differences underline the importance of applying a calibration (Figure 6).

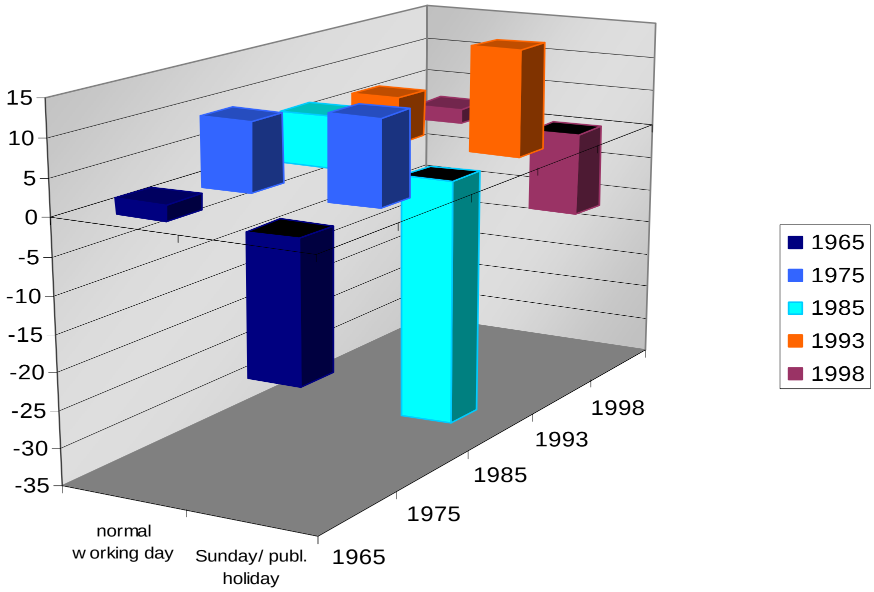
To summarize the results before calibration: There are partially remarkable differences between old weights' totals and desired actual totals. The bias in the demographic representation in all American Heritage Time Use Data for market and non-market time use studies is considerable.

Misleading results have to be expected when the old survey weights are considered in particular according to

- the family context
- children in household
- family type
- the person's age structure (in particular the young and old)
- the day of the week distribution (public holidays)

as demographic variables, which indeed seems to be important for further substantive time use analyses.

Figure 6
Representation of American Heritage Time Use Files 1965 – 1998/99 - Over- and underrepresentation compared to desired totals in %: Representation of days of the week



Source: American Heritage Time Use Files 1965 – 1998/99, own computation.

New harmonised calibration: Calibration weights results and experiences

The adjustment algorithm used in ADJUST converged after 14-17 iterations providing the desired new simultaneous weight for each single microunit in each AHTUD file. Thus, all the discussed differences between the respective actual total and the aggregated socio-demographic characteristic given the new weights indeed vanished (single log-files are available within Merz and Stolze, 2006).

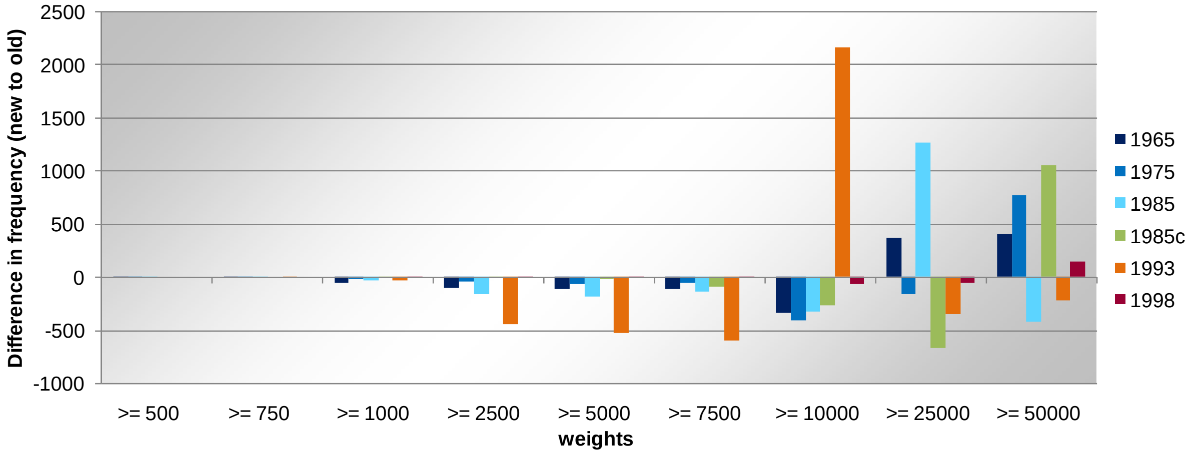
The resulting new weights are available on request as ASCII-Files, connecting the identification variables of the different AHTUD files with the new weighting factor, and can be easily merged for standard statistic software or database applications[16].

The new weights for the AHTUD files will now simultaneously fulfill the given aggregates of the respective CPS-data and population estimates. The frequency distributions of the old and new weights for all five heritage files are provided in Figure 7. Not discussing single results, however, one striking result is the enhanced variance of the new weights in all AHTUD files providing more reliable information with regard to more disaggregated analyses.

Experiences: The advantages as well as the difficulties of a calibration are obvious. It is highly important to balance between the depth of the aggregates, on one hand, and the variance of the weights, on the other hand.

16 CSV-File; Identifier followed by new weight, separated with semicolons.

Figure 7
Frequency distributions of the old and new harmonised weights of the 1965 American Heritage Time Use Data (AHTUD) 1965 – 1998/99



Source: American Heritage Time Use Files 1965 – 1998/99, own computation.

Though the algorithm was able to find a simultaneous solution after a few iterations, the sample size was too small to consider additional aggregates. Even in this constellation with relatively few restrictions to be achieved, there are some cases which must represent far more than a million citizens. Dealing with five samples simultaneously, the set of possible restrictions diminishes if all calibrations follow the same structure. Several calibration settings had to be tried before the selection of a suitable overall restriction set was possible. An additional effort was necessary to prepare the sample with the identification of adequate sample and available aggregate characteristics.

Finally, finding appropriate data for all these studies, reaching 40 years back in time, turned out to be a difficult and demanding task, since methods and surveys have changed quite a lot over this long period of time. Nevertheless, to save the in-depth information of the daily living situation of Americans over the past it was worth doing.

6 Disentangling demographic from behavioural changes – recalibration of the US Heritage Files 1975-1999

To illustrate the wide range of using calibration for time use analyses, we disentangled demographic from behavioural changes in the time use behaviour of the American Heritage Time Use Data by re-calibrating the AHTUD 1975 to 1999 files based on the demographic structure of 1965. These alternative sample weights use the demographic totals from the oldest survey in 1965 as the new demographic totals for the younger files within the new calibrations.

With ADJUST the calibration converged rapidly after maximal 16 iterations providing the desired new weight for each microunit. The resulting weights are available as ASCII-Files on request. With the identification variables of the different AHTUD files and the new weighting factors, the results can easily be merged by standard statistic software or database applications.[17] Needless to say, the new weights for the four younger AHTUDe files will now simultaneously fulfill the given aggregates of the respective 1965 CPS-data and population aggregates.

Table 4 summarises the relative differences in the population structure of the younger AHTUD files compared to the 1965 totals before the re-calibration. The resulting structural differences are remarkable. Keeping in mind that every survey's sampling is different with quite remarkable biased survey weightings (see the above results), wide spread differences could be expected.

Further substantive results in disentangling demographic and time use behavioural changes with the US historic time use files with the above strategy of a re-calibration using a former population structure compared to other strategies are provided in St. Croix and Harvey (2005).

Table 4
Disentangling demographic from behavioural changes: Differences to the 1965 aggregates before re-calibration

Category	Restr. No.	Description	Relative differences to aggregates 1965 [%]					
			1965	1975	1985	1985c	1993	1998
Male # age	1	male, age 18-19	3804236	-54.6	-18,7	-30,9	-74.2	-43,4
	2	male, age 20-24	6899289	10.7	43,2	24,2	-63.1	11,8
	3	male, age 25-30	5612436	40.3	65,2	75	-29.6	101,3
	4	male, age 31-34	5517566	22.0	70,5	66,7	-19.4	84,3
	5	male, age 35-39	5898942	19.0	36,6	55,9	-8.7	67,5
	6	male, age 40-44	6058104	4.5	7,8	1,2	0.4	60,7
	7	male, age 45-49	5552528	-16.4	-17,3	-2	70.6	84,4
	8	male, age 50-54	5101484	-1.2	4,5	5,5	78.9	46,5
	9	male, age 55-59	4582681	16.3	4,1	5,1	112.4	22,2
	10	male, age 60-64	3583081	-2.9	53,5	27,5	201.8	35
	11	male, age 65-69	2972192	66.3	39	32,6	219.4	88,8
	12	male, age 70+	5041923	-23.3	87,8	120,9	120.4	25,1
Female # age	13	female, age 18-19	3672040	0.5	-3	0,5	-67.9	38,3
	14	female, age 20-24	6847150	19.4	44,1	35,2	-33.9	10,1

[17] CSV-File; Identifier followed by new weight, separated with semicolons.

Table 4 (cont.)
Disentangling demographic from behavioural changes: Differences to the 1965 aggregates before re-calibration

Category	Restr. No.	Description	Relative differences to aggregates 1965 [%]					
			1965	1975	1985	1985c	1993	1998
	15	female, age 25-30	5727774	57.7	76,4	90,1	-11.9	57,8
	16	female, age 31-34	5607221	40.8	106,2	87,5	-5.5	99,1
	17	female, age 35-39	6121742	11.6	71,6	67,6	-4.3	82,6
	18	female, age 40-44	6368258	-14.6	1,6	15	32.0	106,2
	19	female, age 45-49	5827607	-4.9	17,1	21,3	65.4	52,9
	20	female, age 50-54	5357560	1.5	3,1	12,1	115.6	22,2
	21	female, age 55-59	4922336	-2.3	56,7	25,8	180.1	15
	22	female, age 60-64	3988792	36.1	36,9	33,3	230.1	33,8
	23	female, age 65-69	3578099	26.7	36,4	17,2	207.6	6,8
	24	female, age 70+	6859179	-11.3	145,2	108,9	67.9	80,9
Children	25	children <18 in HH	68,362,000*	133.3	68,4	55,7	116.9	156,5
Marital status	26	married	84734000	34.0	29,5	30,9	n/a	41,5
	27	single	31945000	-55.8	4,9	12,4	n/a	17,2
Occupational status	28	full-time employed	65,216,000*	19.8	67,9	42,3	67.0	82,2
	29	part-time employed	11,148,000*	-2.3	80,7	50,4	93.1	98,5
Educational attainment	30	none/ only elementary	34045000	-36.0	-40,8	-66,6	-89.6	-72,9
	31	some high school	18617000	-2.5	-1,4	-26,4	-34.0	-5,9
Educational attainment	32	high school grad.	31703000	36.3	84,6	95,6	100.1	78,8
	33	some college	9139000	48.8	151,8	158,1	384.5	366,9
	34	college grad. or more	9742000	n/a	73,4	142,1	418.4	n/a
Weekday	35	normal working day	199	30.0	47,9	50,1	63.3	65,2
	36	Sunday or public holiday	62	32.0	29,7	-7	75.0	41,3

Source: American Heritage Time Use Survey (AHTUD) files, own computations.

7 Conclusions and recommendations

As our analyses has shown, the former available calibration of the five American Heritage Time Use Data (AHTUD) files is seriously biased according to important demographic totals which in addition are of strategic importance for substantial time use analyses. It is important to emphasize that the enourmous wealth of indepth information of the American's daily living situation is unaffected by this calibration bias, since a proper re-calibration will solve this problem of demographic representativity. Our study reports a way to eliminate this bias and deliver a comprehensive harmonized demographic adjustment for all five incorporated U.S. heritage time use surveys.

Our calibration is theoretically founded on information theory, consistent with a simultaneous weighting, including hierarchical data like personal and family/household data. It ensures desired positive weights, considers substantial requirements for time use research analyses, and is harmonised in the demographic calibration characteristics for all heritage files. Our disentangling of demographic vs. time use behavioural changes by re-calibration illustrate the wide range of analysing possibilities using calibration in general.

The new harmonised calibration factors for all five AHTUD files are available on request. In addition, the alternative sample weights using the demographic totals from the oldest survey 1965 for all younger files to disentangle demographic vs. behavioural changes are available as well.

With the available new five sets of consistent and harmonised structured calibration factors, it is possible, in particular, to follow up American time use behaviour over the last 40 years now based on a reliable and valid demographic background delivering representative data for substantial time use analyses.

Based on our calibration experience we recommend above all that

- For any new time use survey, the calibration procedure and the single substantial definitions of the calibration characteristics with their totals must be documented carefully.
- A new calibration of new and actual American Time Use Surveys should be as close as possible to harmonised calibration characteristics when longitudinal analyses are to be done.

Since our software package ADJUST (http:ffb.uni-lueneburg.de/adjust) can be operated easily on every desktop-computer, any new simultaneous calibration can be carried out in a user-friendly and efficient manner. Also, sensitivity analyses with different totals resulting in different weighting sets will help further time use analyses to disentangle demographic effects from behavioural effects.

Appendix

Table A1
Public holidays according to the U.S. code for the years of the AHTUD files

Public Holiday	1965		1975		1985		1993		1998	
	Date	Day	Date	Day	Date	Day	Date	Day	Date	Day
New Year	01/01	Fri	01/01	Wed	01/01	Tue	01/01	Fri	01/01	Thu
Martin Luther King Day	01/18	Mon	01/20	Mon	01/21	Mon	01/18	Mon	01/19	Mon
Presidents' Day	02/15	Mon	02/17	Mon	02/18	Mon	02/15	Mon	02/16	Mon
Memorial Day	05/31	Mon	05/26	Mon	05/27	Mon	05/31	Mon	05/25	Mon
Independence Day	07/04*	Sun	07/04	Fri	07/04	Thu	07/04*	Sun	07/04*	Sat
	07/05	Mon					07/05	Mon	07/03	Fri
Labour Day	09/06	Mon	09/01	Mon	09/02	Mon	09/06	Mon	09/07	Mon
Columbus Day	10/11	Mon	10/13	Mon	10/14	Mon	10/11	Mon	10/12	Mon
Veterans' Day	11/11	Thu	11/11	Tue	11/11	Mon	11/11	Thu	11/11	Wed
Thanksgiving	11/25	Thu	11/27	Thu	11/28	Thu	11/25	Thu	11/26	Thu
Christmas Day	12/25*	Sat	12/25	Thu	12/25	Wed	12/25*	Sat	12/25	Fri
	12/24	Fri					12/24	Fri		

* If the public holiday occurs on a regular non-workday, the day immediately before or after that day will be public holiday instead.
Source: US Code Title 5, part II, Subpart E, Chapter 61, Subchapter I, §6103; own arrangement.

Table A2
Calibration variables of the AHTUD files used to build the calibration microdata-matrix (S)

Category	Restriction number	Description	1965 Variable	1965 Value	1975 Variable	1975 Value	1985 Variable	1985 Value	1992-94 Variable	1992-94 Value	1998-99 Variable	1998-99 Value
Male # age	01	male, age 18-19	sex	1	v403	1	sex	1	sex	1	rsex	1
	02	male, age 20-24	# age	1	# v414	1	# age	1	# age	1	# rage	1
	03	male, age 25-30		1		1		1		1	(computed from birthyear in variable 'p3a')	1
	04	male, age 31-34		1		1		1		1		1
	05	male, age 35-39		1		1		1		1		1
	06	male, age 40-44		1		1		1		1		1
	07	male, age 45-49		1		1		1		1		1
	08	male, age 50-54		1		1		1		1		1
	09	male, age 55-59		1		1		1		1		1
	10	male, age 60-64		1		1		1		1		1
	11	male, age 65-69		1		1		1		1		1
	12	male, age 70+		1		1		1		1		1
Female # age	13	female, age 18-19		2		2		2		2		2
	14	female, age 20-24		2		2		2		2		2
	15	female, age 25-30		2		2		2		2		2
	16	female, age 31-34		2		2		2		2		2
	17	female, age 35-39		2		2		2		2		2

Table A2 (cont.)
Calibration variables of the AHTUD files used to build the calibration microdata-matrix (S)

Category	Restriction number	Description	1965		1975		1985		1992-94		1998-99	
			Variable	Value	Variable	Value	Variable	Value	Variable	Value	Variable	Value
Female # age	18	female, age 40-44		2		2		2		2		2
	19	female, age 45-49		2		2		2		2		2
	20	female, age 50-54		2		2		2		2		2
	21	female, age 55-59		2		2		2		2		2
	22	female, age 60-64		2		2		2		2		2
	23	female, age 65-69		2		2		2		2		2
	24	female, age 70+		2		2		2		2		2
Children	25	children < 18 years in HH	under 18		v415		under 18		kid#		p2	
Marital status	26	married	marital	1	v32	1	marital	1	n/a	--	p6	1
	27	single (never married)		4		5		4		--		5
	28	divorced/ separated/ widowed		2; 3		2; 3; 4		2; 3		--		2; 3; 4
Occupational	29	full-time employed	full	1	v125	>=30	full	1	employ	1	p7	1
	30	part-time employed	part	1		<30	part	1		2		2

Table A2 (cont.)
Calibration variables of the AHTUD files used to build the calibration microdata-matrix (S)

Category	Restriction number	Description	1965 Variable	1965 Value	1975 Variable	1975 Value	1985 Variable	1985 Value	1992-94 Variable	1992-94 Value	1998-99 Variable	1998-99 Value
Educational attainment	31	none/ only elementary	educ	0; 1	v118	0-8	educ	0; 1	educ	0-8	p5	0-8
	32	some high school		2		9-11		2		9-11		9-11
	33	high school grad.		3		12		3		12		12
	34	some college		4		13-15		4		13-15		13-15
	35	college grad. or more		5		>=16		5		>=16		>=16
Weekday	36	normal working day	day	1-4	v432 (only for wave 1)	1-4	day	1-4	day	1-4	pday	1-4
	37	Sunday or public holiday		7		7		7		7		7
ID		respondents' ID	id		Id		respid		respid		respid	
Weight		available weights	demowgt		v7973		wt		adwta		wt	

Source: AHTUD files, own arrangement.

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electronic **International Journal of Time Use Research**
2008, Vol. 5, No. 1, 127-132.

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electronic **International Journal of Time Use Research**

New developments in time technology – projects, data, computing and services

TRAVEL SURVEY DATA TO ESTIMATE TIME SPENT AT IMPORTANT SETTINGS

Michael D Keall
Michael G Baker

The Housing and Health Research Programme at the University of Otago, Wellington looks at the effects of housing on people's health. Many of the exposures in the home to conditions that affect health would not have serious consequences for health if the duration of exposure were short, but we spend a lot of time in our homes, so these exposures become important for health because of their long duration. In general, accurate population level data on time spent in particularly settings (sometimes called microenvironments) and activities is an essential requirement for many forms of environmental risk assessment. Time use surveys are ideal for this purpose (McCurdy et al, 2000; Schweizer et al, 2007), but are expensive to conduct and tend to be carried out infrequently. Few have surveyed children, who are particularly vulnerable to harmful exposures. It is therefore important to try to identify other sources of population exposure data.

Travel surveys offer an alternative source for estimating time spent in settings. However, there are important differences in the way that travel survey and time use survey data are collected and organised: time use studies focus on the type, time and duration, and setting of activity; travel surveys focus on the type, time and duration, and mode of travel. These differences are illustrated in Table 1, which compares notional diaries for the same person for the two different surveys. Travel surveys have no information about what occurs between trips, as shown by the relative sparseness of the right hand side. However, each trip does have a *purpose* recorded, from which general classes of settings can be imputed. The travel survey questionnaire also normally records where the person was at the start of the day, providing the setting for the period prior to the first trip of the day. These derived settings are shown italicised in brackets on the right hand side of Table 1. This method of deriving settings effectively focuses on the composite of the travel activity: a change in setting is normally signalled by a trip, and the composite of the trip information provides the data on the type and duration of time in given settings.

Table 1
Example of a time use diary and a travel survey diary for the same person and activities

Time use diary activities (setting in brackets)	Travel survey diary (imputed setting in brackets)
4.00 AM sleep (at home)	*(home)*
6.00 AM breakfast (at home)	
6.40 AM trip car (in car)	6:40-6:50 car driver purpose: work – main job
6.50 AM work (at work)	*(work – main job)*
9.00 AM coffee break (at work)	
9.30 AM work (at work)	
12.30 PM trip car (in car)	12:30-12:40 car driver purpose: shopping
12.40 PM shopping (at shops)	*(shops)*

The italicised bracketed information for the travel survey is imputed from information provided by the travel survey trip diary

Although deriving duration in settings from travel data appears conceptually straightforward, in practice there is a lot of data processing and data checking required. For example, there may be trips that overlap with other trips according to the times recorded, or trips that were too long or too short in duration due to errors in recording departure and arrival times. We created filters that identified errors of this sort. To validate the use of travel survey data to estimate the time spent in important settings, we compared estimated time spent in the main settings for the New Zealand population aged 12 plus, using a restricted age range to allow comparison between the time use survey, which was restricted to respondents aged 12 and over, and the travel survey, which covered the whole population (Povey and Keall, 2000; Statistics New Zealand, 2001). This population was estimated to spend 71.8% of its time in their homes according to the Time Use data (1998-99) and 72.5% according to the imputed data from the Travel Survey (1997-98). The proportion of time in other settings, such as work and study (12.6% and 12.2% for time use and travel survey data respectively), recreation (5.1% and 8.1% respectively) and using transport (5.8% and 4.7% respectively) had quite good agreement, supporting the validity of this form of use of travel survey data.

This use of travel survey data to estimate time spent in settings has great potential, particularly for researchers who are studying the way that children spend their time and are frustrated by children's lack of representation in most time use surveys worldwide. For researchers who are interested in studying time spent in settings, the fact that travel surveys are more commonly carried out than time use surveys means that their potential data sources are expanded. For us in New Zealand, we have the benefit of an ongoing travel survey[1], which will soon be supplemented by a new time use survey[2]. This is a fortunate situation as the travel survey can fill in some of the gaps between surveys and gaps in age coverage of the time use surveys, even though the information we can derive on time spent in settings from travel surveys is very limited

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Schweizer, C., Edwards, R.D., Bayer-Oglesby, L., Gauderman, W.J., Ilacqua, V., Jantunen, M.J., Lai, H.K., Nieuwenhuijsen, M., Kunzli, N., Schweizer, C., Edwards, R.D., Bayer-Oglesby, L., Gauderman, W.J., Ilacqua, V., Jantunen, M.J., Lai, H.K., Nieuwenhuijsen, M., Kunzli, N. (2007) Indoor time-microenvironment-activity patterns in seven regions of Europe, J Expo Sci Env Epid 17: 170-181.

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[1] http://www.transport.govt.nz/ongoing-travel-survey-index/
[2] http://www.stats.govt.nz/developments/time-use-survey-2009–10.htm

Book notes
by Kimberly Fisher

Alcser, K.H., Belli, R.F., Stafford, F.P., and D.F. Alwin
Calender and time diary methods in life course research (2008)

Contributing Authors: Agrawal, S., Almeida, D.M., Alwin, D.F., Belli, R.F., Broderick, J.E., Callegaro, M., Camburn, E., Correnti, R., Dijkstra, W., Hurd, M.D., James, S.A., Kahneman, D., Martyn, K.K., Mulvey, E.P., Ongena, Y.P., Phipps, P.A., Roberts, J., Rohwedder, S., Rowan, B., Schwarz, N., Smit, J.H., Sobell, M.B., Sobell, L.C., Stafford, F.P., Stone, A.A., Van Hoewyk, J., Vernon, M.K., Wethington, E., Xu, J. and Yoshihama, M *Publisher:* Sage Publications, London
Website: http://www.sagepub.com/
Languages Available: English

This book provides an overview of the development of diary and calendar data collection and analysis. The book considers applications of such methods to a number of specific topics, including substance abuse, health among adolescent and older populations, exposure to stressful events, domestic violence and risk of experience of violence, hedonic/pleasurable experiences, and instruction in schools. The book also covers the validity and reliability of such methods as the data have been collected, and considers how these issues and techniques for analysis may change with the option of real-time data collection. The volume concludes with speculation on the future directions of this field.

Goodin, R.E., Rice, J.M, Parpo, A. and L. Eriksson
Discretionary time: a new measure of freedom (2008)

Publisher: Cambridge University Press, Cambridge
Website:
http://www.cambridge.org/catalogue/catalogue.asp?isbn=9780521709514
Languages Available: English

This book advances the argument that has been fashionable in the time use community for the last few years that time resources are as important as financial resources for quality of life and balancing work and personal life. The authors develop novel algorithms for measuring discretionary time which accounts not only for categories traditionally classed as “leisure” but also for activities traditionally classed as personal care, housework, and paid work which fall outside the range of time requirements similarly positioned people devote to the same categories of activities. The authors aim to measure the proportion of time over which people exercise a level of discretionary control, then compare how different welfare regimes influence levels of discretionary time. The authors also consider how the organisation of households may influence the level of discretionary time enjoyed by members. The book compares trends in Australia, Finland, France, Germany, Sweden and the USA.

Korabik, K., Lero, D.S. and D.Whitehead
Handbook of work-family integration (2008)

Publisher: Elsevier Academic Press, Amsterdam
Website: http://www.elsevier.com/wps/find/homepage.cws_home
Languages Available: English

This edited collection brings together multidisciplinary research into issues and problems contemporary families face carving out time together in the changing work environment. The book begins with a historical overview, then moves on to theoretical and modelling issues and the practical application of models to policy. Later chapters assess the impact of family policies in comparative perspective. Middle chapters consider factors that contribute to the conflict between family and work roles, impacts for organisations of promoting balance for workers, health (physical and emotional) well-being, gender roles, and coping strategies for individuals. The book concludes with speculation of future directions for research in this field.

Odih, P.
Gender and work in capitalist economies (2007)

Publisher: Open University Press, Berkshire
Website: http://mcgraw-hill.co.uk/openup/
Languages Available: English

This book examines how Capitalist economic rhythms organise work time, in particular creating pressures for just in time production and delivery across many sectors of the economy. The author undertakes a sociological investigation of the gender politics generated by the industrial organisation of work time (and its spill-over effects into other dimensions of daily activities). While the book initially concentrates on British examples, the scope is broad, beginning with the 19th Century and tracking changes through the present Post-Fordist and globalised economic environment. The author considers the impacts of the 24 hour economy and pressures of production schedules on women's use of space and time.

You, W.
Time well spent: how watching time can reduce the chances of having overwight children (2008)

Publisher: VDM Verlag Dr. Muller, Saarbrücken
Website: http://www.vdm-publishing.com/
Languages Available: English

This published PhD thesis was awarded the 2006 American Agricultural Economics Association Dissertation Award. The author

electronic ***International Journal of Time Use Research***
2008, Vol. 5, No. 1, 127-132.

uses a two-stage Stackleberg game structure model to examine the impact of household characteristics, personal characteristics, and the daily activities on the risk that children will be overweight (measured by body mass index or BMI) in households with two parents and one child. All three members are treated as separate actors with individual preferences. The model accounts for household expenditure on food, time use of both the parents and the children (including parent's time with children and time on food preparation), individual and household income, spill-over of work into the household, the BMI of parents, and self-reports of stress and coping strategies. The thesis draws on data from the Texas A&M University multi-disciplinary "Parental Time, Role Strains, Coping and Children's Diet and Nutrition" study. The thesis finds that some variables associated with the stress of the mother, mother's BMI and mother's time with children have greater effects than some variables associated with fathers, though the book also reveals the complexity of tracking the causes of obesity.