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special honorary issue for Andrew S. Harvey

special honorary issue editors:
Joachim Merz and Klas Rydenstam

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SPECIAL ISSUE EDITORS' INTRODUCTION

This special eIJTUR issue is to honour Prof. Andrew S. Harvey at his 70th birthday, September 21 September 2009, for his outstanding contributions to time use research and the time use research networks he created over the years. All the issue contributors – acting for many others – known Andrew S. Harvey as a colleague and teacher for many years and are happy to wish him many additional healthy years of good companionship and a balanced life.

Though all the special issue contributors – beyond their personal relationships – are unified in their common interest in time use research, the single contributions vary in kind and concern. The contributions are divided into two parts, one with personal and general observations and the other a paper of scientific concern.

The *first part of personal and general observations* include Klas Rydenstam's (formerly with Statistics Sweden and IATUR vice president) relationship to Andrew Harvey's life and the International Association for Time Use Research (www.iatur.org) which is deepened by Dr. Kimberly Fisher (Oxford University, UK, General Secretary IATUR) with observations on Andrew Harvey's legacy to the time use community. Martha MacDonald (Economics Chair, Saint Mary's University, Halifax, Canada) adds some recollections of Andrew Harvey's time at Saint Mary's and Dalhousie Universities,

The *second part with research papers* are tied in with Andrew's Canadian time use work and networking by Jiri Zuzanek's (University of Waterloo, Canada) paper about time use research in Canada providing history, critique and perspectives. One of Andrew Harvey's practical tools developed for the multi-dimensions of time use activities, "hypercodes" and the "Proptogram", is the topic of Jonathan Gershuny's (Oxford University, UK) contribution.

Specific time use activities and research topics relating to the labour market, non-market production and travel pulses combining market and non-market activities are then addressed. Flexibility aspects of the labour market with daily working hour arrangements and their income impacts are examined by Joachim Merz with his colleagues Paul Böhm and Derik Burgert (Leuphana University Lüneburg, Germany). Non-market activities are addressed by Duncan Ironmonger and Faye Soupourmas (University of Melbourne, Australia) by estimation household production outputs with time use episode data. William Michelson (University of Toronto) explores home-work commuting

Time use of the elderly is then analysed. Iris Niemi (Statistics Finland) examines sharing of tasks and lifestyle among aged couples followed by John P. Robinson and Andrew Caporaso (University of Maryland, USA) who explore time use activities of the elderly by senioritis in repose.

Finally, time use data quality and survey design are highlighted by of Ignace Glorieux and Joeri Minnen (Vrije Universiteit Brussel, Belgium) who compare the characteristics of time-use data from 2-day and 7-day diaries.

We are glad that, with these topics and papers connected by content with Andrew Harvey's time use research and publications, we at least could cover some fields of Andy's rich work which is influencing and stimulating so many further time use research topics.

November 2009

Joachim Merz
Editor and Managing Editor eIJTUR

Klas Rydenstam
former Vice President of IATUR

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IN HONOUR OF DR. ANDREW S. HARVEY

This is not an attempt to portray IATUR (or what later became IATUR) but to honour one man's contribution to the progress and success of IATUR and its consequences. The person I have in mind is Dr. Andrew S. Harvey, Halifax, Nova Scotia.

I have been told that the organisation that formally became IATUR in 1988 – i.e. the International working group on time budgets and social activities - was founded in 1970. Dr. Harvey became the first Secretary-Treasurer when this post was created in 1978 and when he resigned as President of IATUR in 2005 he had also been the longest serving President so far. For close to 30 years he then served on a non-profit basis as either Secretary-Treasurer or President. In course of those years Dr. Harvey invested huge effort in organising about 20 conferences on time use survey related topics in collaboration with various hosts as national statistical institutes or university institutions. He also set up an IATUR web site and amassed a considerable library of time use materials. The conferences were spread worldwide; they took place in Asia, Europe, North and South America. The number of participants and the number of papers presented gradually increased. Nowadays it is not unlikely that more than a hundred participants representing up to 30 countries attend the IATUR conferences. Dr. Harvey's consistent efforts significantly contributed to this achievement.

As a retired representative of a national statistical institute engaged in the development of national and international time use statistics for a quarter of a century it is inescapable to recognise the great support and assistance the activities organised by Dr. Harvey and IATUR has provided. The conferences have offered and initiated opportunities for cooperation between representatives of the academic society and national statistical institutes aiming at coming to common conclusions that benefit both parts; the national and International statistics have improved and the academic researchers have obtained access to more and better data.

Dr. Harvey's contribution goes, however, far beyond organising conferences appealing to and inviting both national statisticians and academic researchers engaged time use related issues and organising discussions of common interest. Particularly two subject matters come to my mind. One has to do with the methodological recommendations on time use surveys Dr. Harvey wrote and presented at an IATUR conference in the mid 1980s. The recommendations became object of recurrent discussions in connection with a number of IATUR conferences and were finally published in Social Indicators Research around 1990. Not only the Recom-

mendations themselves but also the discussions that preceded the final version became a significant input to the project Eurostat started around 1993 aiming at harmonising European time use statistics. And in addition Dr. Harvey came overseas – often at his own expense – to attend and provide support at some of these Eurostat project meetings at Eurostat in Luxembourg. This is in line with his personal style of encouraging people and sharing information that helps creating a friendly and supportive atmosphere, something that still today characterises the IATUR conferences.

The Guidelines that came out of the Eurostat project brought about a growing interest among European national statistical institutes to collect time use statistics. An increasing number of European Member States are now conducting harmonised time use surveys. Several European countries outside the Union are also developing the kind of statistics. A similar trend could also be found worldwide, although with no direct reference to the Eurostat guidelines.

My conclusion is that all this would not yet have happened if IATUR had not developed and addressed the issues like it did as a result of Dr. Harvey's efforts.

For this many of us are most grateful!

Klas Rydenstam
Retired employee of Statistics Sweden, member of IATUR since early 1980s,
friend and collaborator with Andy Harvey

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OBSERVATIONS ON ANDREW HARVEY'S LEGACY TO THE TIME USE COMMUNITY

I first happened upon time diary research while working at the Institute for Social and Economic Research at the University of Essex in early 1999. The ISER Director at that time, Professor Jonathan Gershuny, who now is a friend as well as my employer, asked me to take on the task of organising the International Association for Time Use Research conference which ISER hosted in October of that year. As the former president of IATUR, J (as those who work with Professor Gershuny affectionately know him) had a wealth of IATUR organisational materials as well as an extensive collection of broader time use resources. As I began working with this collection, I was struck by the great range of potential uses of time use data. I had both a personal and a research interest in finding tools to measure quality of life of people living with Multiple Sclerosis and accordingly my first presentation at the 1999 IATUR conference laid out this possibility of using daily activities as a measure of clinical outcomes of treatments for neurological injuries and illnesses (Fisher, 1999, later published as Fisher 2000).

The conference organisational work led me to my first contact with Professor Andrew Harvey. Though at the time I had only just completed my PhD and had no previous experience with time use research, and though Professor Harvey was both the President of IATUR and a founder member of the Association, as well as a long-established tenured academic, Andy (as I soon learned was how most people associated with IATUR know Professor Harvey) welcomed me as a colleague from the outset. After I gave my presentation, he pointed me towards work with which he had been involved with people living with spinal cord injuries, which had already reached the same conclusions (Pentland and McColl, 1999).

Like many of the people participating in the organisation in its first decades, Andy had a thirst for ideas of how to expand the use of time-diary data. This interest in knowledge has meant that Andy shows no ties to strictures of Economics (the discipline in which he was employed)

or other disciplines and welcomes ideas from other fields as well as people with no formal academic background. This quest for knowledge also meant that Andy, J, and many other long – standing IATUR members who also have written contributions to this special issue of the eIJTUR, happily listen to any researcher with a good idea. This spirit of openness has lead to a friendly environment in IATUR where researchers share ideas and programmes and offer

each other support. Arriving at a subsequent IATUR conference in many ways is like arriving at a gathering of friends. Andy helped to set up the tradition that conference dinners start with a toast, proposed by Dagfin Aas, "to the proper use of time" – in recognition of the importance of the social connections as well as collegial spirit he has helped to foster within the time use community.

While the wide range of potential applications of time diaries has been recognised for over a century, notable scholars in the field also have complained for decades that researchers using diary data have made minimal use of this potential, and tended to focus on the easy option of summary time in activities (Sorokin,1943; Carlstein, 1982; Michelson 2005) – at least until recently. Andy has been among the exceptions, not only using the wider features of diary data since the 1970s but also regularly leading the forefront of exploring new levels of diary research. The write-up of the classic 1965 Szalai (1972) surveys conducted in 12 countries analysed secondary activity and who else is present data. Andy Harvey helped to arrange a survey in 1971-1972 of over 2,000 residents of Halifax following the Szalai survey design but with the addition of innovative questions. In 1981, Andy arranged one of the early longitudinal follow-ups of diarists (in this case of Halifax residents). I had the pleasure of working with Andy and J on early work classifying paid work days by the starting and stopping times of work episodes and patterning of work over the whole diary day (Harvey, Gershuny, Fisher, and Akbari 2003). Andy helped to arrange training in the application of genetic algorithms using the package ClustalG (developed by Clarke Wilson in collaboration with others) to examine sequences in diaries at the IATUR conference which he hosted in Halifax in 2005. Having had a long-standing interest in travel surveys, Andy also has been among the early researchers using GPS and other tracking technologies to map people's movements (in Halifax) alongside their activities recorded in time diaries (Harvey and Spinney 2008).

I have worked with Andy on a number of projects, including the development of the American Heritage Time Use Study and a project on non-market accounts in the USA for Yale University and the Glaser Foundation. From the October 2001 IATUR conference in Oslo, I also have had the pleasure of working with Andy on the IATUR executive in my current role of Secretary-Treasurer – the role which Andy himself first held in the organisation. The scope of Andy's contributions to IATUR and time use research inspired the current IATUR President,

Michael Bittman, to propose honouring Andy's contributions by naming the Association's travel assistance grants the Andrew Harvey Fellowships – which the people attending the 2005 IATUR business meeting unanimously approved.

Among his many activities, Andy developed an extensive list of time use publications, which he hoped to one day put up on the IATUR web site. Like other former IATUR presidents, Andy has more good ideas than he has had time and energy to fulfil. My own activities now include the development of a searchable database of time use publications which will reside on the web site of the Centre for Time Use Research, which will include the lists that Andy

has accumulated over the years. It is a privilege to ensure that this element of Andy's legacy to time use research will be realised.

Kimberly Fisher
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University of Oxford

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RECOLLECTIONS OF ANDY HARVEY'S TIME AT SAINT MARY'S UNIVERSITY

Andy Harvey joined Saint Mary's University (Halifax, NS, Canada) as Chair of the Department of Economics in 1983, after many years at the Institute of Public Affairs, Dalhousie University. I had worked door-to-door on his first Halifax time-use survey, as an undergraduate student at Dal in the early 1970s, and had subsequently been a research colleague at the Institute while completing my PhD. I came to SMU a year before Andy, and encouraged him to make the move. I thought he would find a supportive environment for his research and congenial colleagues at SMU. I don't think he was disappointed. Andy chaired our department from 1983-1993, a period of growth in the department and the university. He set up his Time-Use Research Programme, which enhanced the life of the department, and expanded into every nook and cranny of our research space! Andy brought many interesting visitors to the department over the years. He was a truly international and interdisciplinary scholar, who loved to travel and thrived on his wide network of academic relationships. At Saint Mary's he was honoured with the President's Award for Research Excellence and the Frank H. Sobey Faculty of Commerce Award for Research Excellence. He was also an excellent teacher, honoured by the SMU Student Commerce Society for Outsanding Dedication to Student Academics. He taught our honours seminar for many years, passing on his love of messing with data and his enthusiasm for research. During his tenure as chair he was also a great social convener, organizing regular potluck dinners at his house on the lake. We got to know our colleagues and their spouses better and benefitted from his love of good food, drink and conversation. He and Dawn were great hosts! It is hard to believe that over 25 years have passed since Andy joined us at Saint Mary's. We are proud of Andy's outstanding contribution to the advancement of international time-use research. Now an Emeritus Professor, he shows no sign of slowing down. We join in sending him best wishes on his 70th birthday, and look forward to many more!

Martha MacDonald
Chair, Economics
Saint Mary's University

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Time use research in Canada – History, critique, perspectives

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Abstract

The article examines methodological and substantial problems faced by Canadian time use research. It assesses the gains and the limitations of this research from a historical and comparative perspectives.

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1 Introduction

The following article is an indirect tribute to Andy Harvey and his contribution to time use research in Canada and internationally. There are different qualities that we admire in researchers – breadth of interests, statistical sophistication, policy relevance, but one quality is less frequently mentioned, yet is no less important for the advances of social sciences – endurance and ability to create a stimulating family-like research environment. Andy has all of these qualities, but for me he is foremost the "demiurge" of IATUR, a person who was able to create a family of time use researchers, close-knit yet open and marked by true camaraderie. These qualities persevered even after Andy stepped down as the president of IATUR, and that is another unmatched accomplishment. Stay the course, Andy!

2 Time use research in Canada – 1965 - 2005

In the 1960s, and particularly the 1970s, statistical agencies in many countries began collecting systematic information about their population's involvement in leisure activities and overall patterns of daily life as reflected in the use of time. Canada was no exception to this trend.

The interest in time use (or time-budgets as they were originally called) owes a lot to the trend-setting comparative study of time use in 12 countries directed by Alexander Szalai and launched in 1965 under the auspices of UNESCO (Szalai, 1972). In Canada, surveys of leisure and cultural participation were initially spearheaded by the Education, Science and Culture Division of Statistics Canada under the direction of Yvon Ferland. Time use surveys, on the other hand, were first conducted by researchers working in the university environment. Three names personify Canada's early time use research efforts – Martin Meissner, William Michelson and Andrew Harvey. These three researchers embraced Canada's time use research terrain, literally from coast to coast. Martin Meissner used time use data collected in 1965 from 206 workers in an industrial community on Vancouver Island to examine the effects of job constraints on workers' time use and leisure participation (Meissner, 1971). This same researcher used data from a 1971 study of social, temporal, and spatial ecology of urban dwellers in Greater Vancouver to examine gender inequalities in the distribution of time, in particular time allocated to domestic work (Meissner et al., 1975). Meissner's articles "The Long Arm of the Job" and "No exit for wives: Sexual division of labour and the cumulation of household demands" foreshadowed by almost a decade research interests that drew increasing attention in the 1980s and 1990s.

Michelson used time budgets to measure objective behaviour in relation to housing preferences and intentions. His data was collected from approximately 600 families changing housing type and location in the Toronto area. Starting in 1969, data was collected in four phases

over a period of about 5 years extending from before the move, to about four years after (Michelson, 1977).

On the other side of Canada in Halifax, Nova Scotia, a team of researchers at The Institute of Public Affairs, Dalhousie University, under the direction of Andrew Harvey, conducted the *Halifax Time-Budget Survey* in 1970-1971. The design of this survey was similar to the Multi-National Time Budget Survey and it provided one of the first glimpses of time use by a representative sample of urban Canadians (*N* = 2,002). It also included detailed information about respondents' location during their various daily activities. The Halifax survey served as an impulse and a benchmark for time use studies initiated a decade later by Statistics Canada, and its findings were reported in numerous publications (Elliott et al., 1976; Clark and Harvey, 1976; Harvey, 1978; Kinsley and O'Donnell, 1983)

In 1981-1982, Sue Shaw conducted a time use survey of 60 couples (N = 120) also in Halifax. This survey attempted to distinguish between traditional *activity* and alternative *experiential* measurements of leisure. It asked respondents to indicate for each performed activity whether they perceived it as leisure, work or a combination of both. The findings of the survey pointed to methodological problems associated with the use of traditional activity measures of leisure. The study showed that respondents attributed leisure qualities not only to typical free time activities but also to activities traditionally seen as non-leisure (studying, paid work, housework). Free time activities were, on the other hand, often perceived (not surprisingly more so by women than by men) as lacking leisure qualities (Shaw, 1986).

In 1980, Bill Michelson collected data on time use of married and single employed mothers in Toronto (N = 545 families). The main instrument of the survey was a time diary completed by each member of the family above the age of 10. This time diary required respondents to list in detail what they did on the day in question. In addition to time diary data, the survey included respondents' subjective evaluation of activities they performed and covered issues such as mental health and time pressure in the lives of employed mothers (Michelson, 1985).

Approximately at the same time, the Research Group on Leisure and Cultural Development at the University of Waterloo conducted a survey of time use among elderly citizens in the Kitchener-Waterloo area (*N* = 117). This survey collected time diary information on two weekdays and one day off. It included a number of questions about respondents' health and a generalised measurement of life satisfaction based on the Life Satisfaction Index (LSI) of Neugarten, Havighurst, and Tobin (see Zuzanek and Box, 1988).

In the mid 1970s, it became clear that further advancement of systematic and representative time use research required involvement of a national statistical agency that had access to considerably greater resources than were available to individual researchers or university research teams. To enlist such support the Department of the Secretary of State and the Dalhousie University Institute of Public Affairs organised in 1976 an International Conference on Time-Budgets in Tatamagouche, Nova Scotia. A pioneering spirit typical of this fermenting period dominated this informal and open-ended conference which brought together major players of Canadian and international time use research – Andy Harvey (the initiator of the conference),

John Robinson, Phil Stone, and others. For a variety of reasons, of which funding may have been one, the attempt to launch a large scale time use survey proposed at the conference did not materialise, but the seeds of the subsequent involvement of Canadian government and Statistics Canada in the study of time use were planted here. These seeds came to fruition in 1981 when the first Canadian National Time Use Pilot Study was launched, thanks to a concerted effort of the federal Department of Communications, Canada Employment and Immigration Commission, Statistics Canada, Peat, Marwick and Partners, and the Dalhousie University Institute of Public Affairs.

The *National Time-Use Pilot Study* was conducted in September and October of 1981 by telephone in 11 urban centres and three rural counties across Canada (N = 2,685). It collected detailed information from respondents aged 15 and older about their time use during the day before the survey as well as their participation in selected leisure activities during the preceding year. Seizing the data collection opportunity, in addition to a random sample of 496 respondents in Halifax, 450 of the 1971 Halifax respondents were re-interviewed in 1981 on a comparable month and day (Harvey and Elliott, 1983).

In 1986 (October to December), Statistics Canada administered, for the first time, a full-scale national time-use study within the framework of *General Social Surveys* (GSS). Telephone interviews were conducted with respondents 15 years and older from randomly selected households about time-use for 24 hours of the day preceding the interview (N = 9,946). The interview gathered information on the primary activity in which the respondent was involved, the total duration of each activity involvement (reported in minutes), where the activity took place, and with whom the respondent was involved. Activities were classified into 99 categories, which were subsequently grouped in general classes such as work for pay, domestic work, personal care, free time, etc. The survey also contained several labour force participation questions (estimated length of weekly working hours, etc.), and questions about respondents' health and satisfaction with various aspects of life, including the use of non-working time.

Beginning in the early 1990s, Statistics Canada conducted time use surveys within the General Social Surveys framework repeatedly in approximately six-year intervals. The 1992 *GSS* was similar in design and sampling to that of 1986, but time-use data were collected over the entire year rather than a two-month period (N = 8,996). In addition to the duration, location (where) and context (with whom) of the activities, respondents were asked questions about child care, frequency of participation in selected leisure, cultural and sporting activities during the year preceding the survey, volunteer activities during the month preceding the survey, most enjoyed activities and, for the first time, subjective feelings of time pressure (feeling rushed).

The 1998 *GSS* followed the format of the 1992 survey, but added questions about respondents' perceived attachment to their communities, satisfaction with work-family balance, and perceived level of psychological stress (N = 10,749). The survey repeated, as well, questions about life and domain satisfactions asked in the 1986 *GSS*.

The 2005 *GSS* doubled the sample of the surveyed population (*N* = 19,597), but retained most structural components of previous time use surveys. In addition to questions about physical health, the survey for the first time attempted to monitor respondents' mental dispositions (closeness to and trust in people).

Time use data collected by Statistics Canada became the subject of intensive secondary analyses and produced an array of publications addressing various aspects of daily life, work-leisure relationship, changing uses of time, child care, gender and social time use inequalities, social capital, and well-being. A partial account of these publications can be found in Pentland et al. (1999), Zuzanek (2000), and Michelson (2005).

Most recently (2005-2008) Andrew Harvey was principal investigator of the Space Time Activity Research (STAR) project, a GPS augmented time-use study of approximately 2000 households in the Halifax Regional Municipality (HRM). This study developed an integrated tracking and interviewing system to capture temporal-spatial data comparable to the 1971-72 Halifax data.

3 Canada´s time use research – The gains

The title of this article suggests that its main goal is to identify critical issues facing time use research in Canada and to offer some suggestions about future directions of this research. Before doing this it may be appropriate, however, to briefly mention some of the gains of time use research. Understanding of a number of social trends and issues in Canada could not have been achieved, in my opinion, without a systematic study of the use of time. What follows is by no means a comprehensive list of all the gains but rather a sample of findings that attracted serious research and policy attention.

3.1 Social trends

One of the questions often asked in the past was whether shortening of working hours provided more leisure for people in industrial societies. The opinions on this issue varied (Dumazedier, 1967; Linder, 1970; Schor, 1991; Gershuny, 1992; Robinson and Godbey, 1997). Some authors have argued that the amount of free time available to an average citizen has increased over the past two or three decades (Robinson and Godbey, 1997). Others have pointed to the fact that, subjectively, respondents in these same countries appear more pressed for time than ever before (Linder, 1970; Schor, 1991). Analyses of Canadian *GSS* time use data reveal that statistical means computed for combined working and non-working populations have concealed important time use divergences. These analyses showed that from 1981 to 1998 the amount of free time available to *all* Canadians increased by 15 minutes per day, but for the *employed population* it increased by only 8 minutes, and for employed respondents on days when they worked it declined by 14 minutes, while their total work load on these days increased by 30 minutes (Zuzanek, 2004).

These figures tell us that in 1998, proportionately fewer Canadians were in the labour force, those who were employed worked fewer days per annum, and on days when they worked their working hours were longer than in 1986. While some population groups (the elderly) grew in size and gained leisure time, others (self-employed, professionals, managers) seemed to have lost it. Consequently, the question of whether people in modern societies have gained or lost free time may be the wrong question to ask; instead, we should be asking *who* in modern societies is gaining and who is losing free time. The above observation has, of course, serious policy and methodological implications. In the presence of divergent trends, statistics of central tendency averaging time use of the entire population may be obscuring widening real-life time use gaps.

Historical analyses of time use changes disclose a number of other trends that have serious life-style, health, and policy implications. The amount of time spent eating at home, reported in national time use surveys, has steadily declined since 1981. It was almost 30% shorter in 2005 than at the beginning of the 1980s. Other activities that have shown a steady decline are reading and adult education. Reading declined first at the expense of watching television and videos, and in the 1990s at the expense of computer use / Internet surfing, when the latter cut into both reading and TV viewing time.

Educators, physicians, and researchers have been alarmed by teens' short hours of sleep. Medical specialists believe that adolescents need 9.2 hours of sleep to remain healthy and function effectively (Carscadon, 1990), yet in 1998, 24% of Canadian high school students slept less than 7 hours on school days. According to the 2003 Ontario Time Use Survey of adolescents, 27% of 15 to 19 year old Ontario students slept fewer than 7 hours on school days.[1] In 1981 the corresponding figure was only 18%. Unlike in the 1980s, later bedtimes in the late 1990s were associated primarily with Internet surfing (Zuzanek, 2005). Not surprisingly, some schools began considering postponement of class start-up time.

The trends discussed above, obviously, prognosticate arduous life style, educational and health challenges for Canada's population.

3.2 Social and demographic cleavages

Time use research has also mustered tangible evidence about social cleavages affecting time use of different groups of Canadian population.

3.3 Gender gap

Time-use data show that women in general, and particularly employed mothers with small children, are disadvantaged in their access to leisure time compared to men. Employed women interviewed in the 1971-72 time-use survey in Halifax, reported having an average of 4.0 hours of free time per day, compared to men's 4.9 hours (Elliott et al., 1976). According

[1] For more information about the Ontario Time Use Survey of Adolescents (OATUS), see Zuzanek and Mannell, 2005; Zuzanek, 2005; Mannell et al., 2005.

to the 1971 time-budget study in Greater Vancouver, employed married women with children had only 1.8 hours of free time per day, compared to 3.4 hours for the analogous category of men (Meissner et al, 1975).

The gender gap in accessing free time began narrowing in the late 1980s and 1990s, but despite this narrowing it persisted, albeit in a somewhat different form. In 1998, the combined daily load of paid and unpaid work of employed mothers with a child under the age of 18 narrowed to 11 minutes compared to 24 minutes in 1986. Minute per minute, employed fathers seemed to be putting approximately the same amount of time into the combined pool of paid and unpaid work as employed mothers. This seemingly symmetrical distribution of men's and women's total workloads hides, however, a very different composition of paid and unpaid work. In 1998, employed mothers' combined daily workloads, prorated for the entire week, consisted of 5.6 hours of paid work and 4.7 hours of unpaid work, totalling 10.3 hours per day (including work-related travel). Employed fathers' daily workloads contained 7.1 hours of paid work and 3.0 hours of unpaid work, totalling 10.2 hours. Thus, *quantitatively* the "gender gap" in the distribution of family's total workload may have narrowed, but *qualitatively* it remained rather wide. Put simply, employed mothers traded 1.6 hours of paid work for 1.7 hours of domestic chores and family care (Zuzanek, 2000; see also Clark and Harvey, 1976; Michelson, 1985; Shaw, 1986; Hilbrecht, 2009).

3.4 Ageing and life-cycle

Early studies of time-use suggested that relationships between age and access to *free time* resembled a 'bipolar curve,' with the largest amounts of free time reported by the youngest and the oldest respondents and the lowest amounts by middle-aged groups. This situation did not change much over the years. In 2005, 15 to 19 year old teenagers reported on average 6.5 hours of free time per day. The figure for the 30 to 49 year olds was 4.5 hours, and for the 60 to 69 year olds, 7.5 hours. The same pattern applies to participation in physically active leisure that drops radically after the age of 20. In 1981, the 20 to 29 year olds allocated to these activities less than half the time of the 15 to 19 year olds. The good news is that the declining slope of physical activity somewhat flattened in the last decade and in 2005 physically active leisure of respondents in their twenties was only (!) 30% lower than of the 15 to 19 year olds. Obviously, age groupings serve as a substitute for *life-cycle* transitions and the 'time crunch' in the middle of the life course results from a cumulative pressure of multiple career, employment, family and status roles rather than biological age *per se.*

3.5 Social-occupational and educational differences

Social-economic status (SES) represents an important determinant of time-use and leisure behaviour (Wilensky, 1963; Ennis, 1968; Wippler, 1970; Zuzanek, 1978). Analyses of all GSS data show that respondents with the highest SES have less free time than respondents with lower economic status. Managers interviewed in the 1998 *GSS* reported having 4.7 hours of free time per day, compared to 5.1 hours for clerical employees and 5.7 hours for blue-

collar workers. Higher occupational status was also associated with elevated levels of perceived time pressure and feelings of stress (Zuzanek, 2005).

Higher education is not associated with lower amounts of free time, but rather with a different structure of its use. Respondents with a higher level of education spend a greater proportion of their free time than lower educated respondents in physically active leisure, reading and attending cultural events, and less time watching television.

4 Time use, social policy and well-being

Time use surveys contributed significantly to the better understanding of numerous social policy and well-being issues facing Canada. Time use data substantiated interest in the economic significance of non-market work (Harvey, 2001). Analyses of the effects of different work schedules on respondents' well-being provided important insights about the feasibility and effects of flexible and non-traditional work arrangements (Michelson, 1999; Zuzanek and Wenger, 2002; Hilbrecht, 2009). Time use data helped to resolve the controversy about changing levels of parental child care, showing that while the overall amount of time allocated by parents to the care of children has risen over the past two decades (Bianchi et al., 2006) this was due primarily to greater attention to toddlers, while contacts with teen-age children have declined, resulting in a "generation gap" that worries parents as well as policy makers (Zuzanek, 2005).

Time use surveys generated, as well, interesting insights about relationships between time use, well-being, and health. It was traditionally assumed that long hours of work have direct negative effects on respondents' health (Harrington, 2001). Time use data show, however, that this negative impact may be indirect. Self-assessed health of respondents working 45 to 49 hours in 1998 and 2005 was higher than of employees working shorter hours, but so were their levels of perceived time pressure and stress, harbouring dangers of a delayed "time bomb" explosion. Analyses of the social context of time use (with whom) showed that levels of happiness correlate negatively with the amount of time spent by respondents alone (Harvey and Pentland, 1999), that infrequent communication between spouses is an important predictor of possible family dissolution (Hill, 1983), and that social capital of volunteering and social networking contributes to happy and successful life careers (Zuzanek, 2000; Ravanera et al., 2003).

Perhaps somewhat unexpectedly time diary surveys also showed that greater amounts of leisure do not necessarily correlate with elevated levels of happiness and life satisfaction. It is the balance of work and leisure rather than an exponential growth of leisure that contributes to higher levels of subjectively perceived well-being (Robinson, 1977; Zuzanek, 2007).

One could extend the list of findings that exemplify contributions of time use research to the understanding of social processes and issues confronting modern societies, but this may be the

subject of another article. So let us now turn our attention to some of the pitfalls encountered by time use research.

5 Canada´s time use surveys – Limitations and gaps

There are, of course, limitations to what time use research can do. As any research instrument, time use surveys cannot provide answers to all questions that interest us. One of the limitations is that time use surveys are not the best instrument to measure participation in infrequent leisure activities, and attempts to use sophisticated statistical procedures (e.g., tobit regression) to circumvent this limitations are, in my opinion, problematic, particularly in view of the fact that there are other simpler methods (frequency of participation surveys) for obtaining the desired information.

It has been suggested, likewise, that time use surveys are descriptive and do not provide vital information about the meaning and motivation of human behaviour. Time use studies, allegedly, do not tell us why people engage in various activities and what meaning they attach to what they are doing. This may have been true of the early time use studies, but surveys of today usually contain, apart from traditional time-diaries, questions eliciting information about respondents' well-being, feelings of time pressure, most enjoyed activities, life satisfaction, health, etc. It is nevertheless true, that time diaries do not allow researchers to monitor experiential dimensions of human behaviour at the time when this behaviour takes place, something that Experience Sampling Method (ESM) surveys can do.[2]

In addition to these inherent limitations, Canada's time use research missed a few opportunities – things that could have been accomplished but for a variety of reasons have been overlooked or bypassed. It is some of these shortcomings that we will address in the following section.

5.1 One or more diary days?

As previously mentioned, Canadian time use surveys collect information allowing to examine the relationships between what people do, how much time they allocate to various activities, and their well-being. This requires, however, a qualification. One of the problems associated with the analyses of the relationship between time use and well-being in Canadian GSS surveys is that time diary data are collected for one day only. This is a shortcut. While the value

[2] The experiential sampling method, initiated in early 1970s by M. Csikszentmihalyi and associated at the University of Chicago uses pagers or wrist-watches randomly activated during the day to collect detailed information about what members of a surveyed population were doing at a given moment of the day, with whom, and how they felt about this activity. The ESM has increased the amount of information available to researchers for the analysis of changing moods, feelings, and attitudes of the surveyed population and allowed, among other things, to assess the role of *immediate and circumstantial* meanings of and motivations for human actions (see Csikszentmihalyi and Larson, 1987).

of happiness reported by a respondent supposedly defines his or her general life disposition, the time use with which it is correlated is accidental – a single day chosen by Statistics Canada. The question that comes instantly to mind is – how typical is this day of the overall patterns of behaviour of the particular person? Does the fact that he or she reported 9.0 hours of work on the day of the survey validate an assumption that we are dealing with a workaholic or a person typically working long hours? To circumvent this problem, the 1975 US time use survey sampled four days (two weekdays, Saturday and Sunday). In the Netherlands, time use surveys collect diary information for the entire week. Such research strategies are, of course, more elaborate and costly, but they provide better data for the analysis of the relationship between respondents' time use and well-being, something that increasingly interests researchers and policy makers.

5.2 Sampling individuals or households?

There is another issue with Canadian GSS time use surveys. They sample one person from randomly selected households. It is well known, nonetheless, that individual time use is largely influenced and constrained by time use practices and requirements of other members of the household. The gender gap in the use of time that attracted much research attention has been calculated on the basis of time use reported by men and women who did not form a couple. This complicates understanding of the dynamic of family division of labour as it happens within a household.

The use of the household rather than individual as the unit of time use analysis has been adapted in some countries, for example, Australia, Germany, and New Zealand. It was also used in the 1975 and 1981 US time use surveys. Of course, trying to interview several members of the same household complicates the data collection process, yet in return we get much better means for examining problems and challenges faced by families in modern societies.

5.3 Lowering the age threshold?

Another potential miss of Canadian national time use surveys is, in our opinion, the respondents' start-up age. In Canada, as in some other countries, time use surveys followed the Labour Force surveys model and sampled populations aged 15 years and older. This practice is changing, however. In many countries (e.g., United Kingdom, Netherlands, Finland, Norway, Portugal), the age threshold for time use surveys has been lowered to 12 and even 10 years (Finland). Lowering of the respondents' age has been recommended by EUROSTAT. Inclusion of 12 to 15 year olds provides information about the entry of teens into the labour force[3] as well as the relationship between teens' study loads, sleeping habits, well-being, and health. A National Adolescent Time Use and Risk Behavior Study commissioned by the United States Department of Health and Human Services found that the time use patterns of 10th graders were highly predictive of what they would do during one year after high school.

[3] In Canada, adolescents as young as 14 begin to work in the service sector, and paid babysitting or delivery of newspapers start even earlier.

5.4 How big a sample?

The sample of the 2005 GSS, as mentioned, almost doubled the sample of 1998. The underlying reason for extended sampling in Canada is our proverbial concern with regional differences. It would be interesting, however, to learn how frequently, in fact, have been time diary data used to assess regional differences. Unlike the labour force surveys, time use inquiries generally deal with social phenomena of a more universal nature that are relatively immune to local or regional differences. Therefore, if the size of the sample were to be increased, it would be preferable, in our opinion, to use this to lower the age threshold of respondents and use households as units of analysis rather than expand the sampling of individuals horizontally.

5.5 Innovation versus consistency

A serious challenge for time use surveys is a conflict between the desire to improve or add new measurements to the surveys and the need of across-time consistency. It is the latter, of course, that guarantees the possibility of objective trend analyses over longer periods of time. The goals of innovation and consistency, in most instances, can be reconciled by adding rather than modifying activity codes and well-being measurements. It was timely and appropriate for GSS surveys of the 1990s to add to the list of coded pursuits new activities brought about by technological and life style changes, such as watching video movies or surfing the Internet. As well, time use surveys of the 1990s benefited from the inclusion of measurements of time pressure, work-family balance, and perceived stress.[4] It is unfortunate, however, when modifications of activity codes or well-being measurements disallow historical and trend analyses. This happened, for example, when some activities coded in 1981 as domestic work were in 1986 coded as volunteering (e.g. housework and cooking assistance) or when in 2005 the coding of life and domain satisfactions was changed from a 5-point to a 10-point scale.

While a comparison of 1986 and 1998 data shows that life satisfaction levels declined slightly during the period separating the two surveys (from 3.4 to 3.3 on the 5-point scale), the rating of 7.8 (on the 10-point scale) in 2005 complicates historical comparisons. It is unclear what raised the rating (3.9 if divided by 2), particularly in view of the fact that the ratings of happiness and self-assessed health, for which the coding was not changed, remained almost identical in the compared years. The average ratings for happiness and health were 3.3 and 3.7 respectively in 1998 and 3.4 and 3.6 in 2005.

For time use surveys, one of the most important methodological problems is consistency of coding and grouping of activities. Changes in the definition, coding and grouping of activities are among the most common reasons for discrepancies in survey findings. While changes in grouping (classifying) of activities can be rectified by appropriate recodes, different coding instructions may irreparably reduce across-survey comparability. It is likely that lower figures for child care and higher figures for social leisure in the 1992 GSS time use survey, compared

[4] The 2005 GSS included questions about closeness with and trust in other people, but we still seem to be missing a composite measurement of mental health (e.g. depression).

to 1986, were due primarily to differences in coding. Simply stated, innovations should complement rather than confuse historical comparisons.

5.6 How large an omnibus?

General Social Surveys provide a welcome opportunity to examine a variety of social issues, including the use of time. Typically, time use surveys combine time diaries with questions about respondents' labour force participation, engagement in selected leisure and sporting activities, and well-being, including time pressure, perceived stress, life satisfaction, and health. Sometimes, however, GSS are used to "omnibus" fairly unrelated issues such as language proficiency (1986) or hindrances to the use of public transportation (2005). This prolongs the interview and requires psychological re-adjustment on the part of the respondent that may affect the quality of response and contribute to survey fatigue.

It is regrettable that the traditionally high response rates of Canadian time use surveys (approximately 80% in 1992 and 1998) have dropped to 59% in 2005. It has also been noticed that with the proliferation of telephone interviewing the mean number of activities reported by time use respondents has declined over the years. As a result, the emerging picture of daily behaviour becomes increasingly "broad stroked", occasionally blurring significant differences in human behaviour. A careful assessment of the compatibility of survey topics included into the same survey and simplification of excessively detailed questions about sporting and voluntary activities should, in our opinion, be given consideration in future Canadian time use surveys.

5.7 Too much bureaucracy?

In the 1990s, Statistics Canada and the Social Sciences and Research Council of Canada (SSHRC) launched an initiative that was intended to widen researchers' access to and increase their uses of national statistics. Research Data Centres (RDC) were established at major universities, where researchers and students could access unabridged versions of data collected by Statistics Canada. The publicly available data can still be accessed on-line but they often miss important information such as, for example, time of the year when time diaries were collected or exact age of children. The work confined to RDC offices is often cumbersome due to excessive concerns about respondents' privacy. All output files are "censored" before being given to researchers, and this process often takes weeks. While concerns about privacy are legitimate, their application has become excessively formalised and bureaucratised. Any finding in the output file that is based on fewer than 5 cases halts the release of the entire file. Researchers are limited to the analyses of relationships specified in their original applications and may be denied requests for output files containing information that is germane for the project, but was not listed in the original application. Work at RDC puts space and time limitations on researchers' access to the data and is not very convenient. It is our opinion that if, in the publicly accessible files, information about respondents' residency were limited to provinces and urban versus rural areas, potential abuse of time use data and invasion of privacy would cease to be a problem. Unlike social scientists who tend to believe Ben-

jamin Franklin's maxim "time is money", the crooks know that there is little money to be gained by canvassing time use data, and the weirdoes are unlikely to find much compromising time use information in studies that have traditionally underreported sexual, illicit, or illegal activities. In short, relaxation of RDC "censorship" practices and upgrading of publicly available GSS data sets are venues that should be given serious consideration.

6 Time use and well-being – Perspectives and conclusion

The last four years in Canada have been marked by an effort to construct a comprehensive Canadian Index of Well-Being (CIW). This effort initiated by Roy Romanow and spearheaded by the Atkinson Charitable Foundation contains time use as one of its major components. A report about the time use dimension of well-being, prepared for this project by Andy Harvey singles out four major types of time use relevant for the assessment of well-being, namely changing amounts of contracted time (paid work and education); committed time (unpaid work); necessary time (sleep, meals, personal care); and free time. Among "things that matter" the report lists access to "work-life" balance, intensity of social contacts, location of time use, and subjective experience of time, such as sense of time pressure and enjoyment of selected daily activities.

Although the task of creating a synthetic index of well-being and incorporating into it time use data is admirable, it is also tricky. The problem is that the relationship between time use and well-being, unlike relationships between GDP, unemployment rates, and performance of the economy, are not necessarily linear. Too much free time does not make people happier, but neither does its shortage. It is extremely difficult to quantify balanced use of time, yet human well-being is predicated on it. As has been said, teens need about 9 hours of sleep to maintain a healthy life-style. The number of hours supporting a healthy life style in mid-life may be lower. Yet, for both groups, too much sleep, similar to its shortage, carries negative well-being effects. The key word for optimising time use is "balance," yet we do not seem to know how to measure how much of a given activity is "too much" for different gender, age, life-cycle, or social-occupational groups. From this perspective, subjective measures of "time crunch" or "work-family balance" are important indicators of perceived life-style equilibrium, which together with time use data can help us to capture important aspects of personal well-being.

In this context, consideration may also be given to a "modular" design of national time use studies. Such an approach would allow the collection of "core" time diary and labour participation data from the entire GSS sample to be combined with information about specific well-being, health, educational, time-management or other policy relevant issues collected from sub-samples of the surveyed population.

The "modular" approach, unlike enlargement of the topical scope of a single survey, may allow specific issues to be examined in greater detail without over-burdening respondents with long interviews and the state Treasury with excessive costs. Sub-sampling of the GSS could allow researchers to obtain more focused and detailed information about life-style issues facing the youth, employed parents, and people living in rural areas. As well, it could possibly allow selective use of complementary data collection strategies, such as the Experimental Sampling Method (ESM), to obtain more in depth information about relationships between time use, emotional well-being and mental health.

If well-being is becoming increasingly our central policy concern, then broadening the methodological and substantial scope of time use inquiries is one of the most effective ways to enlighten our future policy decisions and contribute to the advances of Canada's time use research that was initiated – to return to the beginning of this article – by Andy Harvey.

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Harvey's hypercodes and the "Propogram" – More than 24 hours per day?

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Abstract

In the 1980s, Harvey originated the key concept for the representation of multiple simultaneous activities without violating the constraint of the 24-hourday – the "hypercode". This implements his conceptual innovation in the context of childcare, and suggests a means of graphical representation.

JEL-Codes: D10, J2, J22

Keywords: Time use, childcare, multiple simultaneous activities

Harvey's hypercodes and the "Propogram" – More than 24 hours per day?

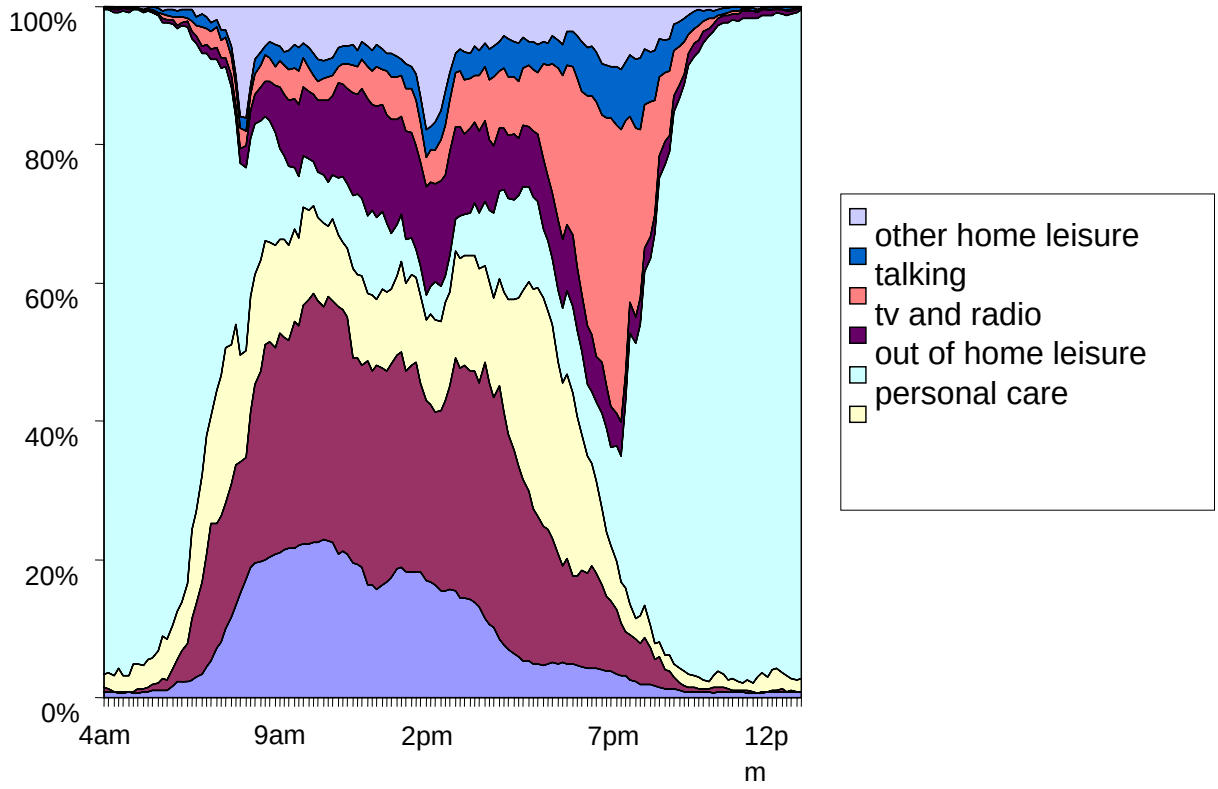
Andy Harvey has always placed himself just ahead of the research curve. He has undertaken innovative data collection and analysis across most if not all of the frontiers of diary analysis. Geo-coding, long duration (7-day) diaries, diary panel studies, real-time activity recording, analysis of activity sequences – all of these have been subject matters for his creative intelligence, frequently well ahead of their emergence into the generality of the social science literature. I first met him at the IATUR sessions (though they were not yet so-named) at the 1982 Mexico meeting of the International Sociological Association; he immediately gave me access to the original Szalai data files, which were the starting point for the Multinational Time Use Study. (He also lent me five dollars, reminding me not infrequently of this until I had the opportunity to pay him back at the 1986 ISA meeting.)

One of his earlier contributions, and perhaps the most important of his influences on my own approach to analyzing time diaries, was his treatment of multiple simultaneous activities. There are plainly just 24 hours in the day, and it is difficult to think of cases where it might be appropriate to sum primary and secondary activity to give more than the customary 1440 minutes (though various of the country time use tables at the back of the Szalai Use of Time volume do have exactly this unfortunate characteristic). There are in fact two alternative approaches: either (1) *ceding priority* to selected activities, or (2) producing *combination activities.*

Take the case of childcare in the lives of women with young children. Figure 1 shows the distribution of childcare – considering just the primary activity alone – through the days of young British women in 2001. Pretty continuous through the waking day, overall, not much more than one twentieth of the 24 hours. Is this a reasonable view of the part played by childcare in their lives?

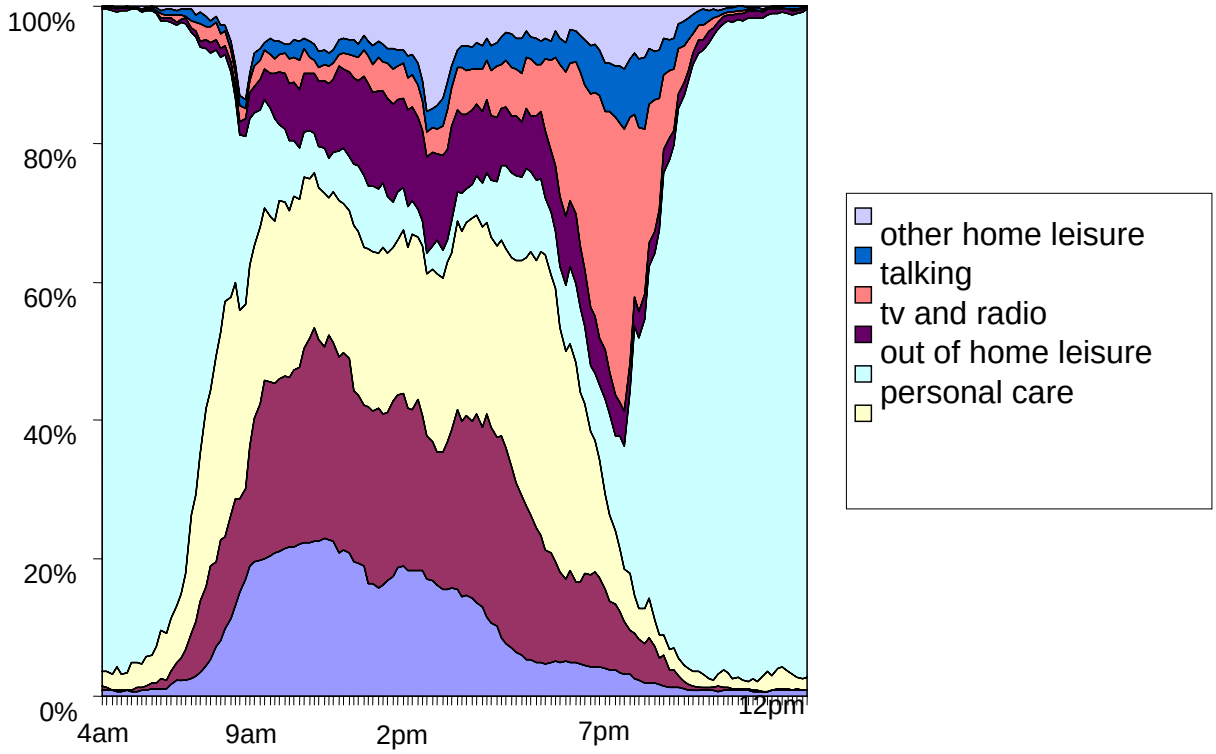
This must be wrong. All of us multitask. Women, with their own lives to lead *and* small children demanding various sorts of care and attention, must multitask more than most. Figure 2 illustrates this phenomenon by ceding priority to childcare, in accounts of the day, irrespective of whether it appears as a primary or as a secondary activity. Childcare time immediately doubles, (though of course this is merely a variant representation of just the same set of diary records) becoming more evenly spread throughout the waking day. This is perhaps a little more recognisable as the experience of mothers of young children, but it still leaves childcare apparently occupying quite a small minority of their time.

Figure 1
Women with young children, primary childcare



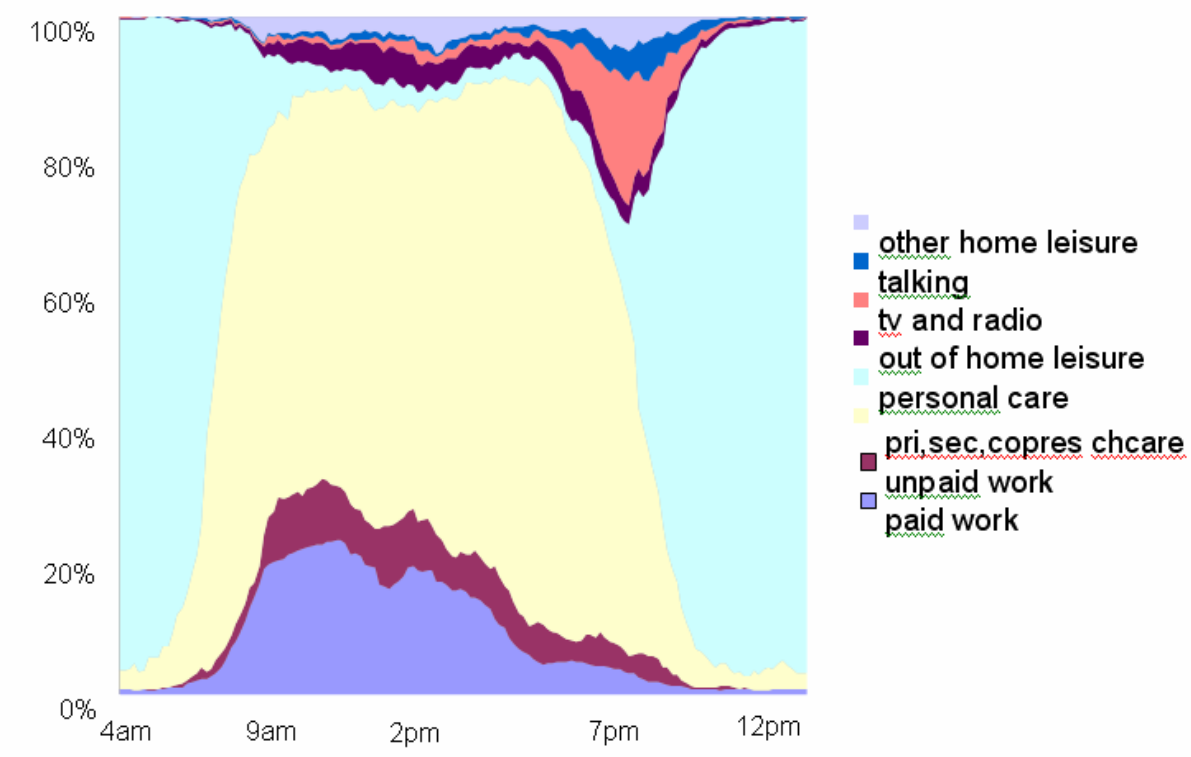
Source: Author's calculation, original UK data source.

Figure 2
Women, young children, primary and secondary



Source: Author's calculation, original UK data source.

Figure 3
Primary and secondary and co-presence



Source: Author's calculation, original UK data source.

Figure 3, which cedes priority not just to secondary childcare, but also to time spent in *the presence of* children, is in one sense the preferable representation, giving the correct impression of the dominant, the overwhelming, significance of child-affected activities in the lives of young mothers. Yet in another sense this picture is still quite wrong. Though it correctly shows the entire waking day suffused with child-related activity, it loses all the information provided by the diary about *what else* the mother is doing.

Hypercodes

Harvey (1978, 1984) tells us that this is the wrong way to go about representing multiple simultaneous activities. He proposes the use of the "hypercode"—in principle a multidimensional (though in practise usually bi-dimensional) representation of the combinations as single complex activities (for a succinct discussion of this technique, see Harvey, 1984, 132-134; Harvey, 1983, 54-59).

Table 1
UK women with children (0-4, 2001) – Primary acts and secondary and co-presence

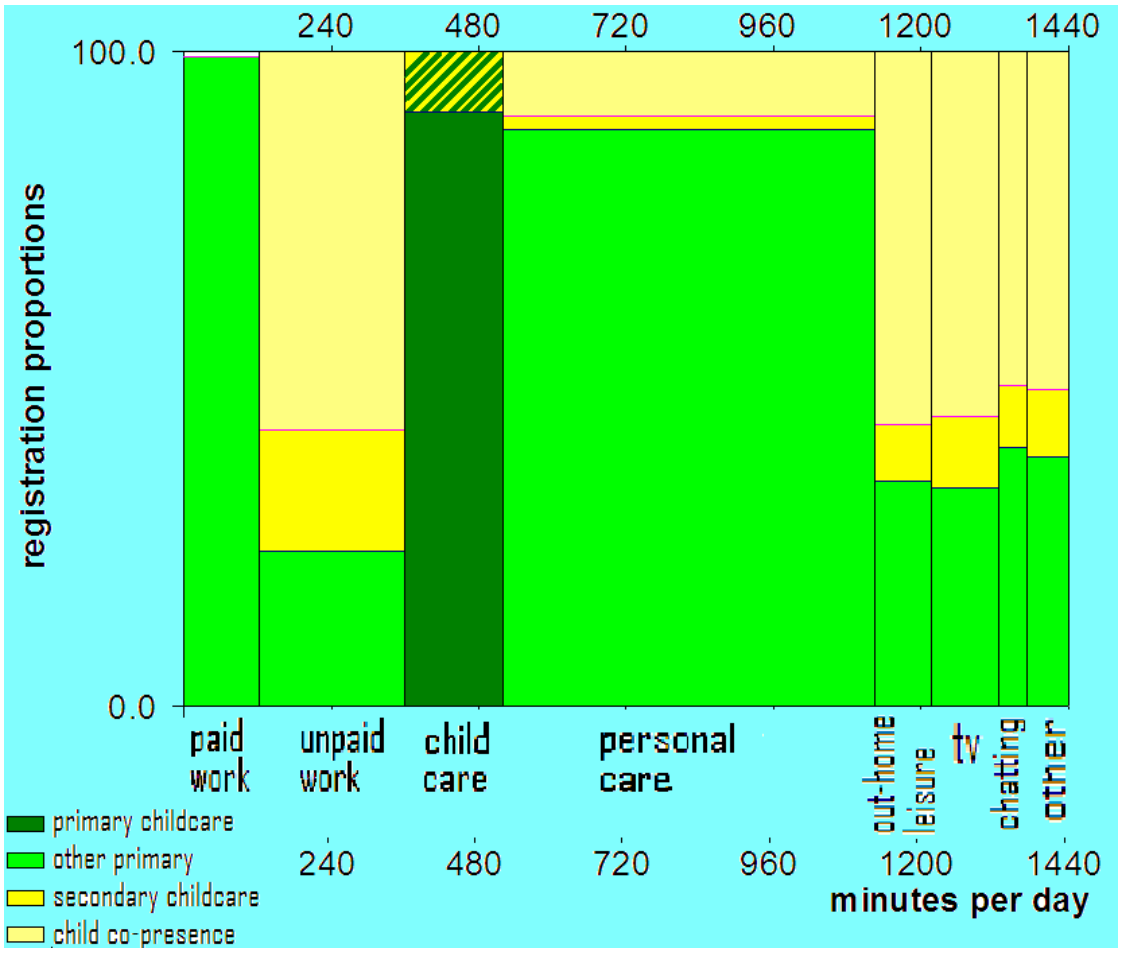
minutes per day	Total	primary only	secondary childcare	other child copresence
paid work	122	121	0	1
unpaid work	237	56	44	138
childcare	160	145	15	0
personal care	606	533	14	59
out-home leisure	93	32	8	53
TV and radio	111	37	12	62
chats etc	43	17	4	22
other home leisure	68	26	7	36
	1440	966	104	370

Source: Author's calculation, original UK data source.

Table 1 shows the same material but now in a much more informative hypercoded manner. The first numerical column "Total" is the normal primary activity "time budget" – in effect, the Figure 1 evidence integrated over the 24 hours. The final three columns are a tabular representation of Harvey's hypercodes, summing to 1440 minutes, yet still reflecting the full complexity of these young women's lives. The first of these columns shows the 966 minutes in which no secondary activity and no co-presence is recorded in the diary – for example, 56 minutes of domestic work with no secondary childcare, and no child-co-presence. More than half of these 966 minutes is accounted for by sleep. The second of the hypercode columns shows the minutes of secondary childcare, where something other than childcare is the primary—for example, 44 minutes of childcare coinciding with other sorts of unpaid work. And the final column gives the minutes of child co-presence that coincide with other non-childcare activities. The 138 minutes of child co-presence while engaged in other non-childcare unpaid work, added to the 44 of secondary childcare while doing other unpaid work, and the 56 minutes of unpaid work alone, sum to the 237 minutes of primary unpaid work time registered in the first column.

We can represent these hypercodes neatly in two dimensions, in the form of a base-proportional histogram or "propogram" illustrated here as Figure 4. Here the horizontal dimension, providing the bases of the activity histograms, represent the minutes in each of the primary activities of the day. The vertical dimension represents the proportions of each of these primary activities spent in that primary activity *alone*, in that primary activity *combined with childcare*, and in that primary activity *combined with child co-presence* (the cross-hatched area in the childcare column represents childcare primary activity combined with a *different* childcare secondary activity). It preserves the essential 24 hour characteristic of the time budget, while presenting it in its full complexity.

Figure 4
Primary activities and other childcare, mothers of children aged 0-4



Source: Author's calculation, original UK data source.

Andy Harvey has spent much of his professional life developing a protocol for collection of time diary material (see Harvey 1993, a fore-runner of the Harmonized European Time Use Study guidelines). In this work he has been determined to promote the collection of a full range of information in time-use diaries, insisting as a minimum on the necessity of multiple activities, co-presence, and location. His hypercodes are the essential conceptual basis for the tabular and graphical presentation of the complex evidence that emerges from the application of this sort of full diary instrument. They constitute the prerequisite for the advance of time budget analysis into the stage beyond that established by Szalai's (1972) path-forming *Use of Time* text.

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Timing and fragmentation of daily working hours arrangements and income inequality – An earnings treatment effects approach with German time use diary data

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Abstract

Traditional well-being analyses based on money income needs to be broadened by its time dimension. In the course of time the traditional full-time work is diminishing and new labour arrangements are discussed (keyword: flexible labour markets) with consequences on the daily work arrangements. Our study is contributing to the research on economic well-being and working hours arrangements by adding insights into particular daily work effort characteristics and its resulting income distribution. The work effort characteristics we regard is about labour market flexibility with focus on relations between the daily timing of work and its fragmentation, and its consequences on the income distribution. Whereas the first part of our study is describing the distribution of timing and fragmentation of daily work time and its resulting income based on more than 35.000 diaries of the most recent German Time Budget Survey 2001/2002, the second part of our study quantifies determinants of arrangement specific earnings functions detecting significant explanatory patterns of what is behind. The related economic theory is a human capital approach in a market and non-market context, extended by non-market time use, the partner's working condition, social networking as well as household and regional characteristics. The econometrics use a treatment effects type interdependent estimation of endogenous participation in a daily working hour pattern (self-selection) and pattern specific earnings function explanation. The overall result: Individual earnings in Germany are dependent on and significant different with regard to the daily working hours arrangement capturing timing and fragmentation of work. Market and non-market factors are important and significant in explaining participation and earnings thereof.

JEL-Codes: J21,J22, J24, D3, D31

Keywords: Time use and inequality, timing and fragmentation of daily work time, daily working hours arrangements, earnings explanation, human capital, market and non-market time use, German Time Budget Survey 2001/2002, time use diary data, treatment effects modelling, self-selection with endogenous selection

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1 Introduction

Personal remarks to Andrew Harvey

"Do you already know this jazz record? It's special." Andy put on another record and we both had another good evening with music and a whisky cheer at his home in Halifax. With a good sense of "a proper use of time" – one of his distinguished advices, promoting Dagfin Aas's IATUR toast, about time use – Andy is linking work and leisure in a compound life – an approach of time use research in general with time as the encompassing dimension and coordinator of all daily activities. While my (Joachim Merz) younger research colleagues Paul Böhm and Derik Burgert had not yet the chance of a more personal contact to Andrew Harvey, nevertheless we all are inspired by Andrew Harvey with regard to our time use research at the Research Institute on Professions (FFB) of the Leuphana University Lüneburg (Germany): Paul Böhm and Derick Burgert have their contact mainly via the research topic here of a fragmented day (see Harvey et al., 2000); Joachim Merz, in addition to the research topic here and many good leisure hours, has known Andy for many years collaborating on work including the assessment of the American Heritage Time Use Data (see eIJTUR time pieces, 2005; Harvey and Croix, 2005; Merz and Stolze, 2008) or as common editors of the electronic International Journal of Time Use Research (www.eIJTUR.org). Both, at work and beyond, it's good to have him looking forward to more common enjoyable hours.

Research topic

Economic well-being described by income and income inequality is a traditional focus of scientific and public interest. The connected time, however, that individuals have to spend to earn that income is a rather infant research field.[1] If only the distribution of money income would be regarded, inequality differences would neglect differences in working time efforts with misleading results about ('total') economic well-being. Our study is contributing to research on economic well-being and working hours arrangements by adding insights into particular work effort characteristics and its resulting income distribution. The work effort characteristics we regard are about the raising importance of labour market flexibility.[2] The focus lies on relations between the daily timing of work and its fragmentation on the one hand, and its consequences on income inequality on the other hand. With our focus on 'who is working

[1] But see Merz (2002a,b), Osberg (2002), Merz and Kirsten (1999), Jenkins and O'Leary (1996), Lee (2001), Doiron and Barrett (1996), Burtless (1993).

[2] Flexible labour markets are discussed under further various topics. To mention only a few: Atypical working hours (Addison and Surfield, 2009; Lesnard, 2008; Glorieux, Mestdag and Minnen, 2008; Glorieux and Minnen, 2004), social policy and flexible working time (Büssing and Seifert, 1995), firm side working time arrangements (Bauer et al., 2001), time famine and time squeeze (Bonke and Gerstoft, 2005; Sullivan, 2007; Clarkberg and Moen, 2000), time and income poverty (Merz and Rathjen, 2009), working hour tension as the tension between desired and actual working hours (Merz, 2002b; Holst and Schupp, 1994), effects of flexible working hours to leisure and family (Le Bihan and Martin, 2005; La Valle et al., 2002; Townsend, 2001; Garhammer, 1994,) or tax and transfer policy impacts on the working hours in the formal and informal economy (Merz, 1990).

when within a day and its earnings impacts' we go beyond traditional labour market analyses where the working situation is characterized by aggregated and stylized labour force participation attributes in general like full and part time work, shift work, atypical work from work weekly or monthly working pattern.

Overall labour market flexibility shows a remarkable change in working hours arrangements within the last decades showing an erosion of normal working arrangements and a growth of atypical and precarious employment. Whereas 1998 about three of four (72.6%) had a normal employment in Germany,[3] there were only two of three (66%) of them in a normal employment 2008. The fraction of atypical jobs has grown in that decade from 16.2% to 22.2%. And, these changes have income consequences for the differently employed: Almost half of the atypical employed have low income (less than two third of the median hourly wage) compared to 11.2% of the normal employed. And, the risk of poverty (2006) is remarkable higher in atypical jobs (14%) than in normal jobs (3.2%) (Federal Statistical Office Germany, 2009).[4]

Though the traditional labour market perspective on weekly or monthly pattern provides important information like the above data about atypical employment, however, many labour market questions require just the daily perspective and its timing of work aspect: What's about the flexibility pattern within the all day living situation? How fragmented is a work day also in case of multiple jobs? What are the impacts of flexibility and fragmentation on social participation and social exclusion? What's about the arrangements of all day personal and family life in particular? What are the consequences of fragmented work days for female labour participation and governmental support of pre-school and school child assistance? With these and more topics the underlying policy relevant general question is how labour market rigidities concerning working time resulting in daily fragmented work is influencing all day individual life and well-being. Once determinants of daily working hours arrangements are detected, a more targeted new economic and social policy will be possible.

Our overall aim to provide quantified information for such daily working hours arrangements and its income consequences will focus – enhancing the paid work perspective – on an additional dimension: we are explicitly interested on the influence of time use patterns beyond paid work such as non-market household activities and social network active engagements and received support.

Analyzing daily timing of work requires a demanding individual data base describing the daily use of time in detail. This data base is available by the new latest German Time Budget Survey 2001/2002 with its more than 35.000 individual time diaries and is the micro data base of our study.

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[3] Normal employment here is defined as full time job or part time job with more than 20 weekly working hours.

[4] A long-run two century discussion of the rise and fall of normal working hours ("Normalarbeitsverhältnisse" in Germany is recently discussed by Pierenkemper (2009).

In the literature, the timing of work time is accentuated by Hamermesh (2002, 1998, 1996a) showing that with 'appropriate data the analysis of time use, labour supply and leisure can move beyond the standard questions of wage and income elasticities of (aggregate) hours supplied' (Hamermesh, 2002, 601). With focus on the daily working hours arrangements the timing and fragmentation of daily work time based on German 1991/92 time use diaries is analyzed by Merz and Burgert (2003a); its development to 2001/02 by Merz and Burgert (2004). Though some insights of German daily working hours arrangements are provided, however, its consequences on income and its distribution needs further analyses: it is the contribution of the paper at hand, an extension to the liberal profession's perspective by Merz and Böhm (2005, 2008). Further associated international working time arrangement studies based on time use diaries are e.g. Harvey et al. (2000) comparing four countries in the early 90s (Canada, the Netherlands, Norway and Sweden) or Callister and Dixon (2001) based on the New Zealand Time Use Survey 1998/99. Harvey's work in particular was an important impetus for us to use the power of time use diary information for this in-depth labour market analysis.

Combining the time and income dimension, naturally, our study is embedded within its single dimensions, the general time use research area (Merz, 2009; Merz and Ehling, 1999; Harvey, 1999; Merz, 2002a; or National Research Council, 2000), the labour market research (see the surveys by Blundell and MaCurdy, 1999; Killingsworth and Heckman, 1986; Pencavel, 1986 and Killingsworth, 1983) and the economic well-being and income distribution literature (see Silber, 1999; Champernowne and Cowell, 1998; Sen, 1992; or Atkinson, 1970).

Paper organisation and topics

Based on diary time use data of the German Time Budget Survey 2001/2002 (Section 2) we describe the daily working hours arrangements into two main dimensions: the timing and fragmentation of daily work time considering core and non-core working episodes and number of working episodes (Section 3). We then analyze the consequences of the daily working hours arrangements to the income distribution (Section 4). The second part of our study quantifies determinants of arrangement specific earnings functions detecting significant explanatory pattern of what is behind. We employ a human capital approach, extended by non-market time use, the partner's working condition, social networking as well as household and regional characteristics. The microeconometrics use a treatment effects type interdependent estimation of participation in a daily working hour pattern (self-selection) and pattern specific earnings function explanation (Section 5). Section 6 concludes.

2 Data – The German time budget survey 2001/2002

The following analysis is based on data from the actual German Time Use Survey conducted by the Federal Statistical Office in 2001/02 (Ehling et al., 2001). The main part of the survey

constitutes the time use diaries. The sample contains 35,813 diaries of 11,962 persons (10 years and older) in 5,171 households.[5] The duration of the individual activities in the diaries was created according to the recommendation for the European time budget survey: each activity is marked on a timescale which shows ten-minute steps. In addition to the diaries the sample also includes information about household and personal characteristics.[6]

The final data used for the analysis restricts the extensiveness of the original data as follows. Although many retirees and children are working, they often have jobs which contribute only a small share to the total household income. For that reason, we restricted our sample to people aged 15 to 65. For the sake of consistency, we deleted all observations reporting activities of gainful employment but not reporting any income. After these restrictions the set contains 26,949 diaries of 9,080 persons in 4,553 households. To construct the different categories of daily working hours arrangements in Chapter 3, it is necessary to define those activities belonging to 'work'. In particular, these are:[7] Main gainful employment, additional gainful employment, extended professional qualification during working time, practical placement.

3 Daily working hours arrangements – Timing and fragmentation of work

The traditional 'normal' full time working day, as mentioned, is more and more replaced by different working hours arrangements in the course of time. Whereas there are many studies concerning an overall defined full-time and part-time working arrangement (see our introduction) at least for Germany there are only some studies which inspect the daily working hours situation based on diary data (Merz and Burgert, 2003a, 2004). The very reason is the so far lack of the needed challenging data base, a diary based time use survey, which is available now by the most recent German Time Budget Survey 2001/2002, the data base of our study.

To analyse the daily working hours arrangements we consider two central dimensions: First, information about the timing of work time (the location of the working hours the day), and second, information about the fragmentation of a working day (the number of working episodes). We expect and will investigate the significance of these dimensions of daily working hours arrangements and ask for consequences on the income pattern and the explanation of earnings.

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5 Every individual was to write down the course of their day on three days (two weekdays and one Saturday or Sunday).

6 The household characteristics can be divided into three groups: The first group contains information about the equipment of the household, e.g. the number of cars, microwave ovens etc. A second group contains household characteristics that cause special time-use for its members, e.g. people in need of special care. The third group of variables reflects the type of household, i.e. household composition or household income. The personal characteristics include socio-economic information of the respondents as e.g. gender, school leaving certificates, etc.. Another part of the German Time Use Survey consists of information about characteristics leading to time use behaviour, for example if and how long a person regularly helps members of other households. A last group of variables reports self-assessment and plans concerning the subject's time use.

7 We hereby follow as much as possible the international definition chosen by Harvey et al. (2000)

Dimension I – The timing of work

In this dimension daily paid work is mainly done within a core working period. In Germany, most of the working episodes start between 7am and 8am and end between 4pm and 5pm. Consequently we define the period between 7am and 5pm as the core working period and the time before and after that core period as the non-core working period. A working day where work mainly is done at this non-core period is the timing aspect of an irregular and 'non-normal' working day with shift and night work.[8]

Dimension II – The fragmentation of a working day

Our second dimension is the fragmentation of a working day. To get information about the fragmentation, we used the number of working episodes which are interrupted by a break.

But what is a break? Can ten minutes, say, of work interruption already be regarded as a break or not? It is obvious that the composition of the categories and our results depends on the definition of a break which forms the basis of the calculations. In the following we interpret – with German workday situations and with respect to the international study of Harvey et al. (2000) – breaks shorter than 60 minutes as a within work period break and thus as an inherent part of the working time. A break longer than an hour is an unusual break and characterizes a real fragmentation with the possibility of starting another secondary job. A further inspection of the type of breaks is given in section 3.3 below.

An interruption of the working episode by at least one break in addition to core vs. non-core work then is the second disturber of a 'normal' workday and a characteristic of a 'non-normal' working day.

With these two dimensions of different daily working hours arrangements, the traditional working day can be interpreted as a working day in which work is mainly done within the core period in one working episode without longer interruptions. Combining these two dimensions we get four different categories of daily working hours arrangements, which are in the further focus of our investigation.

3.1 Daily working hours arrangements in Germany – Combining timing and fragmentation of work

Combining the two dimensions we get a two by two table of daily working hours arrangements in Germany for 2001/02 in Table 1.

Category I includes ‚normal' working days, in which work is mainly done within the core working period and which only consist of one working episode (no interruption by breaks). In contrast here upon the categories II and III differ in exactly one dimension from the definition of a ‚normal' working day. So the working days in category II can be described as days with mainly core work, but which are, at the same time, interrupted by at least one break. Working days without breaks showing a work activity mainly outside the core working period are de-

[8] This is in line with a similar definition in the international study by Harvey et al. (2000).

scribed by category III. Category IV deviates in both dimensions from the normal case. The persons in this category work outside the core period and with at least one interruption.

Table 1
Daily working hours arrangement categories by timing of work and fragmentation in Germany 2001/2002

		Timing of work		
		Mainly core	Mainly non-core	Total
Fragmentation	One episode	I 65.1% n = 6,884 N = 40,503,406	III 6.5% n = 716 N = 4,037,688	71.6%
	Two or more episodes	II 25.1% n = 2,698 N = 15,605,547	IV 3.3% n = 350 N = 2,026,132	28.4%
	Total	90.2%	9.8%	n = 10,648 N = 62,172,772

Source: German Time Use Survey 2001/02, weighted data, own calculations.

The ‚normal' working day is the most frequent case: 65.1% of all working persons belong to category I. At the same time, however, about 35% are working outside such a so far normal daily working hours arrangement and might be characterized as atypical working persons.[9] The prominent category of a ‚non-normal' daily working hours arrangement is category II with a share of more than one fourth of all persons (25.1%). The most irregular working situation is category IV with about 3.3% of all workers. About ten percent are working outside the core period (9.8%), while 28.4% of the working days show at least one longer break per working day.

Remarkably, atypical, non-normal daily working hours arrangements have risen in the last decade by about 6% points to the burden of normal working hours (category I): compared with diary data from the German Time Budget Study 1991/92 the fraction of fragmented working days rose by 4.6% points (core: 4.0% points, non-core 0.6% points) as well as the most irregular non-core/fragmented daily working hours arrangement (1.3% points).

As expected, the arrangement results vary with different definitions of the minimum length of the breaks (see Appendix Table A1). Defining a break as an interruption of only 30 minutes and more, then only 27.4% of all working days remain in a normal workday compared to 65.1% by a 60 minute break. Using a break definition with a larger minimum length the number of breaks decreases and so the number of episodes. Obviously the longer the break is,

[9] About 60% (weighted, 16,301 non-weighted cases) of all total population diaries are not working these days and therefore are not part of the following analysis.

there will be an increasing share of non-fragmented work. For example, 78% of all would count to a normal working day if using a 90-minute-break definition.[10] With respect to the German situation, our 60 minute breaks might be a quite good approximation for a non-normal interruption of a working day, because 'normal' breakfast and lunch time breaks are distinctly less than one hour; more break characteristics are provided in chapter 3.3 supporting our definition.

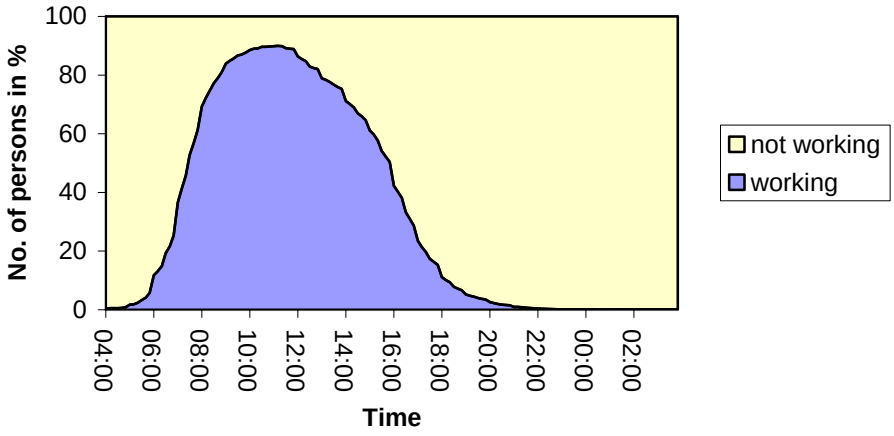
3.2 Some characteristics of daily working hours arrangements

Let us now inspect some more main characteristics of our four daily working hours arrangement categories. For a better understanding, we differentiate between working hours ('working'), temporary interruptions of work ('breaks') and hours in which no work is done ('not working'). The non-working time covers both the period until the first working period and the period after the last working period.

Category I – Core/one episode

Within category I which includes the 'normal' working days, a working episode lasts 7h 40min on average. Figure 1 shows the work frequency profile over the entire day. At 7am – the assumed starting point of the core-period – more than one third of the persons are working. The most people work in the peak period between 11:10 and 11:20 (90%). At the end of the core-working period, i.e. at 5pm, more than 28% of the people are still working.

Figure 1
Daily timing of work – Category I (core/one episode)



Source: German Time Use Survey 2001/02, own illustration.

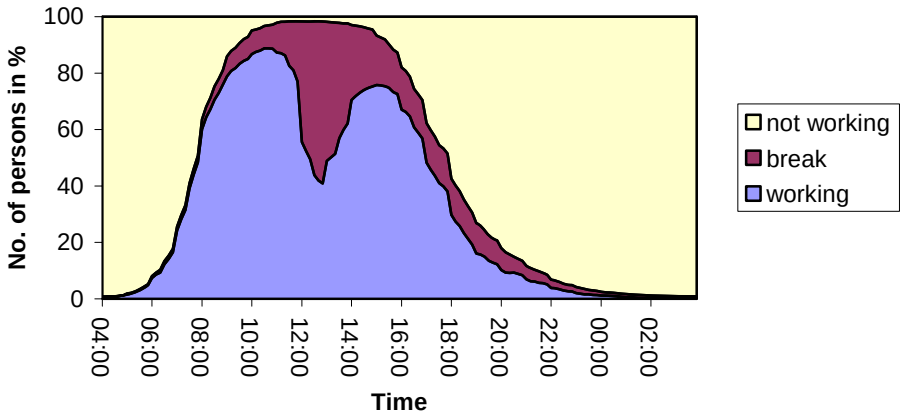
Category II – Core/fragmentation with multiple episodes

This category includes all working days showing mainly core-work activity and with at least one interruption (multiple episodes). On average 7h 22min daily are spent for work, whereas almost two and a half hours are spent for breaks on average.

[10] See further break duration sensitivity results in the appendix.

Figure 2 shows the daily timing of work and breaks within this category. At 4am, only 0.7% of the people are working, while at 7am already 24% have started to work. Noticeable are the two peaks of the working curve at 10:40 (share = 88.8%) und at 3pm (share = 75.7%). Between these two peaks, the share of the persons interrupting their working hours reaches its maximum at lunchtime, i.e. in the period between 12:50 and 1pm (share = 57.4%).

Figure 2
Daily timing of work and breaks – Category II (core/multiple episodes)

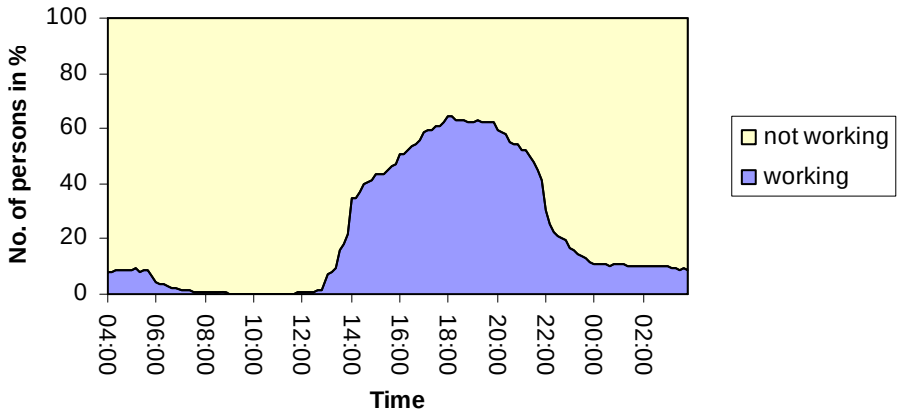


Source: German Time Use Survey 2001/02, own illustration.

Category III – Non-core/one episode

The average working hours in this category is substantially smaller than in the other categories, only five and a half hours are spent for work. Figure 3 shows that the working hours are situated mainly in the afternoon and evening. The peak of the working curve is at 6pm, when almost two thirds of the people are working (share = 64.5%).

Figure 3
Daily timing of work – Category III (non-core/one episode)

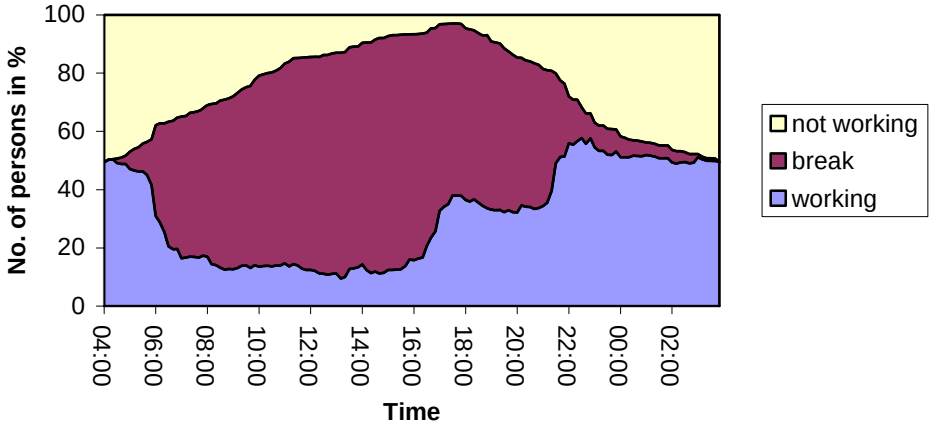


Source: German Time Use Survey 2001/02, own illustration.

Category IV – Non-core/fragmentation with multiple episodes

The structure of the most irregular working day within category IV is relatively fragmented. The big share of night-work is most remarkable, while the period between 6am and 4pm is mainly used for breaks. Hereby it is necessary to mention that the diaries are recorded from 4am on. Changing this specification the analysis would probably bring different results compared to the representation in Figure 4.

Figure 4
Daily timing of work and breaks – Category IV (non-core/multiple episodes)



Source: German Time Use Survey 2001/02, own illustration.

In the case of a night-worker, one reason for these expected differences is, according to our definition, that the time between the end (in the morning) and the beginning of a shift (in the evening) has to be interpreted as a break.[11]

3.3 Activities in the working breaks

The central question with regard to the characterization of multiple episode working days is the character of the respective breaks. Do they break into different working episodes within the same job, or do they mark the switch to another employment? Unfortunately, by the data at hand we can not distinguish between two employments the day, because a second job flag only is provided in general and not connected by the individual activities of that day in the diary. However, we are able to further characterize the breaks to give some hints of the breaks' characteristics and possible changing employment situations.

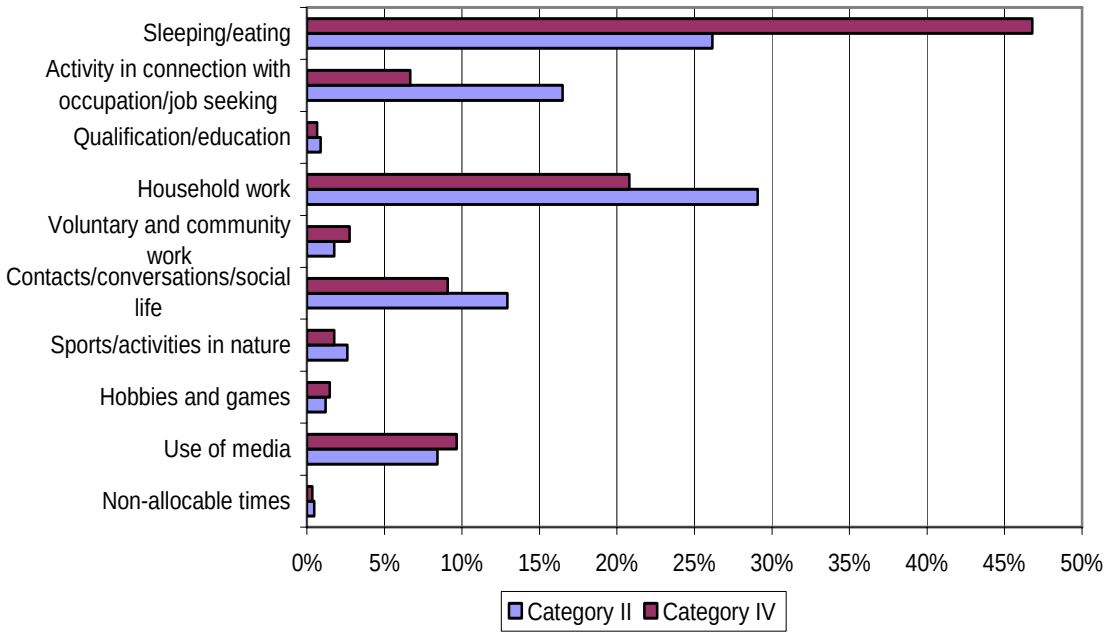
As of our categorization, category II (core/multiple episodes) and category IV (non-core/multiple episodes) have more than one working episode. Figure 5 shows the break activities of the persons within these categories. Regardless the core or non-core situation, in both categories the break is mainly used for sleeping, eating and household work. Nevertheless there are partly large differences between these categories regarding their break activities.

11 Figure A1 in the appendix shows the situation when night workers are excluded. Without the persons who are working between 3:50 and 4:10am only 198 cases remain in this category.

The most irregular working situation of category IV (non-core/multiple episodes) which consists mainly of night-workers has long sleeping breaks. As mentioned above, the period between the end of work time (in the morning after 4am) and the start of work (in the evening) of a night-worker has to be interpreted as a break (with the chance to sleep) as well.

In contrast to this, the persons in category II spend the day time between their working episodes besides sleeping and eating mainly with household work and social life.

Figure 5
Activities in breaks by category



Source: German Time Use Survey 2001/02, own illustration.

To conclude, the inspection of the daily breaks' characteristics does not allow to characterize multiple episodes as multiple jobs directly, however, further aspects of the German working situation and the general second job flag might provide some respective indication (see our microeconometric results).

4 Daily working hours arrangements, income and its distribution

We assume and want to disentangle that different daily working hours arrangements result in different income patterns. How do differences in income look like among different working hours arrangements? Are there at all any significant differences in the distribution of net income and what income can be detected when somebody decides for a certain arrangement?

To answer these questions we analyse the income distributions within the four different daily working hours arrangements first by graphic inspection via Kernel density estimates and cen-

tral distributive measures as well as by Shorrocks' decomposition of inequality. The microeconometric estimation then tries to explain differences.

The available income under inspection is personal net income[12] which is a person's reported monthly income from main and additional gainful employment after taxes and social insurance contributions of a person. To disentangle the influence of the number of working hours and the wage rate per hour we divide our analysis into the inspection of the income as well the hours and wage distribution.

4.1 Income distribution and daily working hours arrangements

The graphical inspection is followed by the discussion of central distributive measures.

Graphic inspection – Kernel income density estimates of daily working hours arrangement

A first graphical inspection of the respective income distributions by Kernel density estimates of monthly net income for the different daily working hours arrangements (Figure 6) in general shows an expected left ascending distribution for all daily working hours arrangements.[13] However, the pictures differ between categories. The normal working activity pattern of category I (core/one episode) is dominating the average all working profile. More episodes within the core working period result in a shift to the right where higher income are met more frequently.

The non-core workdays result in quite different income distributions compared to the normal workday: lower income is more frequent for the one episode case, higher income is more frequent for multiple episodes.

Thus, the first graphical inspection already shows that our daily working hours arrangement specification is important for the resulting income distribution: different income distributions are the result of different daily working hours arrangements; in particular for the non-core arrangements.

Distributive results by respective measures

For getting more differentiating results Table 2 provides central income distributive measures[14] for each single daily working hours arrangements.

The categories with the highest average income are the categories with multiple episodes (categories II: 1,802€ and IV: 1,787€). In contrast to this, persons with ‚normal' working hours arrangements (category I) have an average income of 1,552€, the persons in category III (non-core/one episode) only of 1,320€. The median for each category is smaller than the mean

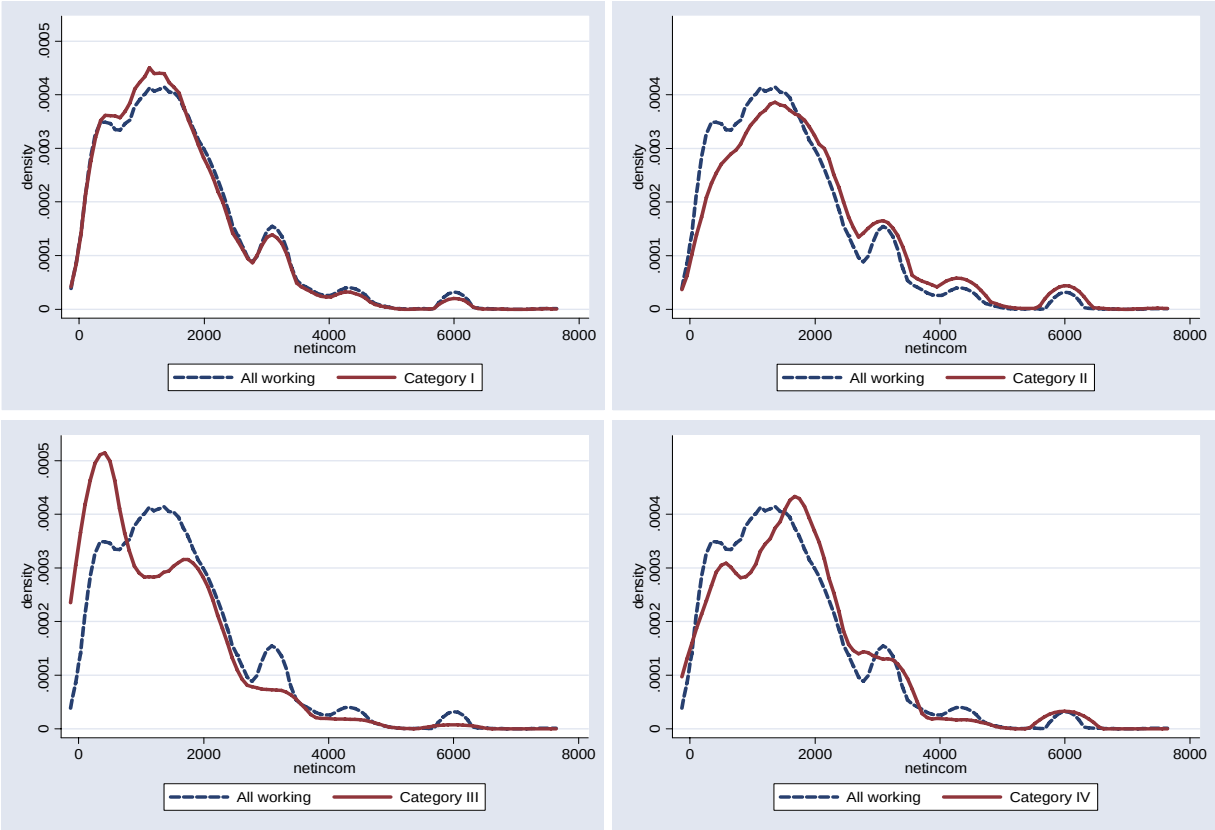
[12] Besides announcing his/her exact monthly income each individual had the possibility to indicate his income in income classes. If income information is given in classes, we replace it by their respective mean. To avoid biased results we excluded 41 extreme outliers through which the number of analysed diaries is reduced to 10,607. Among others all diaries with weakly working hours of less than 1 h were deleted.

[13] Different peaks mainly are due to the middle class approximation of bracketed income data.

[14] Distributive measures are discussed in Atkinson (1970), Lüthi (1981), Cowell (1995) or Maasoumi (1999).

indicating a respective left ascending distribution, which is also supported by the positive values of the skewness coefficients.

Figure 6
Kernel density estimates of monthly net income by different daily working hours arrangements



Notes: (core – one episode (1); core – multiple episodes (2); non-core – one episode (3); non-core –multiple episodes (4)); Epanechnikov kernel using optimal band width.
Source: German Time Budget 2001/02, own illustration (Stata 8.2).

There are remarkable income inequality differences between the four daily working hours arrangement categories measured by the Gini coefficients. This is supported by the relative higher Gini coefficients which are sensitive to middle income. The Atkinson-Index is calculated with a relative small ($\varepsilon = 1$) and a relative high ($\varepsilon = 2$) inequality aversion to cover a broad spectrum with a multitude of possible normative evaluations. Both the Gini coefficient and the Atkinson-Index prove category III (non-core/one episode) as the category with the most unequal income distribution. For this category the Gini coefficient amounts to 0.36723 which is by 9.7% higher than the Gini coefficient for category II, by 16.6% higher than the one for category I and by even 23% higher than the one for category IV – the category, surprisingly, with the relatively most equal distribution. The Atkinson-Index, sensitive for lower income, confirms this result. Remarkable is the fact that the Atkinson-Index for the categories I, II and IV does not show any big differences which indicates that the lower income profile of these categories is not very different. Note: Not expected, the most irregular working hours arrangement (non-core/fragmented) results not only in a relatively high but also in the most

equally distributed income. As we will see in addition category IV will show the highest average working hours.

Table 2
Net income – Distributive measures by daily working hours arrangement

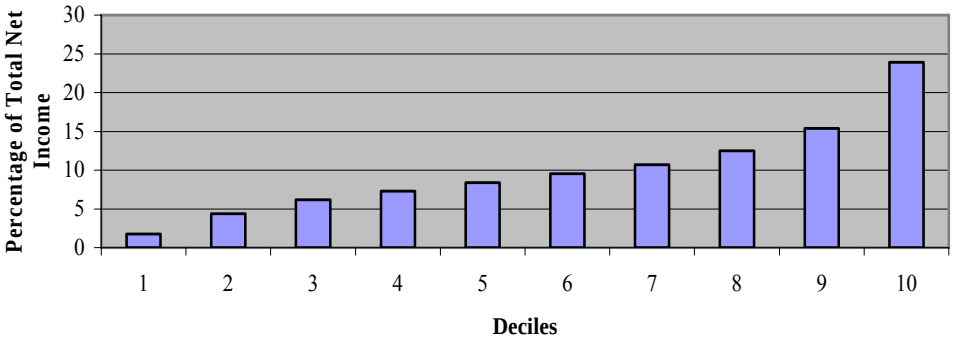
	Working	**Category I** Core One episode	**Category II** Core # episodes > 1	**Category III** Non-core One episode	**Category IV** Non-core # episodes > 1
Mean in €	1,607.69	1,552.22	1,802.42	1,319.72	1,787.20
Median in €	1,431.62	1,380.49	1,556.62	1,252.67	1,636.13
Skewness	1.57	1.51	1.53	1.17	1.76
Kurtosis	4.04	4.07	3.05	2.67	5.10
Variation coefficient	0.63	0.60	0.65	0.68	0.60
Distributive measures					
Gini coefficient	0.32563	0.31487	0.33476	0.36723	0.29871
Atkinson-Index					
$\varepsilon = 1$	0.19580	0.18435	0.19528	0.27102	0.18412
$\varepsilon = 2$	0.45425	0.43385	0.43287	0.58784	0.45809
Decile shares in % (Decile limits in €)					
1st decile	1.77 (511)	1.88 (511)	1.99 (625)	0.98 (230)	1.72 (625)
2rd decile	4.38 (875)	4.53 (875)	4.41 (920)	2.60 (500)	4.57 (1074)
3rd decile	6.17 (1125)	6.33 (1125)	5.93 (1125)	4.76 (750)	7.25 (1375)
4th decile	7.26 (1253)	7.43 (1227)	6.88 (1351)	6.97 (1100)	7.75 (1500)
5th decile	8.37 (1432)	8.49 (1381)	8.05 (1557)	8.99 (1253)	8.42 (1636)
6th decile	9.53 (1625)	9.63 (1585)	9.07 (1770)	10.10 (1432)	9.70 (1875)
7th decile	10.70 (1875)	10.69 (1790)	10.69 (2119)	11.90 (1636)	11.08 (2000)
8th decile	12.49 (2147)	12.50 (2125)	12.47 (2434)	13.40 (1943)	11.66 (2375)
9th decile	15.40 (3000)	15.18 (2812)	15.87 (3170)	15.83 (2250)	14.71 (3125)
10th decile	23.93	23.35	24.62	24.47	23.13
90/10 Relation	13.52	12.42	12.37	24.97	13.45
Decomposition					
Theil Index	0.18166	0.16983	0.18846	0.23217	0.16407
Inequality shares in %		59.94	29.82	6.93	3.31
Group share in %					
within	98.09				
between	1.91	-	-	-	-
n	10,607	6,859	2,689	712	347
N	61,962,578	40,360,174	15,581,494	4,014,101	2,006,809
N in %	100.00	65.14	25.15	6.48	3.24

Source: German Time Use Survey 2001/02, own calculations.

A closer look on the income distribution is provided by income shares of the poorer and the richer population. The deviations of the decile shares of the different daily working hours ar-

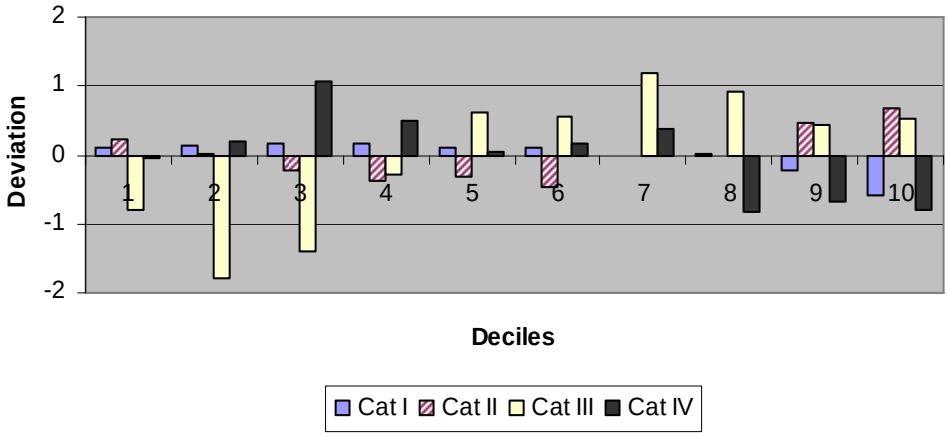
rangements compared to the average decile shares of all working in percentage points are illustrated in Figure 7; Figure 8 shows the cumulative situation by their Lorenz curves.

Figure 7a
Net income – Decile shares of working (all categories)



Source: German Time Use Survey 2001/02, own illustration.

Figure 7b
Net income – Deviation of category decile shares compared to the decile shares of working (all categories) in percentage points



Note: all figures are due to total decile share limits.
Source: German Time Use Survey 2001/02, own illustration.

One of the decile shares is of particular importance: the 50% decile share, the well known median. As of Table 2, the lowest income and most unequal distributed category, category III, also has the lowest median: 50% of those people earn less than 1,252€; that is 24% of the total income of that group.

To characterize the income spread with focus on the poorest and the richest, the 90/10 relation shows the multiple of the richest 10% income share compared to the income share of the poorest 10%. Again, category III is in particular different to the other categories: the richest 10% there gain 25 times as much as the poorest 10%.

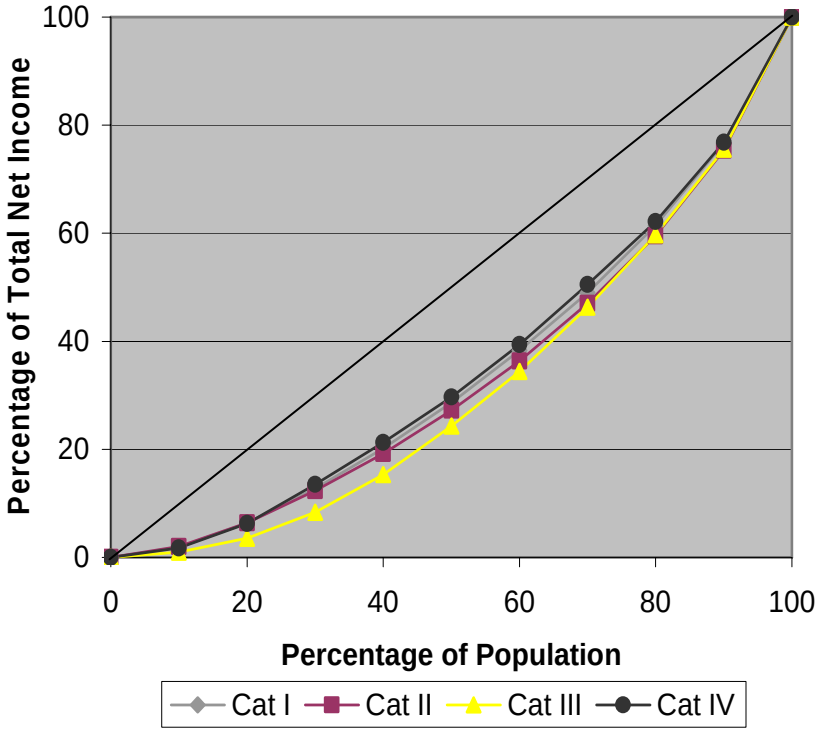
Decomposition of inequality

To answer the question how much of the overall inequality can be 'explained' by the specific groups a decomposition of the overall inequality into inequality within groups and inequality between these groups is required. Such decomposition is available via a class of additively decomposable inequality measures (Shorrocks, 1980, 1984) with

$$I_{total,c} = I_W + I_B = \Sigma_g I_{Wg} + I_B = \Sigma_g (n_g/n) (\mu_g/\mu)^c I_c(y_g) + I_B$$

where I_W is within and I_B is between group inequality, g is the group index, μ is the overall respective group mean, n is the number of observations, $I_c(y_g)$ is the group inequality index dependend on group's incomes y_g; the group weights $w_g = (n_g/n) (\mu_g/\mu)^c$ only sums to unity when c = 0 or c = 1. The only class of inequality measures that satisfies the principle of scale invariance when comparing distributions with different means, and that ensures that the decomposition procedure is valid for arbitrary specifications of the partition, belongs to the generalised entropy class. We use the Theil index decomposition by equations providing additive group specific inequality contributions. Group specific inequality shares (%) are calculated as a group specific percentage of I_w, the overall within group inequality part. The between group inequality share (%) is calculated as I_B as a percentage of the overall inequality index $I_{total,c}$.

Figure 8
Net income – Lorenz curves by category



Source: German Time Use Survey 2001/02, own illustration.

The inequality of the most frequent group of category I (normal workday) contributes with a share of 60% to a large extent to the overall inequality (Table 2). Second in line is the inequality contribution of category II with an inequality share of 30%, whereas the inequality of

category III adds only 7% and category IV even only 3% to the overall inequality. It is remarkable that the between group inequality is only ca. 2%. Thus there is not a big difference between the inequality profiles – but as we have seen in the size of inequality – of our working hours arrangement categories.

4.2 The distribution of working hours and wages

To answer the question which income component – hours worked or wage per hour – is responsible for the overall income distribution discussed we separately analyze the distributions of category specific working hours and wages. Note, with regard to hours worked we do not take into account the diary information but the reported weekly working hours, which is adequate to the comparable reported monthly income.[15] The wage is a calculated net wage per hour and is simply the net monthly personal income divided by weekly working hours times 4.2.

The distribution of working hours

There are remarkable differences in the working hours distributions with regard to the specific daily working hours arrangements (see the numeric results in Appendix figures A2-A4 and table A2). So the average working hours in those categories with more than one episode (categories II and IV) amounts to more than 43 hours, while the average weekly working hours in category I is about 38 hours and in category III even only 34 hours per week.

Comparing the distributive measures it is obvious that the categories with those persons working mainly in the non-core period (categories III and IV) have the most unequal distribution of working hours. The Gini coefficient for category III (0.22893) is 60% higher than the coefficient for the ‚normal' working hours arrangement (category I; 0.14342), which has the most equal distribution of all categories. All further distributive measures confirm the result: the non-core/one episode category III with the lowest hours of work shows the most unequal distribution of working hours; an additional aspect of fragmented working conditions.

The distribution of wages

Are jobs in a non-normal daily working hours arrangement better paid, or characterizes the non-normal working situations bad jobs with lower wages? Does the timing of work and its fragmentation divide the labour market into good and bad jobs?

The answer: though the non-core/one episode category III result in the lowest average wage by 9.17€, the non-core/multiple episode category IV – the most irregular working situation – result in the highest average wage by 10.18€ (see the numeric results in Appendix figures A5-A7 and table A3). Thus, the timing of work time *and* its fragmentation, both, are important to characterize and disentangle the income situation. Remarkably, category III (non-core/one episode) is in both income dimensions the lowest: people there have the lowest wage and the lowest working hours.

[15] Further 106 diaries show no information about the weekly working hours and are therefore not taken into account.

The daily working hours arrangements with the most unequal wage distribution are the categories II and IV (multiple episodes). The differences of the wage Gini coefficients between the daily working hours arrangement with the most unequal wage distribution (category II) and category I – the daily working hours arrangement with the most equal distribution – with a difference of 15% is, however, essentially smaller than the respective difference of the income distribution.

The wage 90/10 relations between the categories are not as different as the income 90/10 relations between the categories showing the important influence of the hours worked. The wage inequality shares are similar to the shares in the income distribution with the normal workday as the determining (and largest) category of the income inequality profile again.

4.3 Intermediate summarizing of income distribution results

A short summary of the above hours and wage results ('+' indicates an above all over average value, '–' indicates a value below the average) are provided in Table 3. The persons with a fragmented daily working hours arrangement of more than one working episode (categories II and IV) do not just work longer than the average but also have a higher wage than the average resulting in an above-average net income. At the same time these categories have the most unequal wage distribution.

Table 3
Results of the income distribution analysis

	Net income				Wage				Working hours			
Categories	I	II	III	IV	I	II	III	IV	I	II	III	IV
Mean	–	+	–	+	–	+	–	+	–	+	–	+
Gini	–	+	+	–	–	+	–	+	–	–	+	+
Atkinson 1	–	–	+	–	–	+	–	+	–	–	+	+
Atkinson 2	–	–	+	+	–	+	–	+	–	–	+	+
90/10 Relation	–	–	+	–	–	+	–	+	–	–	+	+

Source: German Time Use Survey 2001/02, own calculations.

Non-core work without interruptions results in a below average mean net income. This category III (non-core/one episode) shows the most unequal net income distribution in which also the most unequal working hours distribution is given.

In contrast to this, net income, wage and working hours are relatively equally distributed in category I with a below average net income of all working – the category which includes the persons with 'normal' daily working hours arrangements (core/one episode).

Altogether: The descriptive analyses so far show, that the distribution of income is remarkably influenced by the daily working hours arrangement: not only the timing of work time

(core vs. non-core) but in particular the fragmentation of the working period (by number of episodes), are determining the income situation and individual economic well-being.

5 Timing and fragmentation of work and earnings – Microeconomic approach and micro-econometric estimates of earnings function

The following sections quantify an explanatory background of earnings for the different timing and fragmentation daily working hours arrangements. Our model will be based on human capital theory and extended to a market, non-market and social network context. The microeconometric estimates of the respective earnings functions with a treatment effects approach then searches for significant determinants as well as for an overall selection effect ('arrangement treatment effect') with respect to the daily timing of work time and its fragmentation.

5.1 Theoretical background – Human capital in a market and non-market context

The human capital approach – theoretically and empirically – has been proven a successful way in applied economics explaining the earnings function. The human capital theory explains earnings in terms of job skills aquired in school and on the job. Based on a life-cycle model, earnings are explained as consequences of individual investment decisions in their skills (Mincer, 1974; Becker, 1975).

The very basic human capital model explains earnings by the following equation,

(1) $$\ln E_t = \ln E_0 + r_s S + aT + bT^2$$

where E_t is capacity earnings in year t, E_0 is ‚original' capacity earnings, S is years of schooling, T is years of job experience, r_s is the rate of return to schooling and a and b together describe the rate of return to experience. With observed earnings Y the typical human capital earnings equation is

(2) $$\ln Y_t = \alpha_0 + rS + \alpha_1 T + \alpha_2 T^2$$

and base for our regression analyses.

The central variable is the rate of return to schooling which approximates the per cent increase in earnings resulting from one extra year of schooling. The parameters α indicate whether the earnings function is concave, where with positive α_1 and negative α_2 earnings rise, but at a diminishing rate, peaking at experience level T* (computable from the slope $\partial \ln Y / \partial t = \alpha_1 + 2\alpha_2 T$).

A simple extension of the earnings function is considered in the following: further market, non-market and social network variables to be tested as important for a more in depth socio-economic explanation might be comprised in an additional vector x resulting in an extended earnings equation

$$(3) \qquad \ln Y_t = \alpha_0 + rS + \alpha_1 T + \alpha_2 T^2 + x_i'\beta$$

This is our general frame further to be estimated; numerous extensions of the basic model are discussed e.g. by Polachek and Siebert (1999).

5.2 Econometrics – A treatment effects approach for an interdependent estimation of participation and earnings in different daily working hours arrangement categories

Within our microeconometric specification we want to disentangle the explanation of the participation in one of the four discussed daily working hours arrangement categories (covering all core/non-core and one/multiple episodes categories) and the category dependent earnings.

One approach could be a multinomial (MNL) estimation of the participation probability and in a second stage in a (MNL) selectivity bias corrected earnings estimate following Lee (1983) generalizing the original two stage Heckman (1979) procedure. This was done by Merz and Burgert (2003b) for their associated study on a two stage working hours approach with daily working hours arrangements based on the 1991/1992 German Time Budget Survey.

In our study at hand, however, we want to quantify the all over impact of a specific daily working hours arrangement category on the category specific earnings equations – by maintaining the detailed explanation of the probability to select a certain category. Thereby the interdependence of the participation and the earnings equation should be respected, because some common explanatory background is presumed for both equations.

An extension of the self-selection problem fits into our modelling concept: it is the measurement of *treatment effects* and program effectiveness.[16] Our cross sectional earnings equation of each individual i for one category j (j=1,…,J; J=4) accounts for the endogenous decision to work in that category j

$$(4) \qquad \ln Y_{ij} = \alpha_0 + rS + \alpha_1 T + \alpha_2 T^2 + x_{ij}'\beta_j + \delta_j C_{ij} + \varepsilon_{ij} \quad (j = 1,...,4),$$

where C_{ij} is a dummy variable indicating whether or not the individual works in category j. The same principal format has been used in other analyses of programs, experiments, and treatments (Greene, 2003, 787-789). The question is: Does δ_j measure the value and impact of a specific daily working hours arrangement (assuming that the rest of the regression model is correctly specified)? The answer is 'no' if the typical individual who chooses a specific category would have relatively high earnings whether or not an individual chose that cate-

[16] Heckman, Lalonde and Smith (1999), Angrist (2001), Angrist and Pischke (2009).

gory. The problem is one of self-selection. If our observation of interdependence is correct, then least squares estimates of δ_j will actually overestimate the treatment effect. The same applies to estimates of the treatment effects in other settings in which the individuals themselves decide whether or not they will receive the treatment.

Our treatment effects model estimates the effect of the endogenous binary decision to participate in a working hours arrangement category j (treatment) on the continuous earnings variable Y_{ij}, conditional on their respective vector of explanatory variables. The binary decision is modelled as the outcome of an unobserved latent variable C_i^* as:

$$
\begin{aligned}
&C_{ij}^* = w'_{ij}\gamma_j + u_{ij}, \\
&C_{ij} = 1 \; \textit{if} \; C_{ij}^* > 0, \; 0 \; \textit{otherwise.}
\end{aligned}
\tag{5}
$$

Because of the allowed endogenous participation decision, u_{ij} and ε_{ij} are correlated bivariate normal with mean zero and covariance matrix

$$
\operatorname{cov}(u_{ij}, \varepsilon_{ij}) = \begin{pmatrix} \sigma_j & \rho_j \\ \rho_j & 1 \end{pmatrix}.
$$

Bringing the two equation model together, the category j specific earnings function with socio-economic variables and endogenous participation decision is

$$
\begin{aligned}
&E\left[\ln Y_{ij} \mid C_{ij} = 1, S_{ij}, T_{ij}, x_{ij}, w_{ij}\right] \\
&\quad = \alpha_0 + rS + \alpha_1 T + \alpha_2 T^2 + x'_{ij}\beta_j + \delta_j C_{ij} + E\left[\varepsilon_{ij} \mid C_{ij} = 1, S_{ij}, T_{ij}, x_{ij}, w_{ij}\right] \\
&\quad = \alpha_0 + rS + \alpha_1 T + \alpha_2 T^2 + x'_{ij}\beta_j + \delta_j C_{ij} + \rho_j \sigma_{\varepsilon j} \lambda_j(-w'_{ij}\gamma)
\end{aligned}
\tag{6}
$$

The arrangement treatment effect, the selection of a certain daily working hours arrangement, is the difference in expected ln earnings between participants and non participants (Greene, 2003, 788):

$$
E\left[\ln Y_{ij} \mid C_{ij} = 1\right] - E\left[\ln Y_{ij} \mid C_{ij} = 0\right] = \delta_j + \rho_j \sigma_{\varepsilon j}\left[\frac{\phi_{ij}}{\Phi_{ij}(1-\Phi_{ij})}\right].
\tag{7}
$$

If the selectivity correction λ_i is omitted from the least squares regression, then this difference is what is estimated by the least squares coefficient on the treatment dummy variable. But since (by assumption) all terms are positive, we see that least squares overestimates the treatment effect.

With a two step estimator – probit for the participation decision and treatment corrected OLS for the earnings equation – we account for the self-selected nature/treatment of a participation in category j and take into account the correlation of the treatment and the outcome equation with a correct variance covariance matrix of the estimated parameters (STATA: treatreg). Note: this treatment specification is in contrast to other program evaluation approaches where the treatment there is chosen to be independent of the outcome equation.

One open question remains: How do different categories depend on each other. A Hausman and McFadden (1984) test of the independence of irrelevant alternatives (IIA assumption) here confirms our assumption of the independence of different daily working hours arrangements.[17] Thus our approach to specify one choice against the universe of all other working categories, with C_{ij} is zero if category j is not chosen, is strongly supported.

5.3 Results – Earnings explanation considering timing and fragmentation of daily work

One major result of our descriptive analysis was, that daily working hours arrangements measured by its daily timing and fragmentation results in category specific income levels as well as income distributions. Thus income and income inequality is influenced by daily working time patterns. The question we want to answer now is, which factors drive these category specific earnings, where earnings are measured by monthly net income of active workers.

Our microeconometric model discussed above – with an interdependent earnings equation by a treatment effects model and a probit equation for the endogenous participation probability for each category – will quantify those factors and show their statistical significance. In addition, the overall category specific influence is quantified and tested for significance.

The substantial hypotheses to be tested are driven by the following strategy:

- *Category participation probability:* besides human capital and further personal information, the hypotheses and explanatory variables include various concurring *non-market* time use pattern with personal engagement in given active help for others in the social network, partner's employment, household characteristics, income/wealth situation, receiving help from others in the social network and a general regional indicator (Table 4a).
- *Earning'* explanatory variables include above all *market information*: human capital and further socio-economic market oriented factors (occupational status with an explicit consideration of time sovereignty within a self-employment as professions (freelancer, "Freie Berufe", second job indicator, demand side by branches and a regional indicator) (Table 4b).

The particular single results based on the estimation results are discussed now separately for the participation and earnings estimates.

5.3.1 Explaining participation in daily working hours arrangements

The explanation of the probability to participate in the respected four daily working hours arrangements – endogenous to the earnings equation – depicted in Table 4a shows a heterogeneous pattern, where at the first glance, the overwhelming significance of the single underlying hypotheses as in the earnings equations is not given anymore. With reference of each working category to the other working individuals only, our coefficients and estimates have

[17] Results are available from the authors by request.

nothing to do with the general decision to work or not to work. Consequently, all results have to be interpreted as compared to all alternative working situations.

Personal demographics: Age, as a more or less catch-up variable for the lifecycle situation of a person, is significant only for core jobs; non-core job participation is dependent on other respected factors. Gender differences are visible in a significant manner in the non-core categories with a smaller female probability to participate. On the other hand, the participation probability in a normal workday (category I) is smaller for men, whereas there is no gender difference within a fragmented but core job. To be married is in favour for a normal workday.

Education: There is a clear picture that a higher education is less important for odd jobs at non-core times. For core jobs the participation probability is even significantly lower when education is higher. These results are an important hint to separate the participation decision from the final earnings situation, the way we modelled the working situation.

Non-market time use: Our hypothesis, that non-market time use behaviour has an influence on the choice of the daily working hours arrangement,[18] is confirmed by significant effects. Time for children seems to be not significant for the choice of a working hours arrangement – a remarkable result – whereas time for household work and time for 'do it yourself'-work is significant, but with a different sign. More time at home in these activities reduces the fragmented core work but increases non-core engagement.

Social networking: With regard to (active) social networking job participation is merely independent of active help for other households.

Partner's employment: The partner's employment activity as a full time or part time worker seems to be of minor importance for the job participation decision. However, for the most irregular case, non-core/multiple episodes, an additional worker effect outside the normal workday situation becomes visible and significant.

Household characteristics: The household context is described by the household size and the existence of young children ($\leq$ six years, pre-school age). With greater households the participation probability is diminished for normal workdays. Young kids show no influence on the working arrangement decision, a result not expected.

Receiving support in various ways is on the agenda of recent public labour market policy. So far in 2001/2002 receiving help seems to be of no importance for the participation decision between these categories, but might be of importance for the general decision going to work or not.

Income and wealth situation: To analyse the income and wealth situation of the entire household this influence is tested by household net income minus own net income as residual household income and owing the house. The result: Economic opportunities – neither measured by owing the house where the household is living nor by the further available money resources – have an impact on one or the other category decision.

[18] Thus a possible simultaneous consideration of paid and non paid working hours here is intentionally disregarded

Region: Living in East Germany significantly increases the probability to choose a standard daily working hours arrangement with one episode to the burden of a most irregular working pattern of category IV (fragmented non-core jobs).

5.3.2 Explaining earnings in daily working hours arrangements

Because of the ln earnings specification the estimated coefficients in Table 4b in general approximate the percent increase in earnings resulting from one extra unit of a variable.

First of all: for all categories the specific daily working hours arrangement is highly significant in explaining earnings (δ_j). In addition, the selectivity term (λ_j) is highly significant supporting our modelling strategy.

Compared to all other working situations, the multiple episode cases (II and IV) result in significant higher earnings – regardless at core or non-core time – and the most in the core/multiple episode category (*Category j* δ_j variable). In contrast to this, the one episode working arrangements result in below average income, the lowest for the 'normal' workday (category I). The separate influence of working time and wages are discussed above. Thus, the non-traditional daily working hours arrangements overall show higher earnings, a result, which was not expected when non-normal (in this sense) would be attributed to worse labour market conditions.

Reasons behind this phenomenon are disentangled by the single explanatory factors analyzed now:

Human capital: While work experience with concave character is highly significant for all arrangements, years of schooling (measured in years at school until the German "Abitur") are only important for the non-core segment. Beyond the reference of working individuals in general, this effect might be due to the additional control for the occupational status, which sometimes requires a higher education.

Occupational status: Compared to blue collar workers all other occupational stati in all categories raise earnings. The exemption of being a helping family member might show some support as an additional worker effect but in non-core categories only.

Multiple jobs: As discussed earlier, our data base only allows to add a general dummy for a second job. The very interesting case of an additional job at the specific day under investigation could not be specified. Nevertheless, the result is astonishing: nearly by the same size a second job diminishes earnings in all categories indicating the better earnings situation of one job holders in general.

Demand side: As expected earnings outside agriculture are higher. Though the private and public service sector with the most workers is still growing, a job in the industry results in higher income for all working hour categories.

Region: The general dummy for a job in East Germany is significantly positive for core daily working arrangements and negative for non-core working. The traditional timing of work time therefore results in higher income compared to West Germany. Putting it in other words:

only non-core working conditions are lower paid in East Germany. With regard to the participation decision, East Germans tend to work in a more normal category (I) which in general is lower paid then the fragmented ones.

Table 4a
Timing and fragmentation of work – Endogeneous participation probability estimates by a probit model for daily working hours arrangements

Participation Probability	**Category I** Core One episode	**Category II** Core # episodes ≥ 2	**Category III** Non-core One episode	**Category IV** Non-core # episodes ≥ 2
Personal demographics				
Age	.0227389*	-.0182999	-.0220969	.0306111
Age ^{2}	-.0003184**	.0003255**	.0001241	-.0003687
Woman	.1531365***	-.0199893	-.1680781**	-.3783944***
Married	.1552043**	-.1302822**	-.0212925	-.2004843*
Education				
Elemantary	.116942	-.1358193	-.1749561	.254799
Intermediate	.1200956	-.0870726	-.1716882	-.0095316
Spec. upper or upper	-.0835988**	.1385355***	-.2079447***	.1692626**
University	-.2891626***	.330533***	-.1448368	.2736943**
Non-market time use				
Time for household work	.0000759	-.0015483***	.0023518***	.0011799***
Time for child care	.0010501*	-.000907	-.0001078	-.0011221
Time for do-it-yourself	.000299	-.0026076***	.0021689***	.0021063**
Social networking				
Active help (h)	-.0017347	.0013517	-.0014825	.0048663*
Partner`s employment				
partner full time work	-.0763369	.0253924	-.0308513	.3155059***
partner part time work	-.0887075*	.0536556	.0915853	.0799004
Household characteristics				
Receiving help (h)	.0007053	-.0020338	.0010574	.0014867
Number of hh members	-.0652222***	.0669324***	.0017645	.018666
Young kids	-.0634876	.0857412	-.0448537	.0361543
Income/wealth situation				
Own house	-.0602891	.0840075*	-.0599845	.049606
Residual income	8.92e-06	-5.52e-06	-6.23e-06	-1.45e-06
Region				
East Germany	.2765265***	-.2670162***	.014006	-.2985634***
Constant	.0018567	-.4213718	-.7616166*	-2.777401***
Wald chi^2 (16)	1386.03	2525.95	4938.93	6425.18
p-value for chi^2	.00000***	.00000***	.00000***	.00000***
n (working: 10,607)	6852	2678	719	358

Significance levels: * 5%, ** 1%, *** 0.1%
Source: German Time Budget Survey 2001/2002, own calculations.

Table 4b
Earnings and timing and fragmentation of work –
Earnings estimates by a treatment effects model

ln(earnings)	**Category I** Core One episode	**Category II** Core # episodes ≥ 2	**Category III** Non-core One episode	**Category IV** Non-core # episodes ≥ 2
Category j δ_j	-3.908531***	2.850709***	-2.217199***	1.57194***
Hazard lambda	2.362135***	-1.636485***	1.035406***	-.6644788***
Human capital				
School years (S)	.0052858	.0004131	.0429798***	.0545976***
Work experience (T)	.0578081***	.05921***	.0444624***	.0419555***
Work experience^2 (T^2)	-.0010511***	-.001103***	-.0007361***	-.0006443***
Occupational status				
Reference: blue collar	-	-	-	-
Self-employed 0 empl.	.5877811***	.5590384***	.7731187***	.8196024***
Self-employed >0 empl..	.385388*	.3715193**	.6535276***	.7175627***
Liberal professions	.4569893***	.4563182***	.5722316***	.6073045***
Civil servants	.8885734***	.8803991***	.9466153***	.9849433***
White collar worker	.4029769***	.3505992***	.3148965***	.3512981***
Apprentice	-.3574205***	-.3627674***	-.3195913***	-.2942108***
Helping family member	-.1604767	-.1234818	-.2040246***	-.2584336*
Multiple jobs				
Second job	-.2356443***	-.2275196***	-.2438255***	-.263097***
Demand side				
Ref.: agriculture				
Industry	.6705779***	.6928089***	.7440246***	.7576406***
Services	.4377631***	.430295***	.447006***	.4520374***
Region				
Ost	.1744386**	.0219009	-.2191925***	-.1931014***
Constant	8.200124***	5.066563***	5.595438***	5.228578***
Wald chi^2 (16)	1386.03	2525.95	4938.93	6425.18
p-value for chi^2	.00000***	.00000***	.00000***	.00000***
n (working: 10607)	6852	2678	719	358

Significance levels: * 5%, ** 1%, *** 0.1%.
Source: German Time Budget Survey 2001/2002, own calculations.

To summarize: in addition to the significance of human capital, occupational status, the multiple job situation as well as demand side and all over regional factors timing of work plays a significant role in explaining individual earnings. The pattern is different in different daily working hours arrangements. Every working hours arrangement category results in significantly different earnings supporting our modelling strategy.

5.3.3 Summarizing the results of earnings explanation considering timing and fragmentation of daily work

To summarize our results an overview of explanatory factors of earnings considering timing and fragmentation of daily work is given in Table 5.

Table 5
Earnings explanation considering timing and fragmentation of daily work – An overview of explanatory pattern

	Category I Core One episode		**Category II** Core # episodes ≥ 2		**Category III** Non-core One episode		**Category IV** Non-core # episodes ≥ 2	
	earnings	part.	earnings	part.	earnings	part.	earnings	part.
Category j	---		+++		---		+++	
λ	+++		---		+++		---	
Personal characteristics								
Demographics		+++		--		-		--
Human capital	+++		+++		+++		+++	
Education		---		+++		--		++
Occupational status	+++		+++		+++		+++	
Multiple jobs	---		---		---		---	
Non-market time use				---		+++		+++
Demand side: business sectors	+++		+++		+++		+++	
Social networking		0		0		0		+
Partner's characteristics								
Partner`s employment		-		0		0		+++
Household characteristics								
Household characteristics		---		+++		0		0
Income/wealth situation		0		+		0		0
Regional variables								
Region (East Germany)	++	+++	0	---	---		---	---

blank field: not specified, 0 not significant, significance levels: * 5%, ** 1%, *** 0.1% marked by respective coefficients signs .
Source: German Time Budget Survey 2001/2002, own calculations.

Interpreting the stylized results of Table 5 we can conclude with the overall hypothesis: The driving factors of so-called 'normal' and ‚non-normal' workdays are quite different: the timing of work time as well as the fragmentation of daily work are significant factors in explaining individual earnings.

The results support our modelling and the two stage explanation in particular: the probability to participate to a certain daily working hours arrangement shows a different explanatory pattern than the final earnings as the economic result. This is in line with the findings of Merz and Burgert (2003a) for category specific hours of work.

The participation probability of a specific daily working hours arrangement – given working – shows different explanatory pattern for different arrangements. Demographics, education, non-market time use, partner and household characteristics as well as regional variables are important but of different influence in explaining working hours in different daily working hours arrangements.

The earnings function specification results in highly significant – but in size and sign different – coefficients for all variables included, showing the importance of human capital, occupational status, multiple job and demand side factors by business sectors and regional influences.

6 Concluding remarks

Our study is adding insights into economic well-being and working hours arrangements with particular *daily* work effort characteristics and its resulting income distribution. The work effort characteristics we regard are about labour market flexibility with focus on the daily timing of work and its fragmentation, and its consequences on income inequality. The main result: the timing and fragmentation of daily work is significant for the resulting earnings. Fragmented working hours arrangements compared to a continuous daily working schedule yield higher incomes and has distributional consequences which is shown by the descriptive and econometric results.

Descriptive and distributional results

On average: Persons in daily working hours arrangements with more than one working episode (fragmentation, categories II and IV) work longer, have a higher wage rate and thus an above–average income.

Distribution: All non-normal daily working hours arrangements (categories II,III,IV) compared to the normal situation (category I) show higher inequalities with regard to hours worked, wage paid, and income achieved; one exception: the most irregular daily working hours arrangement (category IV) has the most equally distributed income.

Non-core work without interruptions results in a below average wage and mean net income. This category (III, non-core/one episode), consisting of typical part time jobs as well as of less paid jobs, delivers the most unequal net income distribution in which also the most unequal working hours distribution is given.

Thus, the non-normal, atypical working schedules as regarded here result in higher as well lower mean net income. Whereas fragmented work yields above mean income (regardless

core respective non-core work), not interrupted non-core work not only yields a below average but also a highly unequally distributed net income.

The descriptive and distributive analysis thus has shown that the timing and fragmentation of work time do have distinct consequences on the earnings situation and its distribution; atypical work is indeed heterogeneous, it offers a higher income opportunity as well as a precarious job situation.

Microeconometric results

The estimates with endogenous self-selection (treatment effects approach) explaining earnings and participation (MNL-approach) in different daily working hours arrangements support our interdependent two stage modelling strategy with the overall result:

Individual earnings in Germany are dependent on and significantly different with regard to the daily working hours arrangement capturing timing and fragmentation of work.

The participation probability for the core/non-core and number of episodes working time categories follow different explanatory pattern with regard to personal characteristics (demographics, human capital, education, occupational status, multiple jobs, non-market time use) demand side (business sectors), partner's (employment) and household characteristics (composition, wealth) as well as a regional indicator. Whereas active help has some influence on choosing a fragmented/non-core arrangement, getting support, however, seems not to play a role for that decision. Thus, social networking – in contrast to some expectations – has only a small impact on paid working schedules.

The mentioned market and non-market factors also are important and significant in explaining earnings – and thus the income distribution in all daily working hours arrangements, however, in a different pattern. A simple overall explanation of the participation and the earnings situation cannot be deducted: the heterogeneity of atypical work schedules mirrors in the heterogeneity of the individuals behind. However, our detailed findings support *targeted* modern economic and social policy, which has to respect the individual situation when non-traditional labour market situations and flexibility impacts are regarded.

Since our attempt to analyse the timing and fragmentation of daily working hours has shown to be important as working schedules itself and for its impact on income and the income distribution, further research on the growing importance of the broad range of atypical working schemes will miss important factors if fragmentation and the timing of work time would not be considered.

Appendix

Table A1
Number of persons in % by category and different break definition

	Duration of break ≥ 30 minutes			Duration of break ≥ 60 minutes			Duration of break ≥ 90 minutes		
	N in %	N	n	N in %	N	n	N in %	N	n
Category I	27.4	17,031,821	3,429	65.1	40,503,406	6,884	78.1	48,552,582	8,055
Category II	62.9	39,102,162	6,154	25.1	15,605,547	2,698	12.2	7,560,907	1,525
Category III	4.9	3,073,410	588	6.5	4,037,688	716	6.7	4,157,613	743
Category IV	4.8	2,965,380	477	3.3	2,026,132	350	3.1	1,901,671	325
All categories	100	62,172,772	10,648	100	62,172,772	10,648	100	62,172,772	10,648

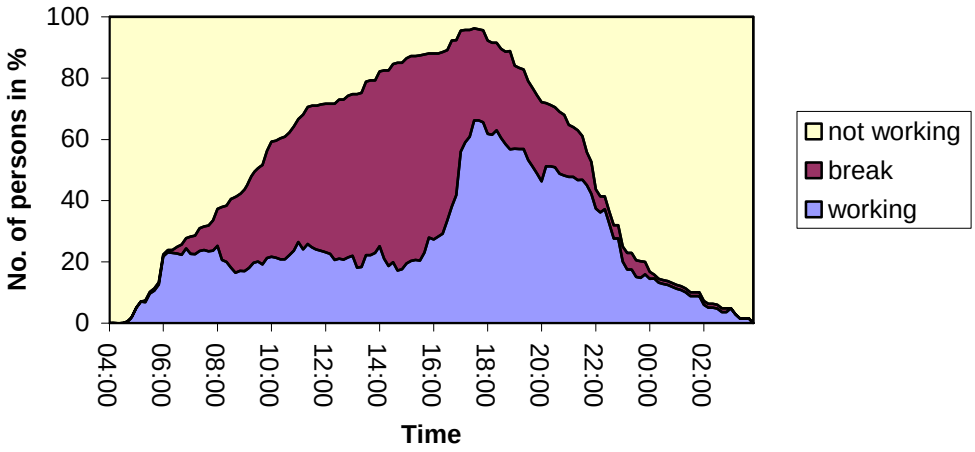
Source: German Time Use Survey 2001/02, own calculations.

Table A2
Time spent for work, breaks, non work by category per day

	Category I Core one episode	Category II Core multiple episodes	Category III Non-core one episode	Category IV Non-core multiple episodes
N	40,503,406	15,605,547	4,037,688	2,026,132
n	6,884	2,698	716	350
Average time spent for work	7’40’’	7’22’’	5’24’’	7’31’’
Average time spent for breaks	---	2’23’’	---	10’22’’
Average time spent for non-work	16’20’’	14’15’’	18’36’’	6’07’’

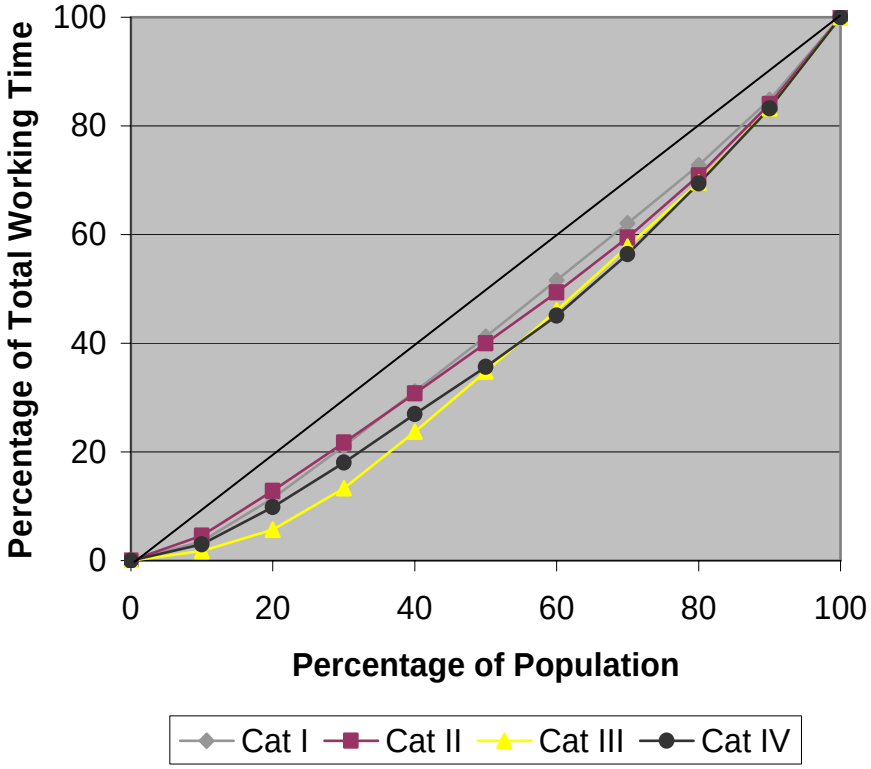
Source: German Time Use Survey 2001/02, own calculations.

Figure A1
No. of persons by activity and day time – Category IV (non-core/multiple episodes) excluding night-workers.



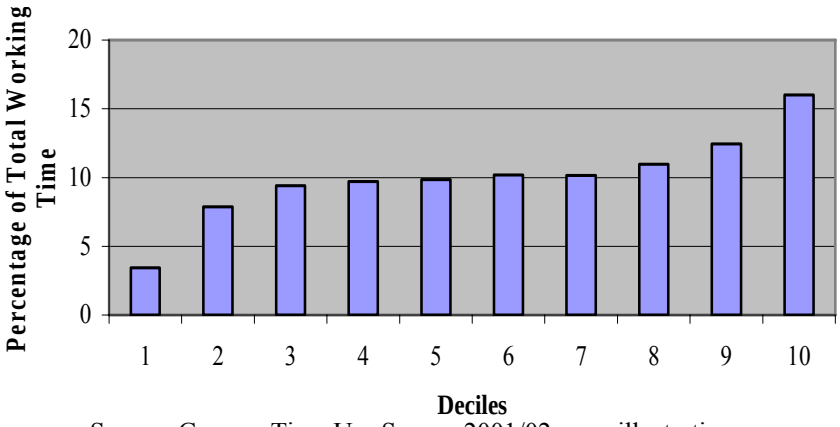
Source: German Time Use Survey 2001/02, own illustration.

Figure A2
Working hours – Lorenz curves by category



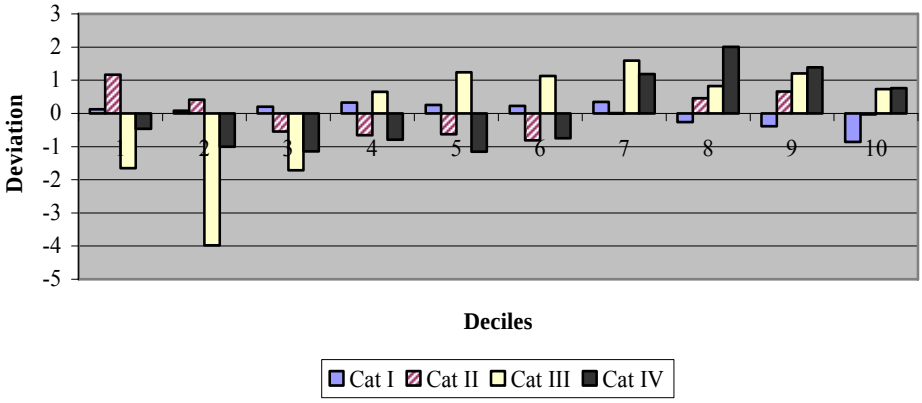
Source: German Time Use Survey 2001/02, own illustration.

Figure A3
Working Hours – Decile Shares of all Categories



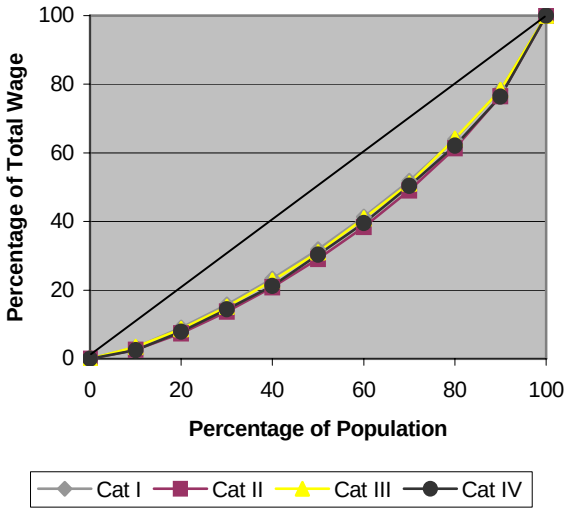
Source: German Time Use Survey 2001/02, own illustration.

Figure A4
Working hours – Deviation of decile shares compared to the decile shares of all categories in percentage points



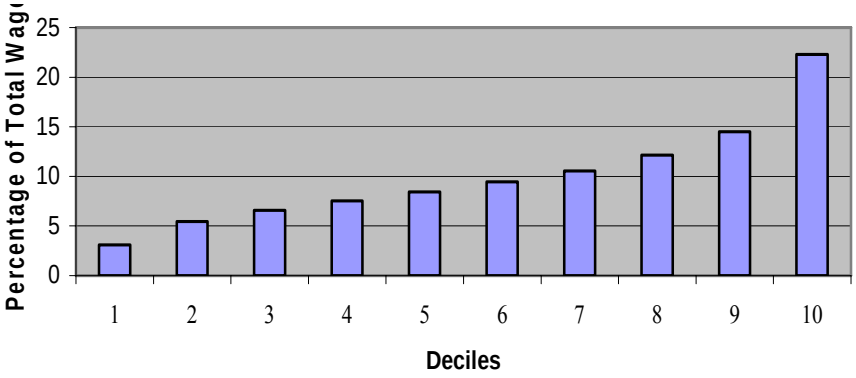
Source: German Time Use Survey 2001/02, own illustration.

Figure A5
Wage – Lorenz curves by category



Source: German Time Use Survey 2001/02, own illustration.

Figure A6
Wage – Decile shares of all categories



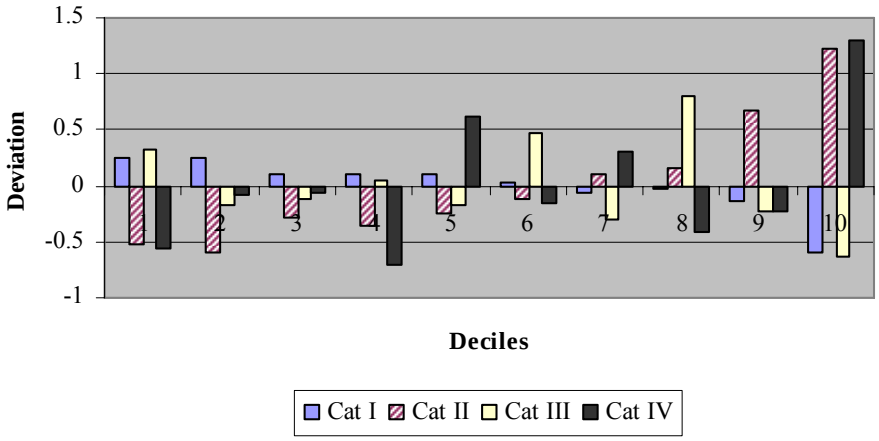
Source: German Time Use Survey 2001/02, own illustration.

Table A3
Working hours – Distributive measures by category

	Total	Category I (core/ episode)	Category II (core/ #episodes>1)	Category (non-core/ one episode)	Category IV (non-core/ #episodes>1)
Mean in h	39.41	38.18	43.35	34.02	44.21
Median in h	40.00	39.00	40.00	38.50	40.00
Kurtosis	2.74	2.86	1.42	0.70	0.98
Variation coefficient	0.32	0.29	2.51	0.43	0.37
Distributive measures					
Gini coefficient	0.15778	0.14342	0.15543	0.22893	0.20019
Atkinson-Index					
$\varepsilon = 1$	0.07333	0.06777	0.05496	0.15147	0.09496
$\varepsilon = 2$	0.23033	0.21972	0.14713	0.42123	0.28201
Decile shares in % (Decile limits in h)					
1st decile	3.44 (22.0)	3.56 (22.0)	4.6 (32.0)	1.79 (10.0)	2.97 (23.0)
2rd decile	7.86 (35.0)	7.94 (35.0)	8.27 (38.0)	3.88 (20.0)	6.85 (35.0)
3rd decile	9.39 (38.0)	9.59 (38.0)	8.84 (38.5)	7.68 (35.0)	8.24 (38.0)
4th decile	9.71 (38.5)	10.03 (38.5)	9.05 (40.0)	10.36 (36.0)	8.92 (40.0)
5th decile	9.84 (40.0)	10.09 (39.0)	9.21 (40.0)	11.08 (38.5)	8.68 (40.0)
6th decile	10.17 (40.0)	10.39 (40.0)	9.36 (42.0)	11.29 (40.0)	9.42 (45.0)
7th decile	10.14 (41.0)	10.48 (40.0)	10.15 (46.5)	11.73 (40.0)	11.33 (52.5)
8th decile	10.97 (45.0)	10.71 (43.0)	11.43 (51.0)	11.79 (42.0)	12.98 (60.0)
9th decile	12.45 (55.0)	12.06 (50.0)	13.11 (60.0)	13.66 (50.0)	13.84 (64.0)
10th decile	16.01	15.15	15.98	16.74	16.77
90/10 Relation	4.65	4.26	3.47	9.35	5.65
Decomposition					
Theil Index	0.05608	0.05011	0.04746	0.11097	0.07504
Inequality shares in %		58.94	24.45	11.48	5.13
Group share in %:					
within	95.72				
between	4.28				
n	10,501	6,788	2,662	704	347
N	61,362,471	39,982,330	15,425,900	3,947,433	2,006,809
N in %	100.00	65.16	25.14	6.43	3.27

Source: German Time Use Survey 2001/02, own calculations.

Figure A7
Wage – Deviation of decile shares compared to the decile shares of all categories in percentage points



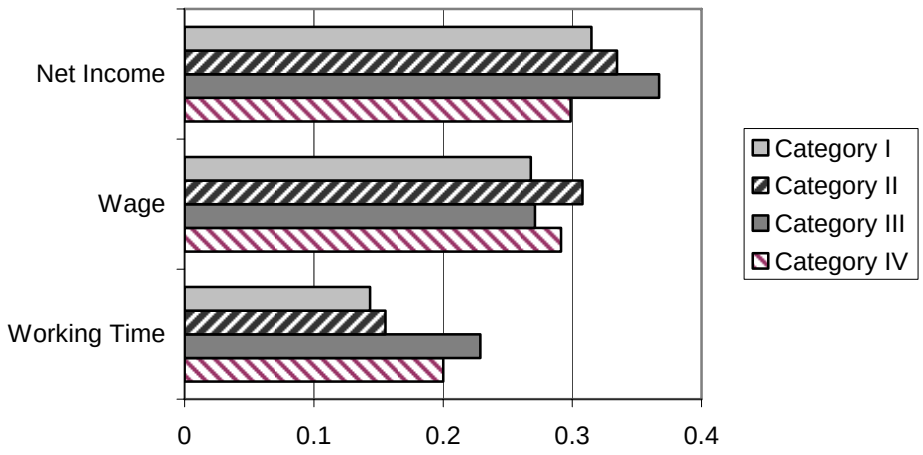
Source: German Time Use Survey 2001/02, own illustration.

Table A4
Wage – Distributive measures by category

	Total	Category I (core/ episode)	Category II (core/ #episodes>1)	Category III (non-core/ one episode)	Category IV (non-core/ #episodes>1)
Mean in €	9.79	9.71	10.10	9.17	10.18
Median in €	8.66	8.63	8.92	8.23	8.62
Scewness	3.00	3.63	1.92	2.75	1.99
Kurtosis	21.56	31.56	6.48	18.96	6.24
Variation coefficient	0.58	0.56	0.61	0.54	0.58
Distributive measures					
Gini Coefficient	0.27981	0.26783	0.30785	0.27126	0.29128
Atkinson-Index					
$\varepsilon = 1$	0.13375	0.12299	0.16215	0.11799	0.14747
$\varepsilon = 2$	0.29146	0.26517	0.35994	0.22803	0.34271
Decile shares in % (Decile limits in €)					
1st decile	3.09 (4.46)	3.34 (4.82)	2.56 (4.06)	3.42 (4.12)	2.54 (4.17)
2rd decile	5.44 (5.95)	5.69 (6.09)	4.85 (5.80)	5.26 (5.41)	5.35 (6.09)
3rd decile	6.58 (6.94)	6.69 (6.96)	6.29 (6.94)	6.46 (6.45)	6.52 (7.37)
4th decile	7.53 (7.81)	7.64 (7.85)	7.17 (7.78)	7.57 (7.3)	6.82 (7.97)
5th decile	8.43 (8.66)	8.54 (8.63)	8.18 (8.96)	8.26 (8.22)	9.05 (8.62)
6th decile	9.43 (9.74)	9.46 (9.67)	9.31(10.05)	9.90 (9.67)	9.28(10.03)
7th decile	10.54(11.05)	10.48(10.86)	10.65(11.45)	10.23(10.42)	10.85(11.75)
8th decile	12.15(12.90)	12.12(12.76)	12.31(13.54)	12.96(11.91)	11.73(12.99)
9th decile	14.51(16.13)	14.37(15.76)	15.18(17.93)	14.29(14.78)	14.28(15.81)
10th decile	22.28	21.68	23.51	21.65	23.58
90/10 Relation	7.21	6.49	9.18	6.33	9.28
Decomposition					
Theil Index	0.1375	0.12803	0.16145	0.12499	0.14783
Inequality shares in %		60.32	30.53	5.49	3.66
Group share in %:					
Within	99.78				
Between	0.22				
n	10,501	6,788	2,662	704	347
N	61,362,471	39,982,330	15,425,900	3,947,433	2,006,809
N in %	100.00	65.16	25.14	6.43	3.27

Source: German Time Use Survey 2001/02, own calculations.

Figure A8
Gini coefficients by category



Source: German Time Use Survey 2001/02, own illustration.

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Estimating household production outputs with time use episode data

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Abstract

It is not widely recognised that diary-based surveys of time use contain data not only on 'input' time but also on 'output' time. The diaries record episodes of time use throughout the day showing activities that can be categorised not only as household production input time, such as preparing a meal, but also household output (or consumption) time such as eating a meal. Harvey and Mukhopadhyay (1996) seem to have been the first to use the methodology of counting output episodes from time use surveys to estimate and value household production outputs. Using episode data from the 1992 Canadian time use survey, they counted the number of meals, the hours of child care and the nights of accommodation. Our paper explores the application of this methodology to the episode data from Australian time use surveys. We extend the outputs to include episodes of transport provided by households. This is in accord with the Eurostat recommendation to include transport as a final output in the preparation of satellite accounts of household production.

JEL-Codes: D13

Keywords: Household production outputs, time use surveys, episode data, gross household product, satellite accounts of household production, accommodation, meals, child care, clean clothes, transport

1 Introduction

It is not widely recognised that diary-based surveys of time use contain data not only on 'input' time but also on 'output' time. The diaries record episodes of time use throughout the day showing activities that can be categorised not only as household production input time, such as preparing a meal, but also household output (or consumption) time such as eating a meal.

Harvey and Mukhopadhyay (1996) appear to have been the first to use the methodology of counting output episodes from time use surveys to estimate and value household production outputs. Using episode data from the 1992 Canadian time use survey, they counted the number of meals, the hours of child care and the nights of accommodation. Using data from other surveys they also made estimates for the value of household clothes laundry, of voluntary or unpaid community oriented activity and of personal development (education). The 1995 INSTRAW monograph, for which Andrew Harvey was the Consultant Project Coordinator, strongly recommended that education should be included in household production satellite accounts.

Our paper explores the application of this innovative methodology to the episode data from Australian time use surveys. We extend the outputs to include episodes of transport provided by households. This is in accord with the Eurostat recommendation to include transport as a final output in the preparation of satellite accounts of household production. Initially household production of transport was classified as an ancillary activity like shopping or gardening (Varjonen and Niemi, 2000).

Andrew Harvey

As Director of the Time Use Research Program of the Department of Economics at St Mary's University, Halifax and as President of the International Association for Time Use Research, Andrew Harvey has had a widespread impact on time use research locally and internationally. Over the past few decades Andrew Harvey has not only been at the forefront of time use research in Canada and the United States but has also helped shape the direction of time use research throughout the world.

His research has covered a wide spectrum – time-space studies, travel behaviour, social indicators, survey design, leisure analysis, population dynamics, time use of teachers, time use metadata and satellite accounts of the household economy. It is through his diverse and often innovative research and his enthusiastic involvement in the promotion of the analysis of time use data, that Andy has been influential in the worldwide development of time use studies.

Andy first met Duncan at the IATUR meeting in Rome in 1992 and Faye at the IATUR meeting in Colchester in 1999. Apart from many other IATUR meetings, Andy and Duncan have

participated together with other time use colleagues at meetings of the International Association for Research in Income and Wealth (IARIW) (Lillehammer, Norway, 1996 and Portoroz, Slovenia, 2008) and at the meeting of the International Statistical Institute in Beijing in 1995.

At these meetings Andy always manages to lead us to the most interesting restaurants for evening meals[1]. Andy is extremely generous professionally and personally. After a visit Duncan made to Ottawa in 1999, Andy arranged for Duncan to give a seminar at St Mary's. Andy's generosity and hospitality extended after the seminar when he and Dawnie welcomed Duncan into their home. He spent a couple of delightful days with them, sampling the local Halifax restaurants and enjoying the coastal scenery.

Andrew is also very munificent with his time. In 1996 when the Multinational Time Use Study (MTUS) was established with Jonathan Gershuny at the University of Essex as Foundation Director, Andy and Duncan became co-directors with ancillary MTUS research centres at their respective universities in Halifax and Melbourne.

Much time use research is slow, painstaking, meticulous work, grinding through large datasets with the aim of finding important results. Sometimes a researcher has a good insight, and sometimes that insight is so brilliant, one thinks "Why didn't I think of that?" Such an occasion was the 1996 IARIW conference paper by Andrew and his Colleague Arun Mukhopadhyay of the Economics Department at St Mary's.

IARIW had organised a special session for the Lillehammer meeting on "Accounting for Time" organised by Ann Chadeau from the OECD with papers also from Louisella Goldschmidt-Clermont, Chris Jackson, Duncan Ironmonger and others. The new insight from St Mary's was to recognise that *time use surveys provide reasonably reliable data on the quantities of household production outputs*, not just on household production input time.

The Harvey and Mukhopadhyay paper followed closely on the publication by INSTRAW of the monograph *Measurement and Valuation of Unpaid Contribution: Accounting through Time and Output* for which Andrew Harvey was the consultant project coordinator. The INSTRAW project was partly conceived at the IATUR meeting in Rome in 1992.

Although Andrew may not regard his Lillehammer paper as brilliant, we do, and have always wished we had been the first to think of its central insight.

[1] Once he even drove three of us with him to an adjoining country for a brief afternoon and evening visit.

2 Framework for household production satellite accounts

2.1 Methods of national accounting

National accounting establishes defined categories and defined variables for which estimates are required – the "boxes" of the accounts. The national accounting statisticians then seek all possible available data to fill the boxes delineated by the established definitions. The accounts are in monetary terms and refer to specific dated periods of years or quarters such as calendar year 2006 or the quarter ended 30 June 2008. The values are thus "flows" of resources and production per year or quarter.

For household production satellite accounts (the national accounts of the household economy) the *variables* are defined in analogous ways to the same variables used in the national accounts of market economy.

National accounts distinguish between inputs and outputs of production and calculate the value added in this production as the contribution in value terms of both labour (human capital) and capital (physical capital). The remaining item is the value of the intermediate inputs used in production (materials and energy). Thus the basic equations linking these variables are:

(1) $V = L + K + M$

(2) $GP = L + K$

where, over a specific period of time,
V = the gross value of production,
L = the value of the labour time used,
K = the rental value of the capital used,
M = the value of the other (intermediate) inputs of materials and energy used and
GP = the gross value added in production.

It is often useful to consider the rental value of capital used in two further categories (i) dwellings, land and buildings and (ii) equipment, furniture and vehicles.

Thus

(3) $K = D + E$

where
D = the rental value of dwellings, land and buildings used and
E = the rental value of equipment, furniture and vehicles used.

The gross value of production and the inputs used can be disaggregated according to categories of commodities (goods or services) produced. In turn each of these categories and the components can be considered as comprising a price and a quantity.

Thus:

(4) $v_i = p_i \times q_i$

where, over a specific period of time
v_i = total value of production of commodity *i* (dollars)
q_i = total quantity of production of commodity *i* (quantity) and
p_i = market price for a unit of commodity *i* (dollars per unit of quantity).

The value of labour input in the production can also be decomposed into price (wage) and quantity (hours) components.

Thus for any commodity produced

(5) $l_i = w_i \times t_i$

where
l_i = total value of labour input to commodity *i* (dollars)
t_i = total quantity of labour time input to commodity *i* (hours) and
w_i = wage rate of labour used to produce commodity *i* (dollars per hour).

The relation in equation (5) also applies in aggregate across all production. So that

$$\sum_i l_i = \sum_i w_i t_i = \frac{\sum_i w_i t_i}{\sum_i t_i} \sum_i t_i = \frac{\sum_i w_i t_i}{\sum_i t_i} T$$

And hence

(6) $L = W \times T$

where
W = the weighted average wage rate across all production (dollars per hour) and
T = the total labour time used in all production (hours).

The variables used in defining equations (1) to (6) apply equally to both the market economy and the household economy.

However, the System of National Accounts (SNA) (Statistical Office of the United Nations, 1993) has defined which types of economic production are to be included within the SNA boundary of production and what types should be excluded. In regard to the household economy the SNA says this economic production should be included in "satellite" accounts which are consistent with the accounts for the standard accounts.

2.2 Categories of household outputs

The household economy can be defined as the productive activities conducted by households using household capital and the unpaid labour of their own members to process goods and provide services for their own use (Ironmonger, 1994).

Household production includes the preparation of food and meals, laundry and house cleaning, child care, shopping, household repairs and maintenance, gardening and other household tasks. The SNA definitions confine household production to "services" and exclude the production of "goods". Thus growing rice and chickens for use within the household is regarded as production of goods to be included in SNA production even if not for sale. Cooking rice and chickens for use within the household is regarded a production of meals and hence services not goods and is excluded from the SNA production boundary.

Amongst the services there are some which are now not regarded as final outputs but as "ancillary" services. These include shopping and gardening. Thus there are just seven final categories of services now considered as final outputs that should be included in the household production satellite accounts.

The seven final outputs are

Accommodation,
Meals,
Clean Clothes,
Child Care,
Transport,
Volunteering and
Education

Some idea of the complexity in counting and finding appropriate market prices for equivalent services provided by the market economy can be seen by considering the variety of types and qualities of the services within each category. In each case we compare the actual range of variety of the services provided by households with the actual procedures used by Harvey and Mukhopadhyay (1996).

A further complication is that some production can be made using market capital and household labour (such as a Laundromat where households use their own labour time to produce clean clothes) and other production can be made using household capital and market labour (such as a hired worker using the household laundry equipment to produce clean clothes).

These types of "mixed modes" of production need to be accommodated within the satellite accounts. However data to make estimates of these modes are hard to find and hence have not been included in the estimates for this paper.

2.3 Accommodation varieties – Size, location, tenure type

The accommodation provided by households for their members is more than just shelter from the elements and is more than just a place to sleep. Accommodation also provides indoor and outdoor space and facilities for a full range of household production and consumption activities including recreation, leisure and social interaction.

Time use surveys provide data on the *quantity* of accommodation (bed nights) that households provide. Analysis of location and time of day data from diary based time use surveys yields information on where adults and children spend their bed nights by the location of their morning and night sleep. Child bed nights can be imputed from the data by examining the presence of a child (or children) during adult sleep episodes. The 2006 Australian Time Use Survey showed about 99.2% of bed nights are provided by households.

Time use surveys provide only limited information on the *quality* of household accommodation - often only basic information about the geographical location, dwelling structure, tenure type and the presence of major items of household technology.

Analysis of data from the census of population and housing shows a very wide range of accommodation from small one-bedroom apartments to large single-household, multi-storied dwellings with three and four bedrooms and large indoor and outdoor space for recreation and leisure in addition to facilities such as dining rooms, kitchens, bathrooms, laundries and garages. These dwellings can be owner occupied or rented and can be located close to and more distant from market and public facilities. Location is a large factor in the value of the accommodation. Dwellings can also vary greatly in their furnishings, furniture and equipment. Thus the market prices for these varieties of accommodation will cover a wide range.

The measurement task involves estimating the number of days of accommodation for each accommodation variety and finding the market equivalent rental price for each variety.

Harvey and Mukhopadhyay (1996) counted the number of bed nights provided by households and valued these at the average price per person of a motel room shared by two people. Whilst this gives an estimate of the value of household accommodation, it seems likely to be an under estimate of the average quantity (in terms of space) and quality (in terms of equipment and facilities) of accommodation provided by households.

From the takings from market accommodation for 2006 the following data are available.

Table 1
Market accommodation, Australia, 2006

2006	Licensed hotels	Motels & guest houses	Serviced apartments	All types
Guest nights ('000)	33,702.2	34,529.8	25,897.5	94,129.5
$ per guest night	99.02	58.32	66.11	75.04

Source: ABS Quarterly Survey of Tourist Accommodation (Cat No 8635.0).

We have used the average of $75.04 per guest night for all types of accommodation as the nearest market rate for equivalent quality household accommodation in Australia in 2006, but have incorporated a discount of 20% to reflect a lower cost for longer term stays.

2.4 Meal varieties – Breakfast, lunch, dinner, snacks, drinks

Meals and snacks vary greatly in their composition and hence in their cost. Although most meals are prepared and eaten at home, some (particularly lunches) are prepared at home and eaten at work or school, and others are eaten at canteens and restaurants. There are also take-away foods such as pizzas which may be collected from the pizza parlour or delivered to the household. The time use surveys provide a snapshot of the number of meals and snacks eaten by adults during an average week, the location, duration and time of day of the eating episodes. However they do not provide any information on the composition, and hence the quantity and quality, of the foods and liquids consumed. Ideally data are needed on the food ingredients of various types of home-produced meals and snacks produced in and consumed by households.

Some information is available from household expenditure surveys of the types and values of foods used for household production of meals.

Using time use survey data Harvey and Mukhopadhyay (1996) estimated the number meals eaten by adults aged 15+ years by time of day and location – home, work, school or restaurant. Combining these estimates of adult's meals with demographic data and data from the family expenditure survey they estimated the number of children's meals. Market surveys of Canadian food establishments then provided the average price of a meal bought in restaurants and other food establishments.

The accuracy of this procedure depends crucially on whether the market research average market price reflects the same mix of types of meals and snacks as the mix of types of meals provided by households. For example there would be a higher proportion of meals for babies and children in home production than in the market. Similarly the data show that a high proportion of lunches are provided by the market. Thus the market research average market meal price should be re-weighted to reflect the composition of household meals.

The accuracy of the final estimates also depends of how accurately people fully report all the meals (and particularly snacks) in the time use diaries. Time use surveys seem to underestimate the number of meals and snacks consumed at home. Harvey and Mukhopadhyay show a Canadian average of only 2.3 home eating episodes per adult per day in 1992. From the Australian time use survey for 2006 we obtain only 2.2 adult home eating episodes per day. We consider both estimates of the number of meals *and snacks* eaten at home are too low. We suspect that in time use diaries people significantly under-report the number of episodes of eating snacks and possibly also the number of meals.

2.5 Clean clothes varieties – Garment types, men's, women's, children's

Commercial laundries and hotels that offer to launder clothing do so at different market prices depending on the type of garment. Thus trousers, skirts and dresses are higher priced that shirts, blouses, tops and shorts which are higher priced than underclothes, socks and handker-

chiefs. Thus to estimate the gross market value of household laundry we need to count the numbers of each type of garment that are laundered by households and value these quantities at the market laundry prices for each type.

The most accurate output measure of clothing care is number of clean clothes of each different garment type (laundered and ironed/folded) produced by the household. Harvey and Mukhopadhyay (1996) assumed the output measure of clothing care to be loads of laundry produced by households. As Harvey and Mukhopadhyay (1996) lamented, time use survey data as it is currently collected, provides "no clue" on either loads of laundry or number of clean clothes produced in households. Using loads of laundry as an output measure of clean clothes is further complicated by the fact that a load of laundry has both personal and household components.

Data on number of clean clothes produced by households can be obtained through other sources such as personal consumption surveys. The Households Research Unit conducted a small scale Melbourne survey of housing, clothes, meals, trips and care in 2005 ("Daily Living in Australia – A Survey of housing, clothes, meals, trips and care"). This survey collected information about the number of clean clothes produced by households (differentiating by garment types for women, men and children).

One advantage of using this method is that the personal and household (sheets, towels, etc) components of loads of laundry do not need to be disentangled and allocated correctly to clothes care and accommodation. Thus, the number of clothing items laundered, including ironing can be obtained from personal consumption diaries such as those used in the "Daily Living in Australia Survey".

2.6 Child care varieties – Physical, teaching, reading, minding, multi child care, multi parent care

The output of child care is measured in child hours of care, not the input hours of parents or other unpaid carers. Rarely do time use surveys record the care received by children[2]. Time use surveys usually cover adults aged 15+ years and record the input hours of child care provided by adult child carers. Some input hours would be providing care of more than one child; sometimes more than one person could record the care of the same child. It is also to be noted that the great proportion of input hours of child care (particularly minding care) are recorded as a secondary activity whilst something else, such as watching television, is recorded as the main activity (Ironmonger, 1996a, 1996b, 2004).

Many time use surveys also collect data on the presence of children during an adult activity episode. Thus we can calculate the time adults had a child (or children) present during all activities, including sleeping. The presence of a child (or children) during adult activities in the household can be an estimate of the time a child is cared for by the household, that is the

[2] An exception is the Longitudinal Study of Australian Children (LSAC) organised by the Australian Institute of Family Studies.

"child hours" of care. The time adults spend in the presence of a child (or children) is really the total time spent in child care (indirect and direct care) that adult household members provide to children. This is a more accurate estimate of all the direct and indirect child care households provide.

An alternative starting point is to use the demographic data on the numbers of children to give estimates of the total hours for which children require care. The hours of care provided by the market (in child care centres and schools) can then be obtained by surveys of these establishments and deducted from the total to give an estimate of the residual care provided at home. This method has been used by the Office for National Statistics (Holloway et al., 2002) to give estimates of child care in the UK and by the present authors to give estimates for Australia (Ironmonger and Soupourmas, 2002).

Harvey and Mukhopadhyay (1996) use data from the Canadian time use survey on input hours combined with a statistical package and data from the family expenditure survey to estimate the number of output hours of child care.

A comparison of the Canadian, Australian and United Kingdom data for recent calendar years shows the following (see Table 2).

Thus whilst the Australian and United Kingdom estimates are similar, an average of about 20 hours per day of child care per child 0-14 years, the Canadian data show less than six hours per child per day.

Table 2
Household production – Output hours of child care, 1992 and 1999

	Canada (1992)	Australia (1999)	United Kingdom (1999)
Million hours	11,984	29,332	87,786
Child population (0-14 yrs) ('000)	5,829	3,933	12,138
Average care per child -			
Per year	2,055.9	7,457.5	7,232.6
Per week	39.5	143.4	139.0
Per day	5.64	20.5	19.9

The Canadian estimates used the market price for an hour of commercially available child care from child care centres for infants, pre-school and school aged children. The Australian and UK estimates used the price for a live-in nanny assuming each nanny minded two children working for a 46 hour week.

2.7 Transport varieties – Distance, purpose, speed, comfort

When households use public transport (trains, trams, buses and ferries) or take taxis they are purchasing a transport service from the market. Households pay fares for these services.

When they use their own cars and other motorised vehicles to drive themselves and their families they are essentially providing their own taxis without charging themselves the fare.

Thus household production of transport services involves the use of household capital equipment (vehicles) and the use of household labour (to drive the vehicles). Taxi fares cover the inputs of labour, capital and other inputs including fuel, maintenance and repairs.

The main way the market charges for taxi costs is by the distance travelled for each trip combined with a "flag-fall" or hiring charge per trip. Commonly there are also extra charges for different times of day, such as a surcharge for late night trips. Thus to count the outputs of household transport services we need to count the number of trips, the distance covered and the time of day. The purpose of a trip does not affect the market price, so there is no need to differentiate between trip purposes. Taxis usually can take up to four passengers without extra charge.

Time use surveys are usually rich in the data needed for the calculations of the household production of transport services. Specifically, time use surveys provide comprehensive information on the number of trips and duration of trips undertaken by adults in motorised transport (car/truck/van/motorbike or scooter) provided by households at different times of the day. The distance travelled in kilometres can then by estimated based on the duration of trip multiplied by average speed obtained via travel surveys. In Australia there are also annual official surveys of samples of both domestic and commercial vehicles to determine, for public transport policy purposes, the annual average number of vehicle kilometres travelled by vehicle type. These surveys provide estimates of household transport vehicle kilometres.

2.8 Volunteering varieties – Organised (indirect) and unorganised (direct)

In its work on measuring and valuing volunteering, the Households Research Unit has distinguished between "organised" and "unorganised" volunteering.

Organised volunteering is defined as unpaid help in the form of time, service or skills willingly given by an individual through an organisation or group. Formal or organised volunteering is *indirect* as it is mediated through an organisation. Reimbursement of expenses or small gifts is not regarded as payment of salary. Work reimbursed by payment in-kind is not regarded as volunteering.

Unorganised volunteering is defined as the informal unpaid help and care that occurs within the personal networks of family, friends, neighbours and acquaintances. Informal or unorganised volunteering is *direct* as it is not mediated through an organisation. It includes regular, spontaneous and sporadic help that takes place between friends and neighbours such as giving advice, looking after other people's children or helping an elderly neighbour.

A more detailed discussion of the definitions of organised (formal) and unorganised (informal) volunteering can be found in Soupourmas and Ironmonger (2002).

For the estimates of volunteering in this paper we have excluded looking after other people's children. This activity has been included on an output basis in the child care category.

For the remaining volunteer activity we are unable to measure the specific outputs of meals, care etc, provided both indirectly through volunteer organisations and directly in support of other adults. Thus we are forced back on measuring the input time and valuing that at an appropriate market rate. The rate is $24.09 per hour based on reports prepared by the Households Research Unit for the state governments of Queensland and Western Australia (Ironmonger, 2008, 2009).

2.9 Education varieties – Pre-school, primary, secondary, tertiary, homework-study

The 1995 INSTRAW monograph *Measurement and valuation of unpaid contribution – Accounting through time and output* makes a persuasive argument that education represents personal, and, hence, household investment that yields a return over time. Hence it is a productive activity although it does not fit within Margaret Reid's third person criterion for production. Education is not a task you could usefully pay someone to do for you as the benefit would not accrue to you. The output of education emerges over a long period of time after the input time and as shown by many studies accrues in the form of higher income over many years.

Robert Eisner and his team at Northwestern University in their path-breaking work on the extended national accounts for the United States included not only the education time of adults but also the education time of children in their estimates of Gross Household Product[3].

Harvey and Mukhopadhyay (1996) included estimates for the income foregone in the education process by Canadians aged 12 to 27 years. In the education estimates we have included estimates for Australians aged 15+ years.

3 Source data

The data must be consistent for a particular year or quarter. For this paper the source data and the estimates are for Australia for the calendar year 2006.

Five types of data are used to make the estimates. These are:

Output and input data from time use surveys

q_i = total quantity of household production of service *i* (measured in appropriate units)
t_i = total quantity of labour time input used in household production of service *i* (hours)

Input data from other surveys and sources

[3] Eisner seems to have been the first to designate the value added added by household production as "Gross Household Product".

p_i = market price for a unit of service *i* (dollars per unit)
m_i = total value of intermediate inputs in household production of service *i* (dollars)
k_i = total rental value of capital input in household production of service *i* (dollars)

The total rental value of each capital input may be split into its components d_i and e_i where d_i = total rental value of dwelling space and land input in household production of service *i* (dollars) and e_i = total rental value of equipment, furniture and vehicles input in household production of service *i* (dollars).

Thus $d_i + e_i = k_i$.

3.1 Calculated data

From the source data, calculated data are prepared for four more variables. These are:

$v_i = p_i \times q_i$ = gross value of household production of service *i* (dollars)
$ghp_i = v_i - m_i$ = value added (GHP) in household production of service *i* (dollars)
$l_i = ghp_i - k_i$ = total value of labour input in household production of service *i* (dollars)
$w_i = l_i \div t_i$ = imputed wage rate of labour input in household production of service *i* (dollars per hour)

3.2 Aggregated data

Adding across all the various household production services gives four more variables *V, M, K* and *T*.
$V = \sum_{i=1,n} v_i$ = total gross value of household production (dollars)
$M = \sum_{i=1,n} m_i$ = total value of intermediate inputs in household production (dollars)
$K = \sum_{i=1,n} k_i$ = total rental value of capital inputs in household production (dollars)
$T = \sum_{i=1,n} t_i$ = total quantity of labour time inputs in household production (hours)
As shown before in equation (3) *K* may be split into two components, *D* and *E*.
From these estimates, three more aggregates can be calculated, *GHP*, *L* and *W*.
$GHP = V - M$ = total Gross Household Product (dollars)
$L = GHP - K$ = total value of labour time inputs in household production (dollars)
$W = L \div T$ = average imputed wage rate in household production (dollars per hour)

The basic identities linking these aggregate variables are
$V = GHP + M$
$GHP = K + L$ and
$L = W \times T$

3.3 Advantage of this new approach over other methods[4]

If we examine the way input-output principles are applied to valuation within the SNA we find there is one large sector where outputs are not sold - the public sector. In this sector the

[4] The discussion in this section follows closely the arguments presented in Ironmonger (1996a).

value added by the provision of goods and services, for example police and defence, is estimated from the value of the purchased capital and labour used, not by the (non-existent) prices of the outputs. For the household, the problem of value added estimation is somewhat different. Here, nearly all the goods and services produced, such as meals, laundry and child care, are also available from the market. So, unlike the public sector, we can count and value the household outputs at the market prices for which these goods and services can be purchased.

The accounting valuation and measurement possibilities for the business sector, the public sector and the household sector are set out in the following Table 3.

In the business sector the accounts can be based on actual transactions for both the inputs of labour, capital and intermediate commodities used in the production process and the outputs of goods and services flowing from this process. For the public sector, actual transactions can be used as the basis of the inputs but in most cases there are no comparable commodities for which we can obtain prices to value the outputs of public goods.

For the household sector we can count the outputs and value them at market prices. The value of the labour inputs can then be calculated as the residual item from the deduction of the cost of the capital used and the cost of the intermediate inputs used in household production. *If we measure the hours of time involved, we can calculate as a residual the value per hour of that time.*

Table 3
Input-output valuation – Business, public and household sectors

	Business	**Public**	**Household**
Inputs			
Labour time	Actual transactions	Actual transactions	- *(Residual*)
Capital goods	Actual transactions	Actual transactions	Counted and priced at market
Intermediate	Actual transactions	Actual transactions	Actual transactions
Outputs	Actual transactions	- *(Residual)*	Counted and priced at market

For example, if a man takes 60 minutes to prepare, serve and clean up after a meal for four people, say valued at $40 at restaurant prices, and the costs of the ingredients, energy for cooking and washing up, together with the use of the kitchen, kitchen equipment, dining room, furniture and utensils are $25, then the wage rate for the man's unpaid labour is $15 per hour. If a woman can prepare the same meal in 30 minutes, her labour would be worth $30 per hour[5].

[5] And, if her meals for four were of higher standard, say worth $44 at restaurant prices, her labour would be worth $38 per hour; $44 - $25 = $19 for 30 minutes work.

Using this approach the values of the labour used in the various types of household production are derived from the market values of the household production outputs less the cost of the capital and intermediate inputs which are also derived from market data. The average labour costs per hour are then simply derived by dividing these values by the time use survey estimates of the unpaid hours used in each type of household production.

This method thus solves the much debated dilemma of which market wage rate to use – opportunity cost wage, specialist wage or general housekeeper wage. The imputed labour costs per hour from this new approach are thus based on the actual technology and productivity of household production not on wage rates determined by the technology and productivity of market production.

The use of an output valuation method on household production also goes a long way towards solving the issue of the joint production of services through simultaneous or parallel uses of time. The joint products - meals prepared and children minded - of the labour and capital used in preparing and minding is counted and valued at market prices. The value of the labour used simultaneously is found indirectly by deducting the materials and capital costs from the market value of the joint outputs.

4 New estimates of Australian household production

The experimental estimates in this paper are for the year 2006 using outputs from the Australian time use survey and other data from official and unofficial statistics.

The estimates cover the Australian household population of 19,891,200 (15,963,900 adults aged 15+ years and 3,927,300 children aged 0-14 years) in 7,954,800 households as recorded by the Australian Bureau of Statistics in the 2006 time use survey. The estimates therefore exclude people living in non-private dwellings such as hotels, motels, boarding houses and other institutions such as hospitals, schools and prisons.

4.1 Accommodation – Number of days of accommodation

Harvey and Mukhopadhyay called this "Housekeeping" and counted the number of bed nights

Table 4
Household production of accommodation, Australia 2006, experimental estimates (m = million)

Category	Item	Unit	Total all households per year		Per household		
					Per year	Per week	Per day
Output	q_i	days(a)	7,115.1	m	894	17.15	2.45
	p_i	$/day(b)	60.03		60.03	60.03	60.03
	v_i	$	427,119	m	53,693	1,030	147.10
Inputs	t_i	hours(c)	6,895	m	866.8	16.62	2.37
	w_i	$/hour	41.65		41.65	41.65	41.65
	l_i	$	287,185	m	36,102	692.37	98.91
	d_i	$	98,307	m	12,358	237.01	33.86
	e_i	$	15,269	m	1,919	36.81	5.26
	k_i	$	113,576	m	14,277	273.82	39.12
	m_i	$	26,358	m	3,313	63.55	9.08
GHP	ghp_i	$	400,761	m	50,380	966.19	138.03

Notes:

(a) The TUS shows the number of accommodation days per year slept at own household or another household were 7,260.3 million. This is 99.06% of all days and implies that only 0.94% of all days (3.42 days per year) were slept in market provided accommodation. We suspect that the TUS methodology of sampling in only four months of the year (avoiding the main holiday periods) led to an undercounting of market accommodation days. We have tentatively adjusted the market days to 2.0% (7.3 days per person per year). This gives an estimate of 7,115.1 million household provided accommodation days.

(b) The market accommodation average of $75.04 per night in 2006 would mostly comprise casual accommodation for short-period stays. The market gives discounts on these casual rates for longer period stays. Hence we have thought it reasonable to make a 20% discount and thus have used the rate of $60.03 per day.

(c) Input hours comprise the following ABS time use categories (mpd = minutes per person per day, hpy = hours per person per year, mhy = million hours per year).

	mpd	hpy	mhy	
Other housework		22	133.8	2,136.5
Grounds, animal care	22	133.8	2,136.5	
Home maintenance	9	54.8	874.0	
Household management	9	54.8	874.0	
Other domestic activities		4	24.3	388.5
Purchasing services	5	30.4	485.6	
Total	71	431.9	6,895.1	

Source: Households Research Unit, Department of Economics, University of Melbourne.

4.2 Meals – Number of meals and snacks

H&M called this "Meal Preparation" and counted the number of meals.

Table 5
Household production of meals, Australia 2006,
experimental estimates (m = million)

Category	Item	Unit	Total all households per year		Per household		
					Per year	Per week	Per day
Output	q_i	meals(a)	34,341	m	4,317	82.79	11.83
	p_i	$/meal(b)	10.39		10.39	10.39	10.39
	v_i	$	356,764	m	44,849	860.11	122.87
Inputs	t_i	hours(c)	6,992.2	m	879.0	16.86	2.41
	w_i	$/hour	40.52		40.52	40.52	40.52
	l_i	$	283,296	m	35,613	982.99	97.57
	d_i	$	0	m	0	0	0
	e_i	$	6,107	m	767.7	14.72	2.10
	k_i	$	6,107	m	767.7	14.72	2.10
	m_i	$	67,361	m	8,468	162.40	23.20
GHP	ghp_i	$	289,403	m	36,381	697.72	99.67

Notes:

(a) Includes snacks. The time use survey episode data records only 2.24 eating episodes at home per adult per day. This is only 15.7 meals and snacks per adult per week. We consider the time use diary methodology probably records only about half of all meals and snacks produced in the household. Thus we have adopted the following numbers for our experimental estimates.

	Adults	Children
At home: Number per person/week	32	36
Number per person/year	1,669	1,877

(b) Estimates based on restaurant, cafe and fast food retail prices

		Adults	Children
Meals	$ per meal	20.00	7.00
Snacks	$ per snack	4.00	2.00
Meals & snacks	$ average	12.00	4.50

(c) Input hours comprise the following ABS time use categories (mpd = minutes per person per day, hpy = hours per person per year, mhy = million hours per year):

	mpd	hpy	mhy
Meal preparation	49	298.1	4,758.8
Purchasing goods	23	139.9	2,233.4
Total	72	438.0	6,992.2

Source: Households Research Unit, Department of Economics, University of Melbourne.

4.3 Clean Clothes – Number of clothing items laundered

H&M called this "Clothing Care" and estimated the number of laundry loads of clothes washing.

Table 6
Household production of clean clothes, Australia 2006, experimental estimates (m = million)

Category	Item	Unit	Total all households per year		Per household		
					Per year	Per week	Per day
Output	q_i	items(a)	34,227	m	4,303	82.52	11.79
	p_i	$/item(b)	2.18		2.18	2.18	2.18
	v_i	$	74,566	m	9,374	179.77	25.68
Inputs	t_i	hours(c)	1,650.9	m	207.54	3.98	0.57
	w_i	$/hour	28.33		28.33	28.33	28.33
	l_i	$	46,775	m	5,880	112.77	16.11
	d_i	$	0	m	0	0	0
	e_i	$ (d)	23,590	m	2,965	56.87	8.12
	k_i	$	23,590	m	2,965	56.87	8.12
	m_i	$	4,201	m	528	10.13	1.45
GHP	ghp_i	$	70,365	m	8,846	169.64	24.23

Notes:

(a) Number of clothing items laundered, including ironing - based on the personal consumption diaries from HRU survey of Living Conditions in Melbourne

		Adults	Children	Persons
At home	Number per person/week	33	33	33
	Number per person/year	1,721	1,721	1,721
	Million per week	526.8	129.6	656.4
	Million per year	27,470	6,757	34,227

(b) The average price of $2.18 per clothing item laundered is calculated as follows.

	$/garment	No/week	$/week
Trousers, skirts, dresses, jumpers	7.00	2	14.00
Shirts, blouses, tops, t shirts, shorts	2.50	8	20.00
Underclothes, socks, handkerchiefs	1.50	18	27.00
All garments	2.18	28	61.00

(c) Input hours comprise the following ABS time use category – (mpd = minutes per person per day, hpy = hours per person per year, mhy = million hours per year).

	mpd	hpy	mhy
Laundry, clothes care	17	103.4	1,650.9

(d) Includes both laundry equipment and clothing.

Source: Households Research Unit, Department of Economics, University of Melbourne.

4.4 Child Care – Number of child hours of care

Table 7
Household production of child care, Australia 2006, experimental estimates (m = million)

Category	Item	Unit	Total all households per year		Per household		
					Per year	Per week	Per day
Output	q_i	hours(a)	26,408	m	3,320	63.67	9.10
	p_i	$/hour(b)	9.25		9.25	9.25	9.25
	v_i	$	244,276	m	30,708	588.92	84.13
Inputs	t_i	hours (c)	10,973.9	m	1379.5	26.46	3.78
	w_i	$/hour	21.32		21.32	21.32	21.32
	l_i	$	233,957	m	29,411	564.04	80.58
	d_i	$	0	m	0	0	0
	e_i	$	6,107	m	768	14.72	2.10
	k_i	$	6,107	m	768	14.72	2.10
	m_i	$	4,212	m	529	10.15	1.45
GHP	ghp_i	$	240,064	m	30,179	578.77	82.68

Notes:

(a) Number of child hours of care; includes care of other households' children.

(b) Hired nanny cost per hour of child care

(c) Input hours comprise the following ABS time use categories – (mpd = minutes per person per day, hpy = hours per person per year, mhy = million hours per year):

	mpd	hpy	mhy
Primary time, including travel	41	249.4	3,981.7
Secondary time	72	438.0	6,992.2
Total	113	687.4	10,973.9

Source: Households Research Unit, Department of Economics, University of Melbourne.

4.5 Transport – Number of vehicle kilometres

H&M did not include this category.

Table 8
Household production of transport, Australia 2006, experimental estimates (m = million)

Category	Item	Unit	Total all households per year		Per household		
					Per year	Per week	Per day
Output	q_i	km(a)	114,158	m	14,351	275.22	39.32
	p_i	$/km(b)	1.80		1.80	1.80	1.80
	v_i	$	205,481	m	25,831	495.39	70.77
Inputs	t_i	Hours(c)	4,963.3	m	624	11.97	1.71
	w_i	$/hour	28.71		28.71	28.71	28.71
	l_i	$	142,515	m	17,916	343.59	49.08
	d_i	$	0	m	0	0	0
	e_i	$	20,523	m	2,580	49.48	7.07
	k_i	$	20,523	m	2,580	49.48	7.07
	m_i	$	42,443	m	5,336	102.33	14.62
GHP	ghp_i	$	163,038	m	20,496	393.06	56.15

Notes:

(a) Household vehicle kilometres, estimated from the ABS TUS which shows for drivers of household vehicles 24.746 million trips per day with an average 33 minutes per trip. This is 4,963.3 million hours per year. At an average speed of 23 kph (from travel survey data) this is 114,156 m km per year.

(b) Average taxi cost per kilometre, including flag fall, Melbourne

(c) Input hours comprise the following ABS time use categories – (mpd = minutes per person per day, hpy = hours per person per year, mhy = million hours per year):

	mpd	hpy	mhy
Car driver and other motorised	51.10	310.9	4,963.3

Source: Households Research Unit, Department of Economics, University of Melbourne.

4.6 Volunteering – Number of hours of volunteer work

H&M called this "Volunteerism" and counted the number of hours of volunteer work.

Table 9
Household production of volunteering, Australia 2006, experimental estimates (m = million)

Category	Item	Unit	Total all households per year		Per household		
					Per year	Per week	Per day
Output	q_i	hours(a)	1,553.8	m	195.3	3.75	0.535
	p_i	$/hour(b)	24.09		24.09	24.09	24.09
	v_i	$	37,432	m	4,705.6	90.24	12.89
Inputs	t_i	hours(c)	1,553.8	m	195.3	3.75	0.535
	w_i	$/hour	24.09		24.09	24.09	24.09
	l_i	$	37,432	m	4,705.6	90.24	12.89
	d_i	$	0	m	0	0	0
	e_i	$	0	m	0	0	0
	k_i	$	0	m	0	0	0
	m_i	$	0	m	0	0	0
GHP	ghp_i	$	37,432	m	4,705.6	90.24	12.89

Notes:

(a) Includes work through organisations and care of adults but excludes care of children.

(b) Estimates of the HRU based on ABS earlier estimates

(c) Input hours (and output hours) comprise the following ABS time use categories – mpd = minutes per person per day, hpy = hours per person per year, mhy = million hours per year

	mpd	hpy	mhy
Support for adults	9	54.75	874.0
Unpaid volunteer work	4	24.33	388.5
Other volunteering	3	18.25	291.3
Total	16	97.33	1,553.8

Source: Households Research Unit, Department of Economics, University of Melbourne.

4.7 Education – Number of hours of education

H&M called this "Education" and also "Personal Development" and counted the number of hours of education.

Table 10
Household production of education, Australia 2006, experimental estimates (m = million)

Category	Item	Unit	Total all households per year		Per household		
					Per year	Per week	Per day
Output	q_i	hours(a)	2,622.1	m	329.6	6.32	0.90
	p_i	$/hour(b)	13.47		13.47	13.47	13.47
	v_i	$	35,319	m	4,440.0	85.15	12.16
Inputs	t_i	hours(c)	2,622.1	m	329.6	6.32	0.90
	w_i	$/hour	15.00		13.47	13.47	13.47
	l_i	$	35,319	m	4,440.0	85.15	12.16
	d_i	$	0	m	0	0	0
	e_i	$	0	m	0	0	0
	k_i	$	0	m	0	0	0
	m_i	$	0	m	0	0	0
GHP	ghp_i	$	35,319	m	4,440.0	85.15	12.16

Notes:

(a) Includes education time of adults aged 15+ but excludes time of children aged 0-14 years.

(b) Standard Federal Minimum Wage of $13.47 per hour.

(c) Input hours (and output hours) comprise the following ABS time use categories – (mpd = minutes per person per day, hpy = hours per person per year, mhy = million hours per year):

Education time	mpd	hpy	mhy
Attend education course	14	85.17	1,359.6
Jobs related training	1	6.08	97.1
Homework/study/research	11	66.92	1,068.3
Other education	1	6.08	97.1
Total	27	164.35	2,622.1

Source: Households Research Unit, Department of Economics, University of Melbourne.

5 All Household Production

These estimates are the aggregation of the seven component categories of household production. As the quantities of component outputs are in different units, there are no aggregates for the total quantity of all household services (Q_{hp}) and for the unit price of the aggregate quantity (P_{hp}).

However, if a series of satellite accounts of household production were constructed for a number of years, it would be possible to construct a series of constant price (or volume) estimates for Q_{hp} and a series of implicit price deflators for P_{hp}.

Table 11
Household production of all services, Australia 2006, experimental estimates (m = million)

Category	Item	Unit	Total all households per year		Per household		
					Per year	Per week	Per day
Output	Q_{hp}		NA		NA	NA	NA
	P_{hp}		NA		NA	NA	NA
	V_{hp}	$	1,380,958	m	173,601	3,329.33	475.62
Inputs	T_{hp}	hours	35,651.2	m	4,482	85.95	12.28
	W_{hp}	$/hour	29.91		29.91	29.91	29.91
	L_{hp}	$	1,066,480	m	134,067	2,571.16	367.31
	D_{hp}	$	98,307	m	12,358	237.01	33.86
	E_{hp}	$	71,596	m	9,000	172.61	24.66
	K_{hp}	$	169,903	m	21,359	409.62	58.52
	M_{hp}	$	144,575	m	18,175	348.55	49.79
GHP	*GHP*	$	1,236,383	m	155,426	2,980.77	425.82

NA = Not applicable.
Source: Households Research Unit, Department of Economics, University of Melbourne.

6 Estimates of Gross Market Product (GMP) and Gross Economic Product (GEP)

Housing owned by households is a large component of the household production of accommodation. The procedure adopted by Harvey and Mukhopadhyay to avoid double counting of the imputed rental value of owner occupied housing (which is included in the estimates of market production, GDP) is to exclude this value from household production.

A more satisfactory way is to adjust the GDP estimates to exclude this non-market production and include it in the GHP estimates. This procedure has been used by the Households Research Unit over many years in its estimates of GHP. The adjusted GDP estimates are renamed Gross Market Product (GMP). Adding GMP to GHP gives an estimate which can be called Gross Economic Product (GEP).

The following table shows estimates for GMP, GHP and GEP for Australia for 2006.

In Australia in 2006 the imputed rental value of owner occupied dwellings, D_{hp} ($98.3 billion) equal to 9.8 per cent of GDP ($1,006.6 billion). Thus GMP ($908.3 billion) is just 90.2% of GDP. The household economy produced well over half (57.6%) of the total Gross Economic Product of $2,144.6 billion. Put another way, the household economy contributed over a third (36.1%) more than the market economy contributed.

Table 12
Production of all goods and services, Australia 2006, experimental estimates (m = million)

Category	Item	Unit	Total all households per year		Per Household		
					Per year	Per week	Per day
GDP	*GDP*	$	1,006,564	m	126,535	2,426.71	346.67
Less	D_{hp} (a)	$	98,307	m	12,358	237.01	33.86
= GMP	*GMP*	$	908,257	m	114,177	2,189.70	312.81
+ GHP	*GHP*	$	1,236,383	m	155,426	2,980.77	425.82
= GEP	*GEP*	$	2,144,640	m	269,603	5,170.47	738.63

(a) Rental value of owner occupied dwellings.

Source: Australian Bureau of Statistics Australian National Accounts – National Income Expenditure and Product (Catalogue No. 5206.0) March 2009 and estimates of the Households Research Unit, Department of Economics, University of Melbourne.

7 Estimates of labour and capital inputs to the market economy, the household economy and the total economy

Using the 2006 time use survey data on the labour inputs to the market economy and data from the ABS National Accounts we can calculate the labour and capital shares of GMP and compare them with the labour and capital shares of GHP. We can also calculate the average market wage per hour to compare with the new estimates of the imputed value per hour of household work.

The capital and labour shares of the two sectors of the total economy are very different. In the market economy labour provides 59.6% of GMP; in the household economy labour provides 86.3% of GHP. Thus the household economy is more labour-intensive than the market economy. Alternately, we can say the market economy is more capital intensive than the household.

Table 13
Labour and capital inputs to economic production, Australia 2006, experimental estimates (m = million)

Category	Item	Unit	Total all households per year		Per household		
					Per year	Per week	Per day
Labour Inputs							
Market	T_{mp}	hours(a)	17,675	m	2,221.9	42.61	6.09
Household	T_{hp}	hours	35,651	m	4,481.7	85.95	12.28
Total	T_{ep}	hours	53,326	m	6,702.6	128.56	18.37
Market	W_{mp}	$/hour	30.64		30.64	30.64	30.64
Household	W_{hp}	$/hour	29.91		29.91	29.91	29.91
Total	W_{ep}	$/hour	30.15		30.15	30.15	30.15
Market	L_{mp}	$(b)	541,502	m	68,072	1,305.50	186.50
Household	L_{hp}	$	1,066,480	m	134,067	2,571.16	367.31
Total	L_{ep}	$	1,607,982	m	202,139	3,876.66	553.81
Capital Inputs							
Market	K_{mp}	$(c)	366,755	m	46,105	884.20	126.31
Household	K_{hp}	$	169,903	m	21,358	409.62	58.52
Total	K_{ep}	$	536,658	m	67,463	1,293.82	184.83

Notes:

(a) Input hours comprise the following ABS time use categories – (mpd = minutes per person per day, hpy = hours per person per year, mhy = million hours per year):

Employment related time -	mpd	hpy	mhy
Main job	179	1,088.92	1,738.4
Other job	1	6.08	97.1
Work breaks	1	6.08	97.1
Other	1	6.08	97.1
Total	182	1,107.17	17,674.7

(b) The following data are from the latest ABS National Accounts for 2006 –

	$m
Compensation of employees	482,764
Labour share (2/3) of mixed income	58,738
Total labour market income	541,502

(c) $K_{mp} = GMP - L_{mp}$

Source: Estimates of the Households Research Unit, Department of Economics, University of Melbourne.

8 Estimates of average wage rates

There is a surprising concurrence in the overall estimate of $29.91 per hour for the (unpaid) household production labour with the $30.64 per hour for the (paid) market production labour.

The market estimates are gross wage rates, that is, they have not been adjusted for deductions of income tax and they include benefits such as superannuation contributions that accrue to the wage earner.

However, the estimates for the categories of household production vary significantly, as shown in the following table.

Table 14
Average wage rates in economic production, Australia 2006, experimental estimates

Production Activity		$/hour
Accommodation		41.65
Meals		40.52
Clean Clothes		28.33
Child Care		21.32
Transport		28.71
Volunteering		24.09
Education		13.47
All household production	W_{hp}	29.91
All market production	W_{mp}	30.64
All economic production	W_{ep}	30.15

The highest values of time, according to our experimental estimates, are in providing accommodation, $41.65 per hour and in providing meals, $40.52 per hour. Transport ($28.71) and clothes laundry ($28.33) are near the average with volunteering ($24.09), child care ($21.32) and education ($13.47) significantly below the average value per hour.

9 Concluding Remarks

Each day households provide the bulk of the community's needs for accommodation, meals, transport, clean clothes and personal care.

The total value of the accommodation, meals, transport, clothes care and child care provided on an unpaid basis by households can be estimated using output data from time use surveys (and other sources).

Harvey and Mukhopadhyay's (1996) ground breaking paper showed how diary based time use surveys can be used to estimate the output quantities of major categories of household production. Specifically, they demonstrated that time use surveys can provide output data to

"fill the boxes" of the household production satellite accounts for accommodation, meals and child care.

Our paper builds on Harvey and Mukhopadhyay's innovative approach of using time use survey data to estimate the quantities of household outputs. It applies their methodology to the latest data for Australia and goes three steps further.

First, it includes transport as a category of household production. Second, it links the market price values of household outputs and the values of the non-labour inputs (the intermediate inputs of purchased materials and energy and the rental values of capital) to estimate the total values of the unpaid labour used in the various household production categories. Finally, by using the time use survey data on the input hours, it provides a new basis for estimating the values per hour of the labour used in each of these activities and overall in all household production.

Acknowledgement

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Appendix

Allocation of Household Final Consumption Expenditure, Australia, 2006
$ million, current prices

	Household Production Category								
HFCE Category	Accommo-dation	Meals	Clean Clothes	Child Care	Transport	Volunteer	Education	*Total HP*	Other Non HP
Food		62,448						62,448	
Tobacco									10,249
Alcohol									11,602
Clothing			20,536					20,536	
Dwelling rent	98,307							98,307	
Energy	4,358	2,913	2,201	2,212				11,684	
Furnishings equipment	15,269	6,107	3,054	6,107				30,537	
Health									29,593
Vehicles purchase					20,523			20,523	
Vehicles operation					32,443			32,443	
Transport services									13,652
Communi-cations									15,789
Recreation culture									67,415
Education services									19,368
Hotels cafes restaurants									43,411
Insurance & financial services	20,000	1,000	1,000		10,000			32,000	8,247
Other goods & services	2,000	1,000	1,000	2,000				6,000	31,347
Total FCE (a)	139,934	73,468	27,791	10,319	62,966	0	0	314,478	250,673
Of which -									
Dwellings	98,307							98,307	
Equipment	15,269	6,107	23,590	6,107	20,523			71,596	
Intermediate Inputs	26,358	67,361	4,201	4,212	42,443			144,575	
Other Expenditure									250,673

Note: (a) The aggregate Household Final Consumption Expenditure (HFCE) in 2006 was $565,151 million of which $314,478 was allocated as inputs to household production and the balance, $250,673 million was direct purchase of consumption goods and services from the market economy.

Source: Australian Bureau of Statistics (2009) *Australian National Accounts* Catalogue No. 5206.0 Excel Spreadsheet 5206008, Household Final Consumption Expenditure.

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Variations in the rational use of time – The travel pulse of commutes between home and job

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Abstract

Ian Cullen and his research colleagues long ago suggested that people form habits in daily life that suboptimize behavior in view of constraints. Such rational suboptimization is posited here to apply to trips between home and work and to vary by time of the day. Previous research suggests that afternoons prove more difficult for people than mornings, with rush hour traffic patterns shown as one aspect. This paper contrasts with episode level data from Statistics Canada's 2005 time-use survey the temporal pattern (shown as a "travel pulse") of weekday commutes between home and job by full-time workers with external workplaces. The mean trip duration in the morning is less than in the afternoon, as is its standard deviation. This is rooted in a visibly greater dispersion of rational starting times from home in the morning with arrival at work at various times in advance of the start to the formal work day, while, in the afternoon, people typically depart from work directly at externally-determined closing times and in concentrated peaks. The result is that nearly twice the number of commuters set out at the same time during the afternoons than in the mornings. The less than individually-rational intensity of the afternoon commuting context is compounded by the concentration of everyday shopping stops during the afternoon commute. Mode of travel accounts for significantly different mean trip times, but differences in trip duration by time of day transcend travel mode. Differences by gender interact with mode of travel but are not generally significant. The rich legacy established by Andrew Harvey is apparent, as he has been an influential shaper and advocate of the Statistics Canada's time-use surveys, the use of such data for transportation analyses, and a focus on episode-level analysis.

JEL-Codes: R41

Keywords: Rationality, suboptimization, commuting, time of day, travel mode, gender

1 Introduction

This paper is intended to assist in the understanding of why certain types of trips take longer in some circumstances than in others. This question arose from a recent paper (Michelson, 2008) that dealt with the nature and extent of changes in everyday behavior occasioned by the semi-annual time changes of an hour lost in the Spring and then regained in the Fall in jurisdictions that have daylight savings time (or "summer time"). While people were found to adapt their sleep habits quickly, due in large part to the clock changes occurring early on Sunday mornings, there were significant increases in time spent traveling on the immediate Monday (as compared to the previous and following Mondays). And this finding was consistent with previous studies documenting but not explaining the same phenomenon. Why does travel take longer on the weekday following clock changes, regardless of whether the hour is gained or lost?

My hypothetical explanation starts from the assumption that there is a strong element of rationality underlying repetitive everyday behavior. Ian Cullen and several different co-authors made the point many years ago (Cullen, 1972, 1978, 1982; Cullen and Godson, 1972; Cullen and Phelps, 1978) that people, when faced by the need to carry out their lives within large, complex urban settings, find it difficult to do exactly what they might want; but in the absence of that, they form habits that suboptimize their objectives as well as possible under the circumstances. Travel to and from work fits this perspective well. By this logic, people build habits within available resources and limits that get them to and from their jobs as efficiently as possible. I view this as including a trial and error process that eventuates in an understanding as to what the conditions of travel will be by various means to make such trips in the least time and with the least hassle. You learn a time frame that will be most successful, and, all else equal, you keep to those means and timetabling until a better habit becomes evident. This leads me to speculate that the semi-annual time changes sufficiently (though temporarily) intervene in the finely-tuned complex of travel habits, so that many travelers are not in sync in time and space as their habits normally suggest, leading to unaccustomed congestion and hence, longer, more risk associated travel.

The data set enabling the semi-annual time change analysis is insufficient for a more detailed examination of this hypothetical process. Therefore, an analogous situation more suitable for analysis is now examined. It is generally acknowledged that afternoons are more difficult than are mornings, with respect to commuting, industrial accidents, and more. For example, the afternoon rush hours cover a longer period and are perceived as more vexing for commuting. Javeau's analysis of journeys to and from work in Belgium (1972) shows not only a longer period of peak travel in the p.m. but also a trip duration for those under way in any fifteen minute period, which trip duration is longer in the afternoon than in the equivalent period in the morning in all but one such period. More recent analyses of Los Angeles weekday traffic (Chester, 1997) demonstrate clearly the longer extent of the p.m. rush hour. While automotive

death *rates* are highest in the hours after midnight, especially on weekends, the *number* of fatalities is greatest between 5 and 7 p.m., with likely ripple effects on the duration and stress of travel for others (Morris, 2008; Poppe, 2009). European studies of industrial accidents indicate that these occur more frequently at the end of a long day of work (Hänecke et al., 1998). While this is true among workers in all the traditional shift work periods, the preponderance of work done during "normal" working hours leads to accident occurrence peaking in the late afternoons. It also puts many tired workers onto the road at that time, a pattern documented also in the case of truck drivers (Lin et al., 1994). Thus, there is support for popular assertions of a.m. and p.m. differences in the commutes between home and work – and for pursuing a greater deal of explanation than has been the case to date. These assertions are not necessarily to the effect that there are inherent differences between morning and afternoon; but to the extent that a variety of factors combine to place people more at risk by late afternoon, differences in the experience of these time periods may be salient.

While many workers do not get to and from work by road transportation, and a certain number of cities have enhanced alternative rail commuting options successfully, the majority of those not working at home get to their work by automobile in most technologically advanced nations, for example, see Niemi and Pääkkönen (2002). Thus, what happens on the roads has a major impact on research findings about the duration and difficulty of commuting. And there has been no lack of study of traffic congestion.

Much explanation of congestion deals with factors outside the control of individuals. For example, the availability and quality of various modes of travel reflect collective decisions. Climate and weather impact travel. Highway design and capacity have a bearing on congestion, in general but also in creating potential conditions of risk. Very specific engineering devices such as controlling the flow on entrance ramps, the synchronization of traffic lights, and the creation of high occupancy lanes can ameliorate congestion marginally. These are examples of factors in the supply side, well out of traveler control. Other measures address the demand side, impacting how travelers choose to travel: through controls on parking, employer opening and closing hours policies, land-use and development controls, and road pricing, for example (see Bull, 2004; Association for Commuter Transportation, 2004).

The Association for Commuter Transportation (2004) identifies five so-called traveler choices: 1) mode, 2) departure time, 3) route, 4) trip reduction, and 5) choices of residential and occupational locations. Of these, only departure times (and possibly route) are primarily within the purview of the individual traveler at the time of undertaking a necessary trip. I pursue departure and arrival times of commutes between home and work in this paper, not as an explanation for all aspects of varying congestion, but for insights on the extent that rationality might be applied to a common situation in daily life – and under what external conditions.

The conventional study of commuting and associated travel has focused on the infrastructure of particular cities and its use. One form of measurement is the count of vehicles passing through particular points on particular roads. These counts are typically presented by one hour periods, though the period may be as short as the quarter hour. Nonetheless, such measures

fail to account for variations of use within the period chosen, nor do they present information on the nature or duration of the trip. A different measure comes from origin-destination studies in which motorists are stopped at particular locations on roads and asked their origin, destination, and purpose of trip. A third form of measurement comes from the gathering of trip diaries, on which people create a log of the trips they make during a given time period such as a day or a week. These various measures are useful in furthering understanding of how people use existing travel facilities in a chosen city or region, with the objective of making improvements.

This last approach has evolved into a perspective called *activity-based analysis*. In this connection, researchers have advocated time-use analysis as a way to improve the specificity and range of trip information, as well as to learn more about travel as a form of behavior and its relationship to other types of behavior. Travel is itself an activity, but it has additional value as a dynamic linkage between other daily activities. F. Stuart Chapin, Jr. was an early proponent of this approach (Chapin, 1965, 1974). Assuming that there is a rational basis for the choice of activities and the process by which they are carried out, some researchers have turned increasingly to simulation and model construction as an alternative to large-scale data collection through surveys (c.f. Stopher et al., 1981; Stopher and Lee-Gosselin, 1997; Timmermans, 2005), largely based on microeconomic theory (Gärling, 1998). Nonetheless, time-use data have an advantage over simulation and model building by providing a systematic record of actual behavior performed in real time among potentially large and representative samples beyond the idiosyncratic constraints of a single subgroup or city.

Andrew Harvey joined Chapin and Javeau in the early 1970's as a major proponent of time-use data to shed light on consumer demand perspectives on everyday travel. He noted (Elliott et al., 1973) not only the richness of time-use data in this regard but also the fact that the time-use method elicits more precision than the more traditional travel research methods, as respondents report their activities with precise timing and more inclusion of trips of marginal durations (Pas and Harvey, 1997; Harvey and Pentland, 1999). When trips are recorded in the context of all daily activities, their starting times, completion times, and duration are more likely to be accurate than when trips are described as isolated events, outside the constraints of other activities. Furthermore, Harvey has elaborated on the value of carrying out analyses of time-use at the level of the *episode* throughout his career. He helped set a precedent for the focus in this paper on the precise timing of particular episodes of commuting occurring between home and job – benefiting from a national time-use survey he helped develop. This features avoiding some of the limitations of focusing on the circumstances of a single city and its transportation infrastructure, as well as potentially providing sensitive behavioral data with which to tease out the dynamics of this commuting situation.

2 Methodology

Statistics Canada's General Social Survey no. 19 (2005), on time-use, was the source of data for this analysis. The main sample file of personal and summary data per respondent has 19,597 cases. The file with all episodes of activity from these 19,597 persons consists of 333,654 cases of activity, or a mean of 17.03 episodes per diary day. Selected data from the main (summary) file were merged into the episode file, so that some data about the respondent and the respondent's time-use day were available as selection criteria and controls in analyses that centered on episodes of travel activity. Selected travel episodes were the units of analysis.

The central focus is on trips between home and work during stated hours on a weekday, among respondents who reported at least 360 minutes in main paid employment and were thus considered as working full-time. Respondents working entirely at home were excluded as lacking travel between home and work. Analyses of the morning commute included trips commencing from 5:00 a.m. to 9:59 a.m. The corresponding five hour period in the afternoon/evening was from 3 p.m. to 7:59 p.m.

These subsamples of commuting trips between home and job consisted of 4,942 in the morning and 4,179 in the afternoon. The difference in number of trips by time of day arises almost entirely from 741 respondents who made stops for everyday commercial purposes in the afternoon, compared to nearly none on the way to work in the morning. The main analyses compare only those traveling between home and work (and the reverse) without an additional destination, so as to more accurately compare the conditions of travel without the additional time and/or distance demanded by one or more stops.

The simple analytic design is to examine the exact timing and duration of morning and afternoon direct commutes with respect to what they might indicate about quantitative and qualitative differences representing the two periods of travel. The basic hypothesis pursued was that the mean duration of episodes of commuting from home directly to the job in the morning would be less than that of the return trip in the afternoon or early evening. Additional analyses were intended to clarify or explain the basic findings.

This assessment looks at degrees of similarity and difference, conventional explanatory factors, and what the findings suggest about travel rationality, as well as the circumstances under which rationality might come into play.

3 Results

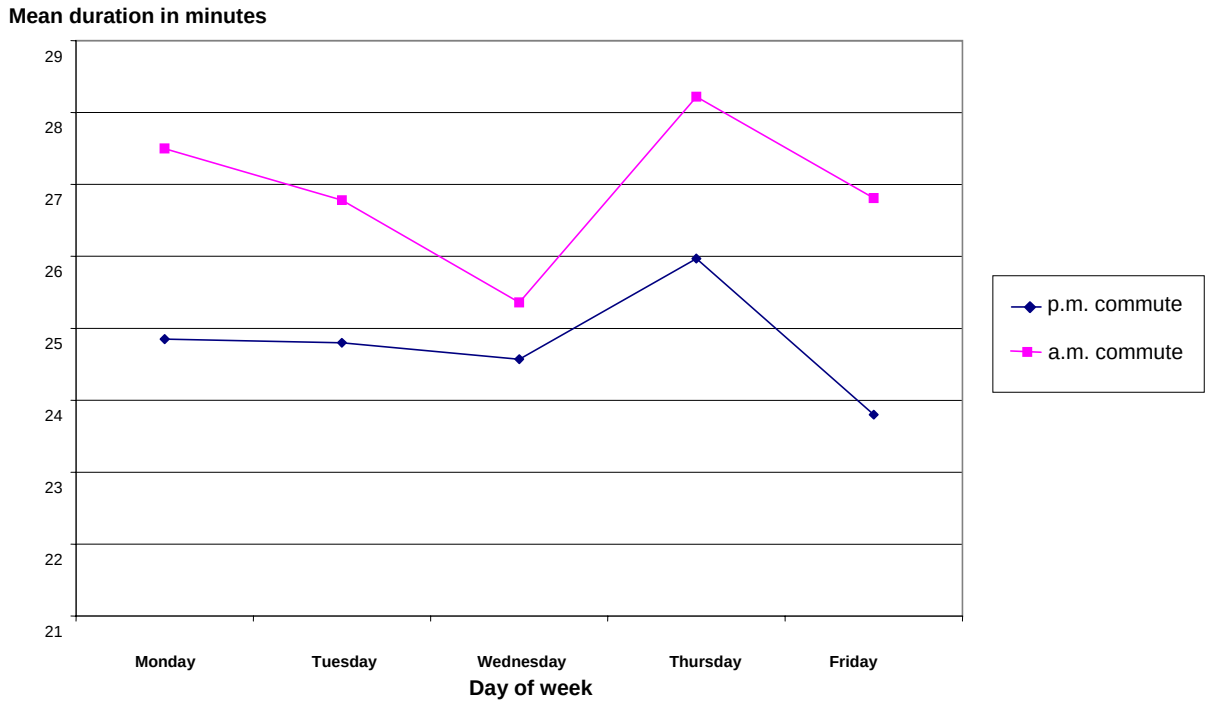
3.1 Mean duration of travel between home and work

The basic hypothesis was confirmed. The mean duration of travel by full-time workers on weekdays from home to work during the five-hour morning travel period was 24.79 minutes,

with a standard deviation of 19.459 minutes. The reverse trip in the afternoon or early evening among the 84.6% who did not stop along the way on one or another kind of errand, took 26.87 minutes, with a larger standard deviation of 24.824 minutes. Such differences in mean trip duration are highly unlikely to have occurred by chance (t = -4.489, d.f. = 9119, sig = .000).

While commuting durations vary day by day during the workweek, the mean afternoon trip home from work takes longer than the morning trip to work regardless of the day. Figure 1 shows this consistent pattern.

Figure 1
Mean duration of travel between home and job by time of day and day of week, among full time workers (Canada, 2005)



Source: Calculated from Statistics Canada, General Social Survey 19, 2005.

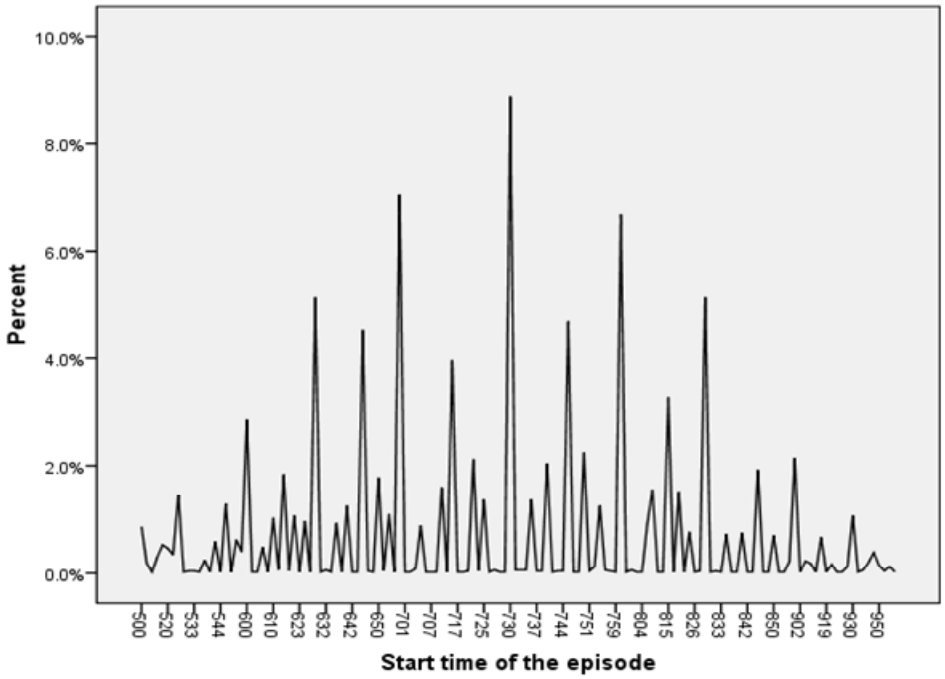
3.2 Times commutes between home and job are commenced

The mean duration of a commute is not the only indicator pertinent to understanding the ease or difficulty of the trip. Another can be viewed in terms of when people get their commuting trips under way. Within the same five hour periods, how dispersed are these trips? Do most people travel at the same time? Or not?

Figure 2 graphs the times that full-time workers said they left their homes for work on weekdays. The vertical axis represents the percentage of all 4,942 trips commenced at a given minute within the five hour morning commute. While the starting times of such trips are refined by the fact that each activity reported has to fit within a larger pattern of activities – and is to some extent validated by the place of other activities in a greater flow of behavior – it is none-

theless common that major activities are often reported to have begun at major points within the hourly cycle: on the hour, half hour, or quarter hour. Hence, on Figure 2, departure times of home to job trips spike on the half hours, with sub spikes at quarter hours. Over all, this is a normal distribution, with 7:30 a.m. as a center point. Nonetheless, no spike accounts for as much as 10% of the trips taken within the five hour period. Furthermore, many such trips start at other than the quarter hour spikes and sub spikes. Thus while there are some clear spikes, the general picture includes a considerable dispersion of trips within the morning rush hours.

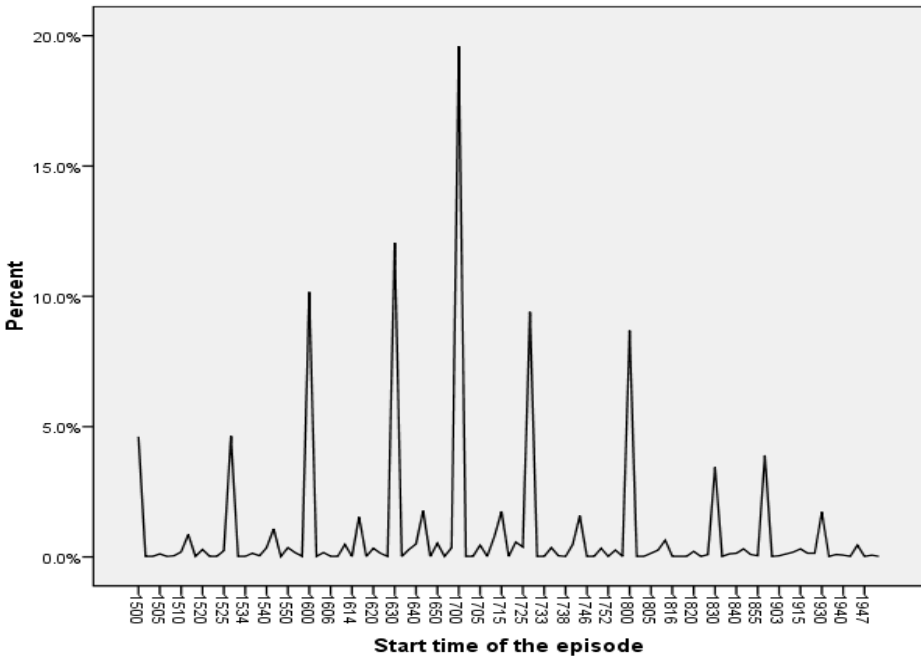
Figure 2
Time at which trip from home to job commenced among full-time workers on weekdays, in % (Canada, 2005) (n = 4942)



Source: Calculated from Statistics Canada, General Social Survey 19, 2005.

Figure 2 becomes more meaningful when compared to Figure 3, a similar graph of starting times for trips from work directly to home in the afternoon/evening five hour travel period. While generally normal in shape, this graph is somewhat skewed to the left side of the 5 p.m. (17:00) mode. Perhaps more important, the half-hourly spikes account for much more of the distribution. The 5 p.m. mode accounts for 20% of the p.m. trips home from work, and three other spikes exceed 10%, a concentration not attained at all in the morning commutes. A relatively few trips begin at any time other than the half hourly spikes.

Figure 3
Time at which trip from job to home commenced among full-time workers on weekdays, in % (Canada, 2005) (n = 4179)



Source: Calculated from Statistics Canada, General Social Survey 19, 2005.

The contrast between Figures 2 and 3 is considerable. Figure 2, the trip *to* work, shows considerably more variation in the choice of when respondents start their commutes, compared to a near fixation on the half-hourly starting times on the trip *from* work. Only about 48% of commuters start their trips to work in the morning on the hour or half hour; the majority picks a time in between, and this is not necessarily on the quarter hours in between. During the afternoon and evening period, nearly 80% leave work on the hour or half hour. These two figures display very different commuting *pulses.*

These contrasting pulses explain why the mean trip takes longer during the p.m. commuting period, not to speak of an even greater difference in the standard deviations of these trips. At the prevailing departure times, nearly twice the number of commuters is traveling in the p.m. than was the case in the a.m. While this suggests that travel might be lighter during the afternoon rush hours towards the end of the half-hourly segments, this is not the reality of vehicular travel on roads. Congestion in one place at one time creates ripple effects for travelers in its temporal and spatial wake. Lingering slowdowns are only reinforced as the next peak of travelers occurs. And places of employment, from which the p.m. trips originate, are likely to be in areas that are more intensively developed than are residential areas, leading to greater travel congestion.

In short, Figures 2-3 suggest that much greater discretion is exercised with respect to a.m. departure times for work than with respect to the commute back home. That time is thereby saved during this exercise of discretion is an indication that the choice of this departure time is made on a rational basis, likely reflecting ongoing experience with this phenomenon. In contrast, people by and large leave their job at the end of the day in lock step, reflecting typi-

cal closing hours. By leaving when they are first able to – or are required to – people are exercising less personal choice regarding the conditions of travel. And they are taking the consequences in terms of temporal delay.

This interpretation is strengthened by similar graphs on the arrival times of these commutes.

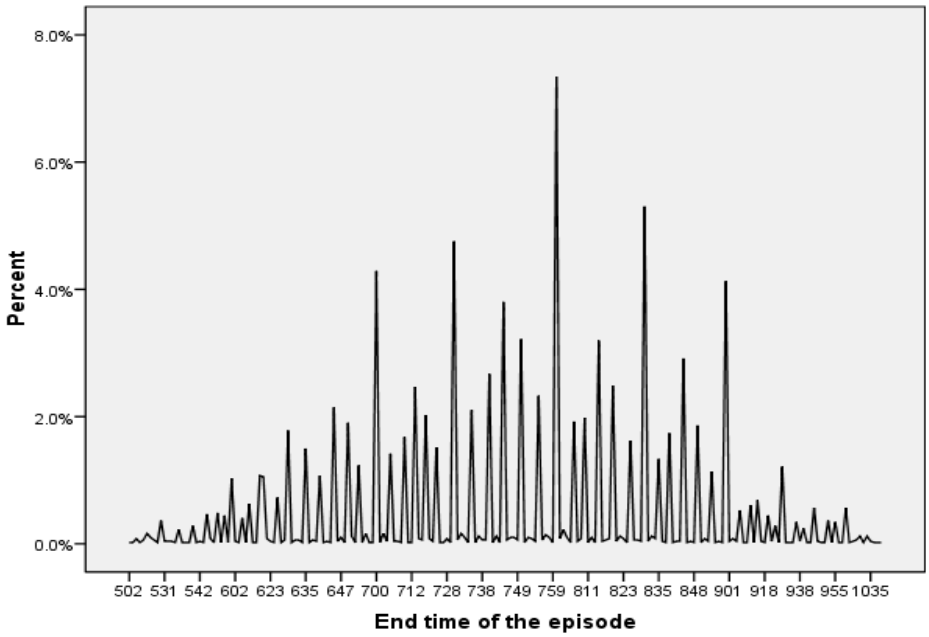
3.3 Times commutes between home and job are concluded

As can be noted on Figure 4, arrivals to workplaces in the morning are even more diffused in time than departures from home. The spikes are on some of the hours and half hours, but each of these spikes accounts for a smaller percentage of arrival times than the equivalent spikes did for departures. The more prominent spikes account for a total of only about 30% of arrivals. Just a very small percentage of these arrival trips occurred after 9 a.m.

In contrast to the relative lock step departure from work in the afternoon, the arrival time in the morning is more flexible, provided that it precedes whatever starting time the employer might set. Leaving for work at a time that experience has shown to minimize the risks accompanying congestion and planning to arrive with a cushion of time in advance of opening hours combine to represent a rational strategy of time planning. Previous studies have suggested that workers typically plan to arrive about fifteen minutes early (Liepmann, 1944; Mahmassani et al., 1997). The data represented in Figure 4 do not challenge this suggestion, as spikes on the half hour are accompanied by plentiful dispersion of arrivals in the preceding minutes. The interpretation of these data also requires acknowledgement that not all jobs have fixed hours or the punching of time clocks.

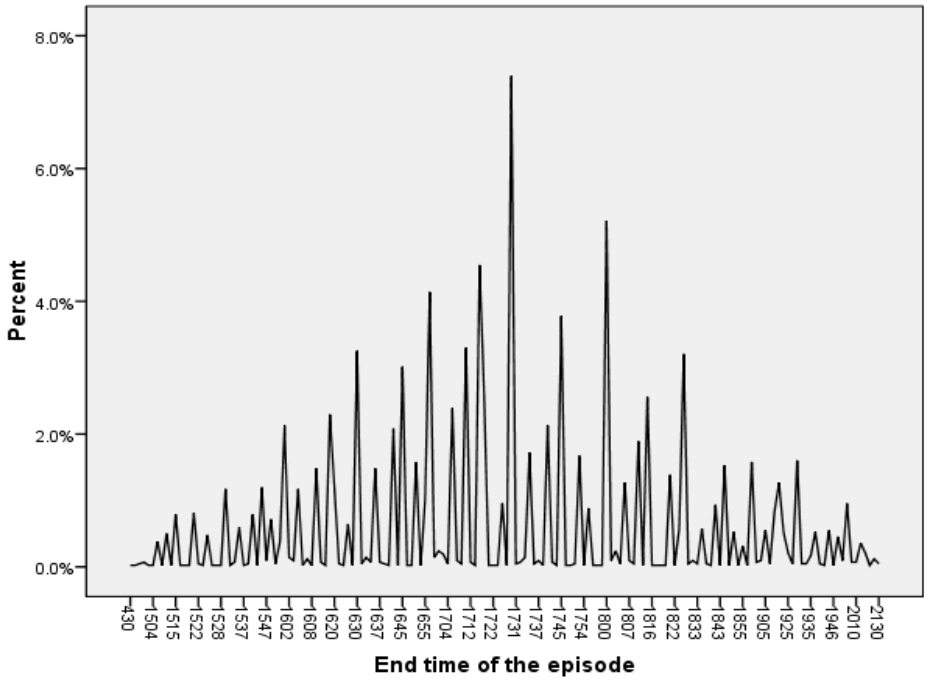
In the afternoons and evenings, once people have departed from work immediately after fixed closing hours and braved the transportation congestion accompanying mass exodus at a particular time and place, their residential destinations are at varying locations and hence distances. Thus, it is not surprising that the p.m. arrival time at home varies greatly. Figure 5 shows this distribution of arrival times. There is a mode at 5:30 p.m. (17.30), but this accounts for only 7% of all trips directly from workplace to home.

Figure 4
Time trip from home to job ended among full-time workers on weekdays, in % (Canada, 2005) (n = 4942)



Source: Calculated from Statistics Canada, General Social Survey 19, 2005.

Figure 5
Time trip from job to home ended among full-time workers on weekdays, in % (Canada, 2005) (n = 4179)



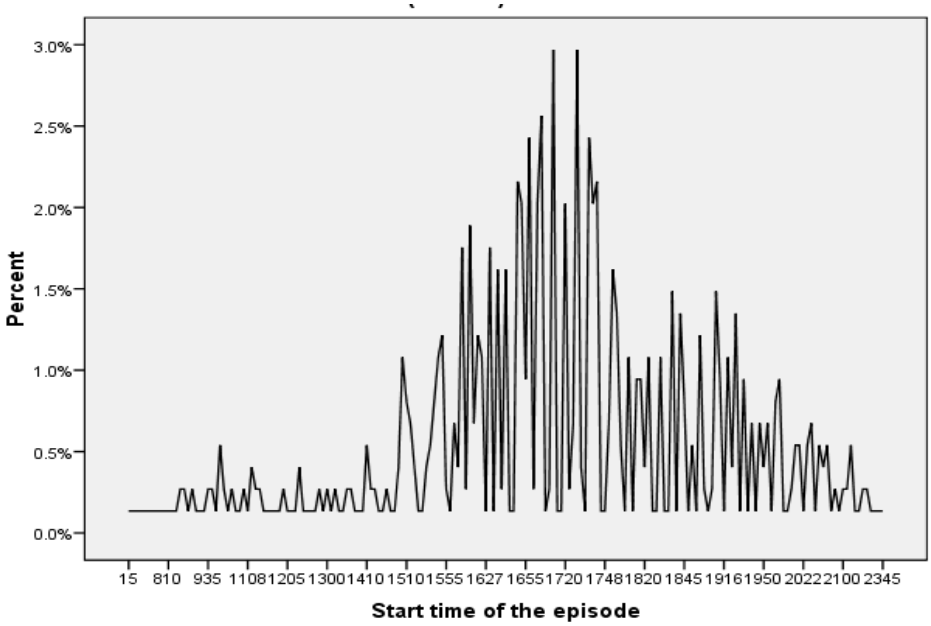
Source: Calculated from Statistics Canada, General Social Survey 19, 2005.

The afternoon/evening commutes are further compounded and lengthened by the additional 15% of afternoon trips that full-time workers take that include everyday commercial stops. Figure 6 shows when in the day this sample of persons employed full-time on weekdays starts

episodes of shopping for food, other everyday purchases, and finance (e.g. banking). The horizontal axis covers all hours of the day, not just the two five hour rush periods. The graph is not linear, because it plots only times when people actually started episodes of shopping. What is unambiguous, though, is that virtually all such stops by full-time workers occur in the afternoon and evening, primarily between 4 and 5:30 p.m., and this distribution is skewed to later yet in the day rather than earlier.

Thus, p.m. commuting times bring in considerations of workplace practices and customs, as well as the need to run household errands en route, not just the rational use of time to get to work comfortably on time. Largely rational use of time, as demonstrated in the morning commute, is modified by other types of considerations in the afternoon. It is likely that inserting errands into the trip back from work is more efficient than turning the errands into a separate sequence of events. It is not only a rational strategy, but also one likely to be carried out rationally. But running these errands in the afternoon involves a greater range of needs and wants than simply minimizing the work to home commute.

Figure 6
Start times of episodes of shopping for food, everyday purchases, and finance on weekdays by workers with full-time jobs (Canada, 2005) (n = 844)



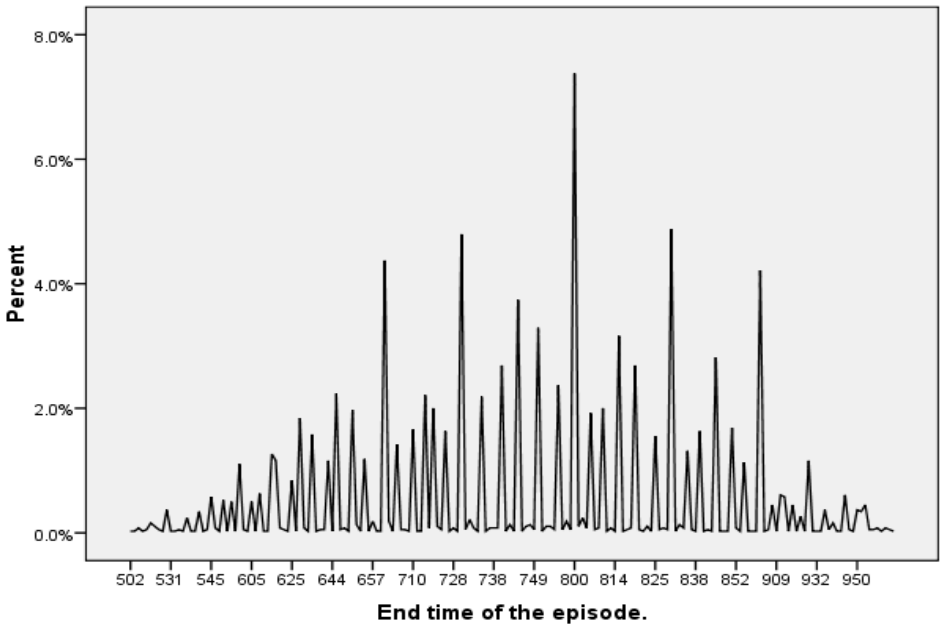
Source: Calculated from Statistics Canada, General Social Survey 19, 2005.

3.4 Mode of transportation

To what extent does this portrayal of how the time of day impacts on commuters obscure differences among those whose commutes are by differing modes of transportation? The great majority of the morning trips to work in Canada are by persons driving their own cars (77%). What are the relative impacts on these patterns of departure and arrival time of mode of travel, on the one hand, and time of day, on the other?

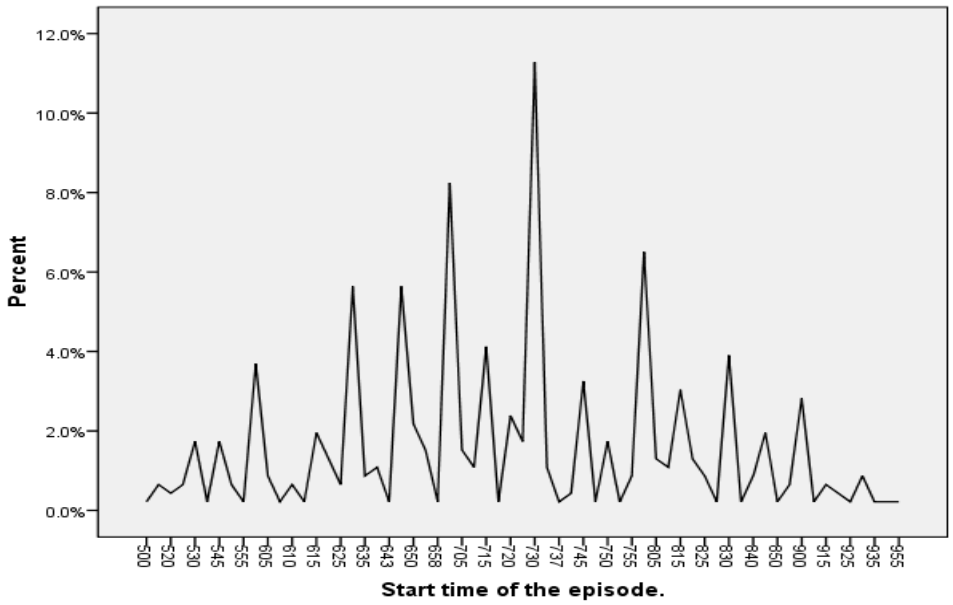
Figures 7-10 break down Figures 2-3 by selected, clearly-differing modes of transportation utilized: drivers and transit riders. One difference in the graphs reflects the prevalence of drivers. In contrast to the 77% of all morning trips being taken by drivers, those traveling by mass transit represent only 9% of the trips in question. (Respondents traveling by other means, such as cycling or combinations of modes are not considered in this section.) Graphs 7 and 9 reflect many more respondents than do Graphs 8 and 10, thereby giving the impression of a more complex pattern. Yet, when these graphs are viewed with respect to the extent of difference by mode versus time of day, it is the latter that shows greater variance. For example, apart from the degree of detail, Figures 7 and 8, on trips by drivers and transit riders in the morning, are relatively similar. Figures 7 and 9, on trips by drivers in the a.m. and the p.m., are remarkably different. While driving one's own car can allow more flexibility than a bus, subway, or train, this does not show up in departure timing from work in the afternoon. The comparison of Figures 9 and 10, departure times of the two modes of transportation in the p.m., show considerable similarity in their depiction of lock step departures from work. In both comparisons, those taking transit do show less dispersion in their pulse patterns.

Figure 7
Time at which trip from home to job commenced among full-time workers driving an automobile on weekdays, in % (Canada, 2005) (n = 3795)



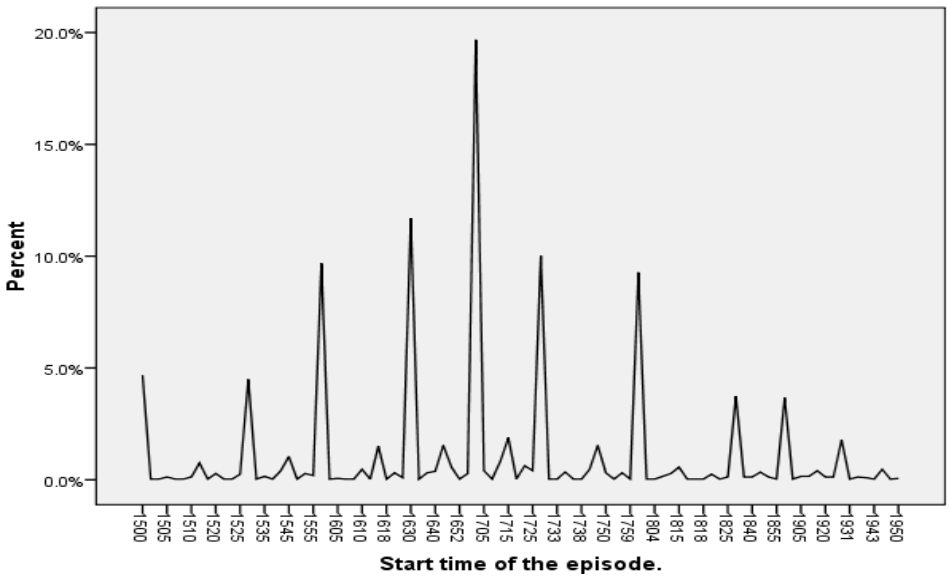
Source: Calculated from Statistics Canada, General Social Survey 19, 2005.

Figure 8
Time at which trip from home to job commenced among full-time workers taking public transit on weekdays, in % (Canada, 2005) (n = 461)



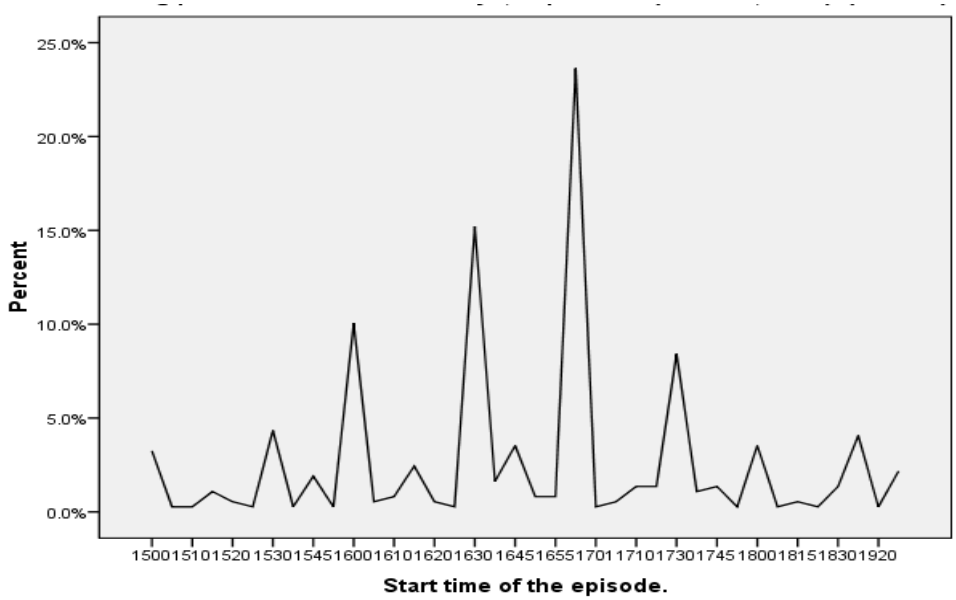
Source: Calculated from Statistics Canada, General Social Survey 19, 2005.

Figure 9
Time at which trip from job to home commenced among full-time workers driving an automobile on weekdays, in % (Canada, 2005) (n = 3181)



Source: Calculated from Statistics Canada, General Social Survey 19, 2005.

Figure 10
Time at which trip from job to home commenced among full-time workers taking public transit on weekdays, in % (Canada, 2005) (n = 368)



Source: Calculated from Statistics Canada, General Social Survey 19, 2005.

than do the drivers, beyond what reflects sample size limitations. Nonetheless, the dramatic pulse differences for both drivers and transit users are between a.m. and p.m. Despite the impact of different numbers of drivers and transit users on graph appearances, the transit riders clearly vary by time of day in the nature of their travel pulse in the same way as do drivers.

Where drivers and transit users differ significantly is in the *duration* of commutes between home and job. Figure 11 shows that the transit riders take approximately twice as long in their commutes than do the drivers, Depending on the time of day, drivers have a mean of between 22 and 24 minutes for their trips, while the transit riders take between 43 and 46 minutes.

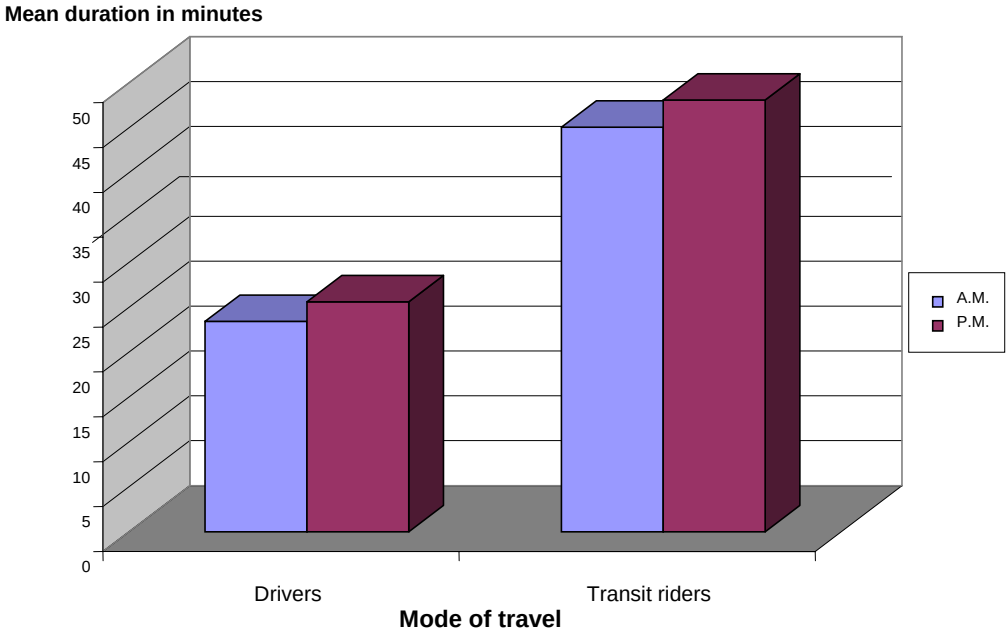
Nonetheless, as can also be noted in Figure 11, the p.m. commute is equally longer than that in the morning among both drivers and transit riders. Many transit riders share the road with cars when traveling by bus, with the result that road congestion impacts both drivers and transit riders. The similarities in travel pulse shared by drivers and many transit riders are borne out by their common differences in mean commuting times between morning and afternoon/evening.

3.5 Gender

Gender has been shown a factor in understanding commuting, as it is with many topics having to do with everyday life. Women have been shown to choose workplace locations closer to home than do men. They are less likely to have access to family cars, not to speak of the likelihood of holding a driver's license. Consequently, they are more likely to take public transportation. Trips between home and work are more stressful for women due to responsibilities

they face at both ends of the commuting trip. (c.f. Palm and Pred, 1974; Michelson, 1985a, b, 1994).

Figure 11
Mean Duration of Commutes between Home and Job by Time of Day and Mode of Travel, among Full-time Workers (Canada, 2005)



Source: Calculated from Statistics Canada, General Social Survey 19, 2005.

However, in the present analysis, gender does not appear to intervene in the results presented. While men's mean trip durations are marginally greater than women's, the differences, both in the morning and afternoon/evening, are a statistically insignificant minute's difference. While women are marginally more likely to take public transit than men and less likely to be drivers, the clear majority of trips to and from work by both men and women are as drivers: 80% of men and 71% of women. And the pulse patterns for men's and women's trips at the beginning and end of the work day are identical. Although an understanding of how men and women experience the sequence of events in their everyday lives is frequently germane, gender does not appear to play a role in understanding why p.m. commuting is more strenuous than a.m. commuting. Women with full-time jobs are equal contributors to this time of day difference.

4 Concluding remarks

This analysis confirms once again that the afternoon/evening rush hour is more time-consuming than the morning rush hour. But with the graphic device of the *travel pulse*, it teases out more understanding of the dynamics underlying this difference. The Canadian commute to work in the morning is more likely than the trip back home later on to have a

foundation in rational choice – to be able to make the trip to work within an acceptable time frame and to be there with time to spare before any established starting time. The return trip later in the day appears from the travel pulse to represent immediate departure from the workplace at the first legitimated opportunity, loading roads and transit modes in the vicinity of the workplace with nearly double the load at any given time as was the case in the morning. Neither departures from home nor arrivals at workplaces in the morning showed the concentration of trips within a short period of time as was indicated in the p.m. travel pulse on departures from work. The suboptimization process is more complicated when more considerations within the daily routine come to bear in the afternoon and evening.

Workplace-related travel congestion is hardly new. Transportation planners and large employers have been proactive in implementing such policies as staggered hours (between places of employment), flexible hours where feasible for work situations and employees, and home-based work (in those situations in which the employees does not need to be physically present at a workplace – more suited to some forms of white collar work than to, for example, manufacturing). Nonetheless, these measures do not deal with the micro context, for example, the fact that most of the workers get on their way home at the first opportunity and overburden the transportation infrastructure close to the trip origin. In some situations in which the nature of work is highly individuated, the end of the workday is a non-event. Apparently, in many situations, it is an event, either as a function of employer rules or a situation in which, by afternoon, the worker is motivated to depart as soon as possible, if only to get on to other activities and responsibilities that must be fit into the day (cf. Michelson, 2005).

Travel pulse data constitute a challenge toward further re-examination of practices to facilitate everyday life. There is a need to smooth over situations fostering unproductive use of time that leaves less time available for other, more engaging activities and/or demanding responsibilities.

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Sharing of tasks and lifestyle among aged couples

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Abstract

Family is often thought of as an efficient work unit where tasks are apportioned and shared among the workers. This paper studies the sharing of domestic work in aged families. Do spouses divide tasks between them more evenly than in the middle years now that they have more time? The findings of the Finnish Time Use Survey in 1999/2000 did not support such presumptions about task sharing. The wife of a man who spends a lot of time on domestic work also does a lot of it, both in the middle years and in retirement. Same types of chores, such as shopping, cooking, cleaning, home maintenance or helping another household, are done on the same days. Even in retirement, the wife does the lion's share of domestic work, although certain evening out does happen. The lifestyle of these families is more consistent in free-time activities than in domestic work. The spouses have adopted similar hobbies both at home and outside it. Instead of pursuing their personal choice, they engage in the same hobbies as their spouse. This change begins before the retirement age, for the similarity in time use begins to show clearly already among middle-aged couples.

JEL-Codes: D13, J26

Keywords: Sharing domestic work, leisure activities, aged

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.

Personal remarks to Andy Harvey

The first time Andy appeared in my life was up on Vitosha Mountain near Sofia where the International Research Group on Time Budgets and Social Activities - previous name of IATUR - arranged the seventh reunion in 1980. I had just arrived to my hotel room and waited for the welcome dinner when a power cut occurred. It continued and I did not have a flashlight with me. I just had to sit in the dark and wait… After a while somebody knocked on the door. It was Andy who accompanied the missing participants to the candlelit restaurant. More experienced travellers had flashlights with them, as well as I after that shocking experience.

The kind and informal atmosphere among time use researchers has its origin in Andy's sociability. When the group was smaller Andy invited the participants for welcome drinks in his suite, told spontaneously where to meet for dinner etc. We can still experience this in IATUR conferences even though the group has grown from 25 in Vitosha to more than 100.

Another expression of Andy's humanity was his reaction when I told about a vague plan for a study trip to U.S. Andy asked why not Halifax. He had just set up a Time Use Research Center at Saint Mary's University. He immediately promised to arrange a workspace and a computer as well as help finding an accommodation. During those three months we worked together on a standard activity classification we presented at the following IATUR conference in Amsterdam. Andy and Dawnie also led me to the very heart of the academic life of Halifax.

A more concrete outcome of this visit was that my son Jyri started next year at the famous art college NSCAD in Halifax and graduated four years later with a degree that brought him a successful job in Helsinki. During Jyri's stay in Halifax Andy and Dawnie offered him a homelike contact, even by representing the family at Jyri's thesis presentation.

Andy arranged the 2005 IATUR conference in Halifax where this article was presented.

1 The research problem

Retirement changes time use. A considerable amount of extra time that can be spent on domestic work, free time activities, sleeping, resting and meals becomes released from gainful work. The family can also decide more freely how they want to use their time.

In terms of time use, pensioner families form a markedly more homogeneous group than the working age population where working life and looking after children influence the lives of families in various ways.

How do spouses use their time when it is no longer dominated by working life? Do they pursue their personal likings or influence each other's time use and participate in similar activities? In other words, does the daily life of spouses grow increasingly dissimilar or alike in retirement?

According to the Time Use Survey, Finnish men aged 65 or over do clearly more domestic work today than they used to. From the 1987-1988 survey to the 1999-2000 survey the amount of time they spend on it increased by as much as 40 minutes (23%) per day, whereas with women it remained unchanged (Niemi and Pääkkönen, 2002, 27-28). When examining the whole population inclusive of people living alone, we can see that the time women and men spend on domestic work evens out along with age so that men aged 75 and over use roughly the same amount of time, three hours and 18 minutes, per day as women of the same age do, which is three hours and 24 minutes (Pääkkönen and Niemi, 2002, 68). This raises the question of whether this is related to having been left alone in life or whether it also applies to couples.

This paper examines the sharing of domestic work in aged households. Domestic work includes general housekeeping and maintenance, shopping and services and care work. How does the total time spent on domestic work vary between households? How do spouses share it? Is it divided equally between the genders now that both have copious time available? Does women's burden of domestic work get lighter in retirement when men could spend more time on domestic work, or does the main responsibility for performing domestic work continue to rest with the wife?

How are the tasks of domestic work divided? Do spouses share the work between them by doing different or same domestic tasks during the same day?

Besides domestic work, this paper also studies how aged couples spend their free time. Do the spouses pursue different interests according to their own, personal likings, or spend their free time engaged similar activities?

2 The research data

Aged couples are here defined by the age of the man to include the families where he has reached the official age of old-age retirement of 65. The data obtained from spouses for the same day the Finnish Time Use Survey contained data on 470 shared days. Because the determinant was the age of the man, the data also relate to women aged under 65, from whom data were obtained on 126 days, which accounted for 27% of the diaries kept by women. Most, or 65%, of these women were over 60. Equal proportions, or 9%, of the women and men were employed.

3 Time spent on domestic work and its division between the spouses

At first we will see (Table 1) how much time altogether is spent on domestic work in the families and then go on to examine how the families share different domestic tasks. Conventionally, wives have done most of the domestic work, one reason being that the husband has put in longer hours into gainful work while the wife has taken care of most of the unpaid domestic work. How is the total work load divided between the genders when the man reaches retirement age?

3.1 Comparing time spent on domestic work by aged and middle-aged couples

We will start by examining how the sharing of domestic work differs between aged couples and couples that are slightly younger and often still participating in working life. For the sake of comparability, we have only included families where the husband is aged 45-64 and there are no children aged under 18. In this article we refer to them as *middle-aged couples or families*.

Table 1
Time spent on domestic work and its division between spouses in aged and middle-aged couples

	Men	Women	Total	Diary days
	(hrs.mins./day)			
Middle-aged couples	2.49	4.10	6.59	899
Aged couples	3.29	4.49	8.18	470
%				
Middle-aged couples	40	60	100	899
Aged couples	42	58	100	470

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

On average, both men and women spend 40 minutes more per day on domestic work in aged couples than in middle-aged couples without children. The division of domestic work between the spouses changes slightly at the retirement age and men's proportion of domestic work goes up from 40 to 42%.

3.2 Ageing and time spent on domestic work

We will next examine how the total time spent on domestic work changes as pensioners grow older. We are comparing here couples representing a younger (man aged 65-74) and an older (man aged over 75) group of pensioners. We have already stated above that women and men aged over 75 use almost equal amounts of time for domestic work if the examination is extended to the entire age group inclusive of people who live alone. Does this also apply to couples, in other words is work divided more equally in older families?

We can see from Table 2 that both men and women spend less time on domestic work as they get older, but that there is no appreciable change in the way it is divided between the spouses. In the age group of the under 75s, men's proportion of the total time the couple spends on domestic work is 42% and in the older age group 43%.

Table 2
Time spent on domestic work and its division between aged spouses by age of man

	Men	Women	Total	Diary days
	(hrs.mins./day)			
65-74	3.35	5.00	8.35	338
Over 75	3.14	4.19	7.33	132
%				
65-74	42	58	100	338
Over 75	43	57	100	132

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

We cannot refer to any clear proportional evening out in the amounts of work, for women still do the lion's share of domestic work even in families where the man is over 75.

Thus, the evening out of the shares of time spent on domestic work that became evident when the total population over the age of 75 was examined does not apply to couples. The wives of the men who are aged over 75 use clearly more time for domestic work than single women aged over 75 do (3 hours and 10 minutes). By comparison, men aged over 75 use the same amount of time for domestic work irrespective of their family status, and the amount is almost the same as it is for single women of the same age. Because single women form the majority in the group of people aged over 75, the amounts of time spent by men and women on domestic work seem to be approaching each other in the oldest age group.

From here on I will be examining aged couples as a single group, because age does not appear to have any appreciable bearing on the division of domestic work among aged couples.

3.3 Day of the week and time spent on domestic work

It would be justified to assume that the time use of retired people does not vary much according to the day of the week. Does this also concern weekends, or do they differ from weekdays in respect of the amount of time spent on domestic work? The observation that has been made when examining the whole population is that less domestic work is done during weekdays than during the weekend, when more of it is done on the Saturday than on the Sunday (Niemi and Pääkkönen, 2002, 15). Is this also true with aged couples or do the days of the week grow increasingly alike when people retire?

Aged couples follow a different weekly rhythm on domestic work than people of working age. They do the largest amounts of work on weekdays, slightly less on Saturdays and least of all on Sundays (Table 3). This concerns both men and women. Their weekdays seem to retain the nature of a working day even though they no longer do gainful work. The surplus of time it has left is filled with unpaid domestic work. The nature of Sunday as a day of rest becomes emphasised among pensioners so that they do clearly less domestic work then than, for example, on Saturdays.

Table 3
Time spent by aged couples on domestic work by day of the week

	Men	Women	Total	Diary days
		(hrs.mins./day)		
Weekdays	3.51	5.08	8.59	235
Saturdays	3.16	4.50	8.06	115
Sundays	1.52	3.10	5.02	120
%				
Weekdays	43	57	100	235
Saturdays	40	60	100	115
Sundays	37	63	100	120

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

The division of work between the genders varies somewhat by the day of the week. Work is most evenly distributed during weekdays, while the traditional division of work steps in on Sundays, which are more clearly days of rest for men than for their wives.

3.4 Distribution of time spent on domestic work between spouses

We have examined above the total time spent on domestic work as an average concerning all couples. We will now go on to see how the amounts of domestic work the spouses do affect each other. Do the spouses divide domestic work between them daily so that when one does less of it, domestic work increases for the other, or does domestic work increase for both spouses on the same days? In other words, do the amounts substitute or complement each other (Ruuskanen, 2004)?

The initial hypothesis is that the spouse doing more domestic work, i.e. the wife, adapts to the work input of the spouse doing less of it, i.e. the man. Because the distribution of more detailed domestic activities is very skew, quartiles suit well this kind of an analysis. We have divided retired men into four groups of roughly equal size, or quartiles, according to the amount of time they spend on domestic work. Then we examine differences in the amounts of time the wives in each quartile spend on domestic work on the same day. The point of view is to analyse the women's behaviour from the perspective of the husbands' time use.

Table 4 reveals that on the diary day the time the wife uses for domestic work does not substitute the man's time so that the wife of a man who does a smaller than average amount of domestic work would do a larger than average amount of it. Quite the opposite, on the days when the man has done a larger than average amount of domestic work, the wife, too, has spent more time on it. The correlation in domestic work between spouses is .31***[1].

Table 4
Time spent by wife relative to time spent by man on domestic work in *aged families*, all days of the week and weekdays (hrs.mins./day)

Quartiles of men by amount of time spent on domestic work and quartile parameters (hrs.mins.)	Men's average	Women's average	Diary days
All days of the week			
I quartile (0 – 1.10)	0.25	4.02	152
II quartile (1.20 – 3.20)	2.20	4.19	129
III quartile (3.30 – 5.20)	4.25	5.09	103
IV quartile (5.30 +)	7.10	5.52	86
All	3.29	4.49	470
Weekdays			
I quartile (0 – 1.40)	0.38	4.17	65
II quartile (1.50 – 3.40)	2.48	5.02	57
III quartile (3.50 – 5.50)	4.49	5.07	62
IV quartile (6.00 +)	7.27	6.11	51
All	3.51	5.08	235

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

Thus, the amounts of time spouses spend on domestic work do not substitute each other, but are complementary. One could assume this to come from differences between the days of the week, as more domestic work is done on weekdays than at the weekend. However, this does not explain the correlation, because the same effect can also be seen when only weekdays are examined.

The finding is somewhat surprising and it would be fair to presume that it only concerns aged families. People of working age may share domestic work more clearly because they have

[1] * p<0.05 almost significant, ** p<0.01, significant *** p<0.001 very significant.

less time for it. As regards middle-aged couples, it is especially important to also study weekdays separately.

Middle-aged couples differ from aged ones in that the spouses of the men doing the least amount of domestic work do slightly more of it than the spouses of the men in the second quartile (Table 5). Otherwise, the same phenomenon can be observed as with aged families: the wives of the men who do a lot of domestic work also do more of it than the wives of the men who do little domestic work. This concerns all days of the week and weekdays alike. The correlation in domestic work between middle-aged spouses is .35***.

Table 5
Time spent by wife relative to time spent by man on domestic work in middle-aged families, all days of the week and weekdays (hrs.mins./day)

Quartiles of men by amount of time spent on domestic work and quartile parameters (hrs.mins.)	Men's average	Women's average	Diary days
All days of the week			
I quartile (0 – 0.40)	0.15	3.37	225
II quartile (0.50 – 2.00)	1.20	3.20	205
III quartile (2.10 – 4.20)	3.10	4.15	243
IV quartile (4.30 +)	6.45	5.34	226
All	2.49	4.10	899
Weekdays			
I quartile (0 – 0.40)	0.15	3.39	117
II quartile (0.50 – 1.50)	1.17	3.24	111
III quartile (2.00 – 4.10)	3.03	4.07	110
IV quartile (4.20 +)	6.35	5.25	111
All	2.43	4.07	449

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

Thus, the amounts of time aged spouses spend on domestic work seem to complement, rather than substitute, each other. This means that there is no such division of work where the wife would clearly compensate for the man's lesser work input or reduce her own input whenever the man does a lot of domestic work. Instead, both spouses do either a lot or a little domestic work on the same days.

4 Participation of spouses in different domestic tasks

As we have learned above, the total amounts of time spouses spend on domestic work are complementary rather than substitutes. We can, nevertheless, assume that the spouses divide the work between them so that they do different kinds of domestic tasks during the same day.

We will next examine how the spouses share the time spent on the most common tasks, such as cooking, washing dishes, doing laundry, doing repairs and maintenance and shopping. Helping other households is included of the less usual domestic work categories.

4.1 Cooking

Cooking is the most time-consuming of the daily domestic work categories. Around one half (48%) of the aged men, but almost all (91%) of the women had participated in cooking during the diary day. We now analyse the hypothesis that either one of the spouses looks after most of the daily cooking, in other words that the days differ so that when the man spends little time for cooking the wife spends a lot of time for it. We are comparing aged and middle-aged couples here in this respect. Here the husband's quartile tells how the wife behaves when he does more cooking. Does she spend less time on cooking on those days?

In aged families, the wife's participation in cooking is connected very little with the amount of time her husband spends on it (Table 6). On the average, the wife spends as much time on cooking in families where the man hardly spends any time on it as she does in families where

Table 6
Time used by wife relative to time spent by man on the same day on cooking in aged and middle-aged families

Quartiles of men by amount of time spent on cooking and quartile parameters (hrs.mins.)	Men's average	Women's average	Diary days
Aged couples			
I-II quartiles (0)	0.00	1.16	254
III quartile (0.10 - 0.20)	0.14	1.08	115
IV quartile (0.30+)	1.01	1.14	101
All	0.17	1.14	470
Middle-aged couples			
I quartile (0)	0.00	0.52	395
II quartile (0.10)	0.10	0.55	204
III quartile (0.20)	0.20	0.40	102
IV quartile (0.30+)	0.57	0.49	198
All	0.17	0.51	899

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

the man uses the largest amount of time for it. There is no statistically significant correlation (r=-.04) between the amounts of time men and women spend on cooking, either.

By comparison, some division of work can be seen in middle-aged families so that the wife spends slightly more time on cooking in the families where the man spends little time on it. The correlation between the amounts of time the spouses use for cooking is -.03, which does

not, however, support the existence of a clear division of work between the spouses. 56% of the middle-aged men and 88% of the women prepared food on the diary day.

4.2 Dish washing

In everyday talk, washing dishes is often used as an example describing the division of domestic work between women and men. However, only 14% of the aged men, but 78% of the women had washed dishes on the diary day. Due to the low participation of men in this task, we are not examining quartiles here but comparing the men who had washed dishes with the men who had not.

The man's participation in dish washing seems to reduce clearly the amount of time his wife spends on it in aged families (Table 7). The correlation between the spouses (r= -.17 **) is significant.

Table 7
Time spent by wife relative to time spent by man on the same day on washing dishes in aged and middle-aged families

Time spent by man on dish washing	Men's average	Women's average	Diary days
Aged couples			
Used no time	0.00	0.28	403
Used some time	0.27	0.13	67
All	0.04	0.26	470
Middle-aged couples			
Used no time	0.00	0.16	763
Used some time	0.20	0.16	136
All	0.03	0.16	899

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

By contrast, the time spent on washing dishes does not appear to affect the division of work between the spouses in any way in middle-aged families. The wife uses the same amount of time for it irrespective of whether her husband has washed dishes or not. In these families, 15% of the men and 61% of the women had washed dishes on the diary day. The correlation between the spouses (r=-.00) is not statistically significant.

4.3 Shopping and services

We are interested here in finding out whether either one of the spouses takes care of daily shopping and services or whether they both do it on the same day.

The amounts of time aged spouses use for shopping and services are fairly similar (Table 8). On the days when the men spend a lot of time on shopping and services, the women also spend a lot of time on them. On the diary day, 51% of the men and 47% of the women had done shopping and services. The correlation is statistically very significant (r=.51***). Al-

though this article does not study whether activities are done simultaneously, we can talk about families having shared shopping days.

Table 8
Time spent by wife relative to time spent by man on the same day on shopping and services in aged and middle-aged families

Quartiles of men by amount of time spent on shopping and services and quartile parameters (hrs.mins.)	Men's average	Women's average	Diary days
Aged couples			
I-II quartiles (0 - 0.10)	0.00	0.25	265
III quartile (0.20 - 1.20)	0.52	0.40	121
IV quartile (1.30+)	2.28	1.32	84
All	0.46	0.43	470
Middle-aged couples			
I-II quartiles (0)	0.00	0.31	498
III quartile (0.10 - 1.00)	0.35	0.39	227
IV quartile (1.10+)	2.17	1.24	174
All	0.38	0.44	899

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

The correlation is very similar among middle-aged couples. Spouses go shopping and run errands on same days. On the diary day, 47% of the men and 55% of the women had done shopping and run errands. The correlation is statistically significant (r=.40***) and indicates that spouses also generally go shopping together. This is supported by the finding of Ruuskanen (2004), according to which shopping is the domestic task that people of working age mostly do together with their spouse. Ruuskanen has used the data from the same Time Use Survey to study the simultaneity of activities and spending of time together among spouses.

5 Cleaning

One aged man in two and four women in five had cleaned on the diary day. Does either spouse do the daily cleaning or do both spouses do it on the same day?

The amount of time aged women spend on cleaning is almost entirely independent of the amount of time men spend on it (Table 9). Men spending time on cleaning does not mean that women would spend less time on it, almost the opposite. On the days when the man has done a lot of cleaning, the wife has also used more time for it than on the average. The correlation between the spouses is statistically significant (r=.21***). This indicates towards the likelihood of shared cleaning days in the family.

Table 9
Time spent by wife relative to time used by man on the same day on cleaning in aged and middle-aged families

Time spent by man on cleaning	Men's average	Women's average	Diary days
Aged couples – All days of the week			
Used no time	0.00	0.47	250
Used some time	0.55	0.57	153
All	0.22	0.50	470
Middle-aged couples – All days of the week			
Used no time	0.00	0.34	483
Used some time	0.38	0.51	416
All	0.17	0.42	899
Weekdays			
Used no time	0.00	0.34	254
Used some time	0.34	0.46	195
All	0.15	0.39	449

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

The correlation is clearer with people of working age (r=.42***), which could be because weekdays and weekend days are different as far as cleaning is concerned. However, this is not the case because a similar correlation can be observed when only weekdays are examined. The wives of the men who clean on weekdays also spend more time on it. In middle-aged families without children under the age of 18, 45% of the men and 74% of the wives had cleaned during the day.

5.1 Repair and maintenance work

By tradition, repairs and maintenance are men's work. They include here heating and water, home repairs and construction, car maintenance, gardening and pet care.

Even in aged families men do distinctly more home maintenance and construction work than their wives (Table 10). Especially heating and water maintenance, which 29% of the men and 13% of the women did on the diary day, are typically men's work. Men also do clearly more repairs and construction, and car maintenance. However, both spouses participate actively in gardening and pet care. Spouses usually engage in home maintenance on the same days. The correlation can be seen both with retired couples (r=.17**) and with couples of working age (r=.24***).

Table 10
Time spent by wife relative to time used by man on the same day on maintenance work in aged and middle-aged families

Time spent by man on maintenance	Men's average	Women's average	Diary days
Aged couples			
Used no time	0.00	0.02	296
Used some time	1.15	0.11	174
All	0.29	0.06	470
Middle-aged couples			
Used no time	0.00	0.03	594
Used some time	1.11	0.08	305
All	0.23	0.04	899

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

5.2 Helping other households

Helping other households refers here to assisting children who have moved away from home, own parents, or other relatives, neighbours, friends or acquaintances. The assistance may be provision of childcare, running errands, or the like.

Spouses are clearly assisting another household on the same days (Table 11). The helping seems to be a joint project in the family. 10% of the men and 12% of the women of retirement age had assisted another household on the diary day. Of the middle-aged respondents included in the comparison, 12% of the men and 15% of the wives had helped people outside their own household on the diary day.

5.3 Summary concerning domestic work

The amounts of time aged spouses spend on domestic work do not substitute but complement each other. If the amount of work to be shared is standardised, the wife of a man who has done little domestic work does not do any more domestic work than the wife of a man who has done a lot of domestic work, as one might assume. Quite the opposite, the amounts of time the spouses spend on domestic work follow each other. If the man has used a lot of time for domestic work, his wife has done so, too. However, this does not eliminate the fact that the amounts of domestic work families do on different days may vary. There are days with high or low emphasis on domestic work, on which the spouses' time use follow each other.

Table 11
Time spent by wife relative to time used by man on the same day on assisting neighbours in aged and middle-aged families

Time spent by man on assisting neighbours	Men's average	Women's average	Diary days
Aged couples			
Used no time	0.00	0.09	427
Used some time	3.04	0.58	43
All	0.19	0.14	470
Middle-aged couples			
Used no time	0.00	0.08	792
Used some time	2.22	1.18	107
All	0.17	0.17	899

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

The distribution of domestic work varies by task. There is no clear division in domestic work so that the man's increased input into, say, cleaning or shopping and services would reduce the amount of time the wife spends on them. On the contrary, the wives of the men who use a lot of time for cleaning also use more than average time for it on the same day. The complementation is even more pronounced in the time spent on shopping. However, the time the wife spends on cooking is not in any way dependent on the time the man spends on it. Dish washing is the only activity where the amount of time the man spends on it reduces the time the wife spends on it. However, the number of men taking care of dish washing is low, despite the opposite impression created by everyday talk.

The low division of responsibilities not only concerns aged couples but also middle-aged ones without children under the age of 18. The finding reflects the similarity of the spouses' time use. Work is not divided between the spouses according to tasks, but both do the same tasks on the same day. We cannot talk about rational division of domestic tasks but perhaps more aptly about joint performing of domestic work. This examination does not extend to the question of whether domestic work is done together or simultaneously. Among couples of working age, this has been studied by e.g. Ruuskanen (2004), who has observed that especially shopping is an activity that spouses usually do together.

6 Spouses' free-time activities

We have already established that spouses tend to do the same domestic tasks on the same days. In this chapter we will examine whether this uniformity also concerns the use of free time, or whether the spouses then follow their own likings.

Of the free-time activities, I have included four of the most popular, which are television watching, reading, physical exercise and socialising.

6.1 Television watching

The time spent on watching television is connected with the amount of available free time (Robinson, 1979). Television is watched most by the population groups that are not gainfully employed. Pensioners are mass consumers of television programmes. We will study here whether spouses influence the amounts of time each one of them spends on watching television.

Almost all aged spouses, 95% of the men and 92% of the women, had watched television on the diary day. The amounts of time they spend on watching television run very parallel (Table 12). On the days when the man has spent a lot of time watching television, his wife has also done so, and spent considerably more time at the television than the wife of a man who has watched little television. The same connection can also be seen in younger families, although the amounts of time they spend on watching television are clearly smaller. The correlations between spouses strengthen this finding, being .63*** for aged couples and .46*** for middle-aged ones.

Table 12
Time spent by wife relative to time used by man on the same day on watching television in aged and middle-aged families

Quartiles of men by amount of time spent on watching television and quartile parameters (hrs.mins.)	Men's average	Women's average	Diary days
Aged couples			
I quartile (0 - 1.40)	0.50	1.27	115
II quartile (1.50 - 3.00)	2.30	2.21	115
III quartile (3.10 - 4.20)	3.44	3.10	114
IV quartile (4.50+)	5.48	4.20	126
All	3.11	2.48	470
Middle-aged couples			
I quartile (0 - 1.10)	0.26	1.12	244
II quartile (1.20 - 2.10)	1.46	1.50	186
III quartile (2.20 - 3.40)	2.53	2.07	239
IV quartile (3.50+)	5.18	3.02	230
All	2.29	2.00	899

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

Television watching seems to be a shared pastime of spouses. A set that is left on influences the time use of the persons in the same room. Passive listening becomes active watching when something interesting is on or when the minds of the household members are not occupied by some other activity (Robinson, 1979).

6.2 Reading

Another typical way of spending time at home is reading, which clearly increases in retirement.

Spouses' reading habits are similar (Table 13). The wife of a man who reads a lot also reads more than the wife of a man who does not read much. This applies to both aged couples (correlation .32***) and slightly younger ones (correlation .31***).

Table 13
Time spent by wife relative to time used by man on the same day on reading in aged and middle-aged families

Quartiles of men by amount of time spent on reading and quartile parameters (hrs.mins.)	Men's average	Women's average	Diary days
Aged couples			
I quartile (0 - 0.20)	0.07	0.40	130
II quartile (0.30 - 0.50)	0.40	0.56	110
III quartile (1.00 - 1.40)	1.14	1.06	116
IV quartile (1.50+)	1.14	1.03	114
All	3.01	1.33	470
Middle-aged couples			
I quartile (0 - 0.10)	0.02	0.42	279
II quartile (0.20 - 0.40)	0.29	0.46	227
III quartile (0.50 - 1.10)	0.55	0.54	177
IV quartile (1.20+)	2.25	0.54	216
All	0.59	1.16	889

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

Does the similarity in reading apply to the reading of everything, that is, newspapers, magazines and books? Because of the small distribution we are not examining quartiles here but compare those having read very little or not at all with those having used more time than on the average for reading.

The reading habits of spouses follow each other in respect of both printed media and books (Table 14). This is understandable as regards subscribed and purchased periodicals, but it is surprising that the connection can also be seen in the reading of book.

20% of the women and 15% of the men had been reading a book during the day. Reading newspapers was done as a principle activity during the day by 69% of the aged men and 59% of the women. Reading reflects the spouses' level of education, unlike television watching which almost all aged people do daily. The correlations between the level of general education and reading are statistically significant for aged men (r=.21***) and wives (r=.23***).

Table 14
Time used by wife relative to time used by man on the same day for reading printed media and books in aged families

Man used time for reading versus wife used for reading during the day	Men's average	Women's average	Diary days
Newspapers			
Little (under 30 mins.)	0.05	0.15	211
A lot (over 30 mins.)	1.08	0.35	204
All	0.35	0.25	470
Periodicals			
Used no time	0.00	0.04	439
Used some time	0.43	0.16	31
All	0.03	0.05	470
Books			
Used no time	0.00	0.10	400
Used some time	1.43	0.48	70
All	0.16	0.16	470

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

6.3 Physical exercise

Physical exercise is a pastime that mainly happens outside the home and it would be justified to assume that the spouses do not influence each other's activity in it in the same way they do with the activities that take place at home.

The spouses also seem to be similar in physical exercise (Table 15). This concerns equally pensioners (correlation .43***) and younger couples (correlation .42***). Some families take more exercise than others, at least as a daily activity.

Does the similarity only concern going for walks, which is easy to do together, or perhaps also more active forms of exercise?

The similarity in physical exercise does not apply to walking as a pastime only but also to more active types of sport (Table 16). The spouses probably take walks together and engage in more active types of exercise on the same day, and partly perhaps even together. Ruuskanen (2004) obtained similar results when examining how couples of working age use their free time together. After socialising with other family members, outdoor exercise was the next most popular free-time activity families did together at weekends.

6.4 Socialising

Socialising includes socialising at home as well as outside the home. Socialising with the family, and friends and relatives, as well as telephone and other conversations are included in the examination when they are entered in the diary as a primary activity. Conversations con-

ducted as a secondary activity to something else, such as during mealtimes, are not taken into account here.

Table 15
Time spent by wife relative to time used by man on the same day on physical exercise in aged and middle-aged families

Quartiles of men by amount of time spent on physical exercise and quartile parameters (hrs.mins.)	Men's average	Women's average	Diary days
Aged couples			
I-II quartiles (0 - 0.10)	0.00	0.24	230
III quartile (0.20 - 1.10)	0.49	0.38	119
IV quartile (1.20+)	2.30	1.13	121
Total	0.49	0.39	470
Middle-aged couples			
I – II quartiles (0)	0.00	0.24	434
III quartile (0.10 - 1.20)	0.48	0.37	231
IV quartile (1.30+)	3.03	1.15	234
Total	0.56	0.39	889

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

Table 16
Time spent by wife relative to time used by man on the same day on walking and active exercise in aged families

Man has participated in versus wife spent on exercise (concerned per day)	Men's average	Women's average	Diary days
Walking			
Has not participated	0.00	0.16	283
Has participated	1.07	0.41	187
All	0.26	0.25	470
Active exercise			
Has not participated	0.00	0.06	379
Has participated	1.00	0.27	91
All	0.12	0.10	470

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

The amounts of time spouses spend on socialising run fairly complementary to each other (Table 17). This becomes quite obvious with both aged and middle-aged couples. The correlation between spouses is .67*** for aged couples and .74*** for middle-aged couples.

Table 17
Time spent by wife relative to time used by man on the same day on socialising in aged and middle-aged families

Quartiles of men by amount of time spent on socialising and quartile parameters (hrs.mins.)	Men's average	Women's average	Diary days
Aged couples			
I-II quartiles (0)	0.00	0.27	230
III quartile (0.10 - 1.00)	0.32	0.39	112
IV quartile (1.10+)	2.39	2.10	128
All	0.47	0.56	470
Middle-aged couples			
I-II quartiles (0)	0.00	0.24	434
III quartile (0.10 - 1.00)	0.29	0.41	228
IV quartile (1.10+)	2.47	2.11	237
All	0.46	0.53	470

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

The high correlation may come from communication between the spouses (Ruuskanen, 2004). However, the recorded socialising of aged couples mainly consists of conversation with friends and relatives. What is surprising is that although aged couples usually spend a lot of time at home, only 13% of the men and 15% of the women had recorded in the time use diary conversation with another member of the family. Family conversations are quite apparently mainly conducted alongside other activities.

Socialising seems to be a shared activity of the family, indicating that both spouses usually participate in the socialising with friends and relatives.

6.5 Summary concerning free-time activities

As a summary concerning free time we can observe that the ways spouses use it daily are quite similar. This extends to the content more clearly in free-time activities than in domestic work. The highest degree of similarity occurs in socialising and television watching. These are followed by physical exercise and reading. Thus, the choices of the spouses clearly affect each other. The uniformity is not associated with ageing as assumed, for it is clearly observable among both aged and middle-aged couples.

7 Conclusions

This article studies how domestic work is shared in aged families. Do spouses divide tasks between them more equally than in the middle years now that they have more time? Surprisingly, however, the findings do not support this presumption about task sharing. Domestic work is not actually divided but the spouses do it on the same days, maybe even simultane-

ously. Domestic work accumulates to the same days, and perhaps also to the same families. When a man spends more time on domestic work the wife also does a lot of it.

Family is often thought of as an efficient work unit where tasks are apportioned and shared among the workers. However, the time use of aged spouses reflects a situation where time use has become alike. Same types of domestic chores, such as shopping, cooking, cleaning, home maintenance or helping another household, are done on the same days. Even in retirement, the wife does the lion's share of domestic work, although certain evening out does happen.

The lifestyles of families are more consistent in free-time activities than in domestic work. The spouses have adopted similar interests both at home and outside it. Especially socialising is an element that unites the structure of spouses' time use, for it is done together as a couple with friends and relatives. The amounts of time spent on watching television run clearly in the same direction. A physically active person also has a physically active spouse and time uses on reading are very alike. Instead of pursuing their own, personal choices, spouses engage in the same activities. This is observed already before the retirement age, among middle-aged couples.

All in all, the time use of spouses looks surprisingly similar if we examine what each one of them has done during the same day. The spouses may have been much alike to start with, or the similarity in their lifestyles may have evolved over the years. Family seems to have a strong unifying effect. When studying couples of working age, Ruuskanen (2004) observed that the age of the spouses was connected with the analogy of activities. This could mean that similarity in time use increases the likelihood of the marriage continuing. Couples whose lifestyles have not become sufficiently identical may drift apart, whereas those having adopted similar lifestyles are more likely to stay together.

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Senioritis in repose

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Abstract

Media and other accounts of life after retirement suggest it to be "The Golden Years" of life, when the elderly have true leisure in the classic sense of freedom from responsibilities of work. However, like earlier time-diary studies, data from the 2003-07 Americans Time Use Project (ATUS) indicate that the great majority of seniors' extra 20+ hours of free time is concentrated on three activities – TV, reading and rest. Only a few more hours are spent on sleep. Despite reports of increased work time among seniors, relatively few of those in Andy's new age bracket remain in the labor force and they work fewer hours.

JEL-Codes: J11, J14, J21, J26

Keywords: Time use, elderly, retirement, free time, TV, aging

Prepared for Andy Harvey´s IATUR birthday bash and induction into seniorhood. While having known and enjoyed Andy's warm company over the years, our most serious (and successful) collaborative time efforts has been in the pursuit of the proper pints in the evening hours.

Time is an essential resource for seniors in modern life, particularly since they have so much of it. Indeed, most of them meet the classical definition of leisure of Greek philosophers, namely freedom from the necessity of work. Thus, they should expect to have maximal freedom in choosing how they spend their time. In other words, examining time-use patterns among the elderly should provide clearer insights into their underlying values and attitudes toward life.

1 Measuring people's time-use – Estimates vs. diaries

There are two basic types of US data sources from which to infer patterns and trends in how time is spent: time estimates and time diaries (Robinson and Godbey, 1999). Reliance here is on the more elaborate and comprehensive technique of the time diary, because with diaries, we can assess *all* daily activities—not merely individual work or free-time activities (Robinson, 1985). Having equivalent measures for younger adults of working age from the American Time-Use Survey (ATUS) at *www.bls.gov* further allows one to see how daily life changes for people who retire – as shown below.

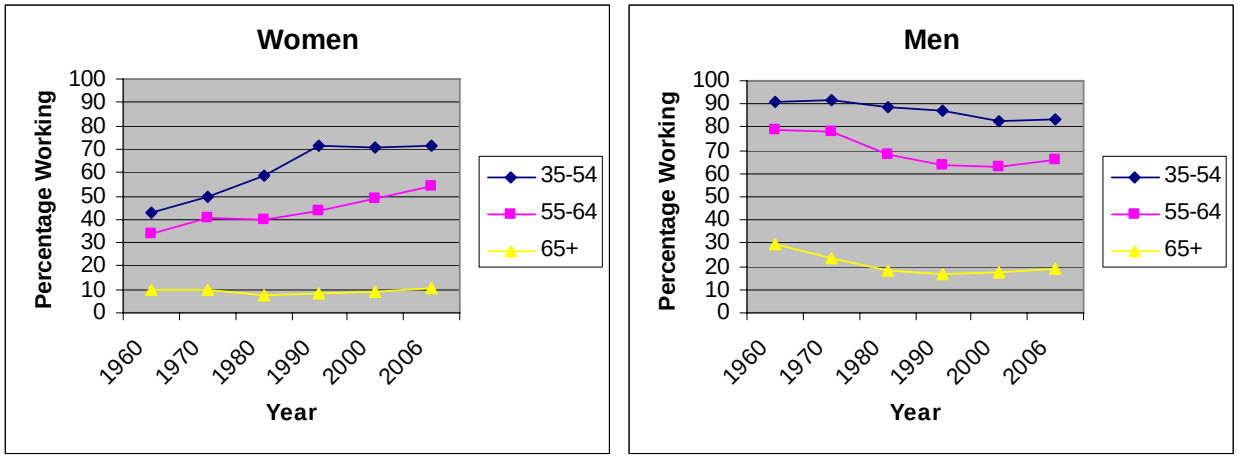
However, there are alternative series of time-estimate questions. These estimates have the advantages over time diaries of 1) extending back earlier in historical decades, 2) having larger sample sizes and 3) covering specialized or more detailed activities.

1.1 BLS work estimates

The Bureau of Labor Statistics (BLS) has the oldest time series of relevant data on employment status and work hours, some dating back 100 years or more. Figure 1 shows decennial trends in employment status since 1960. It documents the steady increases in percent employed for women (from 42.5% in 1960 to 71.5% today for those aged 35-54, and from 34% in 1960 to 54.5% today for those aged 55-64). In contrast, one sees the steady *declines* for men (from 91% in 1960 to 84% today for those 35-54, and from 79% in 1960 to 66% today for those aged 55-64).

The contrasts for those past the nominal retirement age of 65 can be seen to be quite different, however. Thus for senior men, there is the decrease from 29% employment in 1960 to 19% today, but for senior women, there is no change – 10% in both 1960 and today. Thus, senior women are not taking part in gender work revolution of younger women, with their rate of being employed only half of that of senior men. Moreover, even those senior women who do work put in less than half the work-time (3 weekly hours) of senior employed men (7 hours).

Figure 1
Changes in proportions working at a paid job by age – 1960-2006



Source: Timetables www.webuse.umd.edu from BLS/US Census Data.

1.2 GSS free-time activities

The US General Social Survey (GSS) of the University of Chicago has been asking different activity estimate questions about participation in 8 free-time activities since 1972. In the area of socializing, the GSS data show slight increases among seniors in visits with friends and with relatives, but decreasing visits with neighbors and at bars – trends that mirror historical trends for adults under age 65. At the same time, GSS-estimated participation in all four of these forms of socializing activity do decline as seniors get older. However, by far the greatest GSS declines with age are found for sexual activity – from 36 annual occasions for those 55-64 to 18 occasions for those 65-74 and 6 occasions for those 75 and older; overall occasions of sex for seniors, however, have not declined since 1989.

Unlike the declining GSS participation trends in attending religious services for younger adults, senior church attendance has remained fairly steady over the last 35 years. However, religious attendance does also decline with age, particularly as seniors reach their mid-80s. Similarly, reading newspapers has not declined for seniors over time (as it dramatically has for younger adults), but does decline for seniors in their 80s.

In contrast, estimated TV viewing among seniors has increased slightly since the 1970s, and viewing is one activity that does increase with age into one's 80s. (More detailed and insightful data on TV viewing come from the time-diary data reviewed in Table 1 and related text below).

2 Time-diary studies

In time-diary accounts that Andy helped pioneer, respondents are not asked to estimate or to make complex, vague and changing calculations, but to simply recall their activities sequentially for a specific period, usually the previous day. In that way, it becomes possible not only

to reduce the respondents' recall period and reporting task, but to cover all daily activity and to ensure that the resulting account respects the "zero-sum" property of time -- in that the activities total to exactly 24 hours a day. In other words, if time on paid work decreases, then, it must be "zeroed out" by increases in time spent on other activities. Considerable evidence supports the basic reliability and validity of such diary data (Robinson and Godbey 1999; Juster and Stafford 1985; Gershuny, 2000). That is the various diary accounts are consistent with each other and with other ways of collecting time data (like observation or "beeper" studies).

2.1 Diary availability

Seniors were not included in the first US national diary study in 1965, but they were included in the subsequent US diary studies in 1975, 1985 and 1992-95. However, the number of seniors in these smaller samples was notably lower than for the 2003-07 data collections for the most recent BLS diary survey, in which more than 8000 seniors were interviewed – the data from which are shown in Table 1.

2.2 Diary patterns and trends

Table 1 shows the activity times of men and women age 65+ in comparison to those two younger age groups: those aged 55-64 and those aged 35-54. The age 55-64 group may be seen as a transition age group, involved in "anticipatory socialization' for retirement, in that they generally bridge differences between those 35-54 and those age 65+ in anticipation of the activity changes that take place after retirement.

First, as in Figure 1, we see the dramatic decline in senior's paid work time and its related commute by 6-10 hours per week for those aged 55-64, one that will drop another 15-20 hours after age 64. These drops are mainly offset by increases of 4-5 hours of housework, 4-5 hours of sleep, 11 hours of TV, 5 hours of reading, 1 hour of hobbies and about 3 hours of relaxation. Activities that show smaller increases are eating and grooming, with an expected decline in child care. The main changes in free time are thus concentrated in TV, reading and relaxing and hence do not generally extend to other free-time activities. Note that this means that we do not find the expected declines in organizational activity, fitness (sports) activities, or attending movies and other social events; however, total travel outside the home does decline, probably a function of decreased need to commute to work.

Of particular interest is the increased housework of both men and women, since these are the "empty nest" years, presumably with fewer family members and smaller homes to care for. Although male hours of housework (and shopping) do increase from 10 to over 13 hours per week, women continue to do almost 2/3 of the housework.

Also of interest is the relatively greater increase in TV viewing. Indeed of the 20+ hours of increased free time for those age 65+, over half of it goes to TV. However, in percentage terms, the increase in TV's share of free time only rises from 42% to 46% among women age

65+, while for men it declines slightly from 51% to 49% of free time – thus closing the gender gap in viewing time.

Table 1
Time/activity differences by age (in Hours per week from 2003-2007)

Time uses/activities								
	Women			**AgeDiff**	**Men**			**AgeDiff**
Age	35-54	55-64	65-	+/-	35-54	55-64	65-	+/-
Contracted time								
1. Paid Work	25.4	19.8	3.3	-22	38.1	28.1	6.5	-32
2. Commute	2.0	1.4	.2	-2	3.1	2.4	.5	-3
2x. Education	.9	.4	.3	-1	.5	.2	.1	0
Total =				*-25*				*-35*
Committed time								
3. Housework	17.8	19.0	23.0	+5	10.2	12.5	13.8	+4
4. Child care	6.7	2.6	1.3	-5	3.5	1.2	.8	-3
5. Shopping	7.2	7.6	6.7	-1	4.7	5.0	6.3	+2
Total =				*-1*				*+3*
Personal care								
6. Sleeping	58.5	58.3	62.3	+4	57.2	57.7	62.0	+5
7. Eating	7.2	8.2	9.2	+2	8.0	9.3	10.2	+2
8. Grooming	8.6	9.8	9.6	+1	6.6	7.3	8.2	+2
Total =				*+7*				*+9*
Free time								
9. Religion	.9	1.3	1.5	+1	.7	.8	1.1	0
10. Organizations	1.8	1.7	2.1	0	1.3	1.3	1.9	+1
11. Social Events	.9	.9	.8	0	.9	.9	.7	0
12. Visiting	4.7	5.4	5.1	0	3.8	3.7	4.2	0
13. Fitness Activity	1.3	1.1	1.1	0	2.0	2.3	2.2	0
14. Hobbies	.7	1.4	2.0	+1	.8	1.1	2.0	+1
15. TV	14.4	17.6	25.1	+11	18.7	22.2	29.3	+11
16. Radio/records	.2	.2	.5	0	.5	.4	.7	0
17. Reading	2.2	4.3	7.1	+5	1.7	3.0	6.7	+5
18. Home Comm.	2.1	2.4	2.6	0	1.7	1.9	2.1	0
19. IT	.7	.8	.8	0	1.1	1.2	1.0	0
20. Rest/relax	1.7	2.3	4.3	+3	2.0	2.9	5.5	+4
21. Free travel	1.9	2.1	1.9	0	1.9	2.1	2.2	0
Total =				*+20*				*+20*
22. Total travel	8.7	7.6	5.5	-3	7.7	7.8	6.4	-1

Note: Subtotals may not add to zero because of rounding errors.
Source: Timetables www.webuse.umd.edu based on BLS/US Census Data.

Finally, it is important to note that many of the age differences in activity in Table 1 reflect differences not in age but in hours at work. When the increases in housework, sleep, TV and reading are adjusted for employment status, they largely disappear. In other words, seniors who continue to work show activity patterns quite similar to workers under age 65.

2.3 Differences by background factors

There are variations in the Table 1 results by many of the same predictors as for younger adults. For *age* itself, average paid work hours decline from 8 hours for those aged 65-72 to 3 hours for those 73-79 to less than an hour for those aged 80 and older. Housework hours also decline but only from 18 hours to 15 hours for those 80+. Sleeping hours do increase by about 5 hours but only for those 85+, and TV, relaxing and reading hours also increase -- by about 4 hours a week. Both free time and overall travel decline almost 4 hours past age 84.

Table 1 does show many of the same *gender* patterns as for younger men and women, as noted for women's domination of housework (and childcare) above. In contrast, senior men continue to do 2/3 of the paid work. In terms of personal care, sleep hours of men and women remain virtually identical, while men spend more time eating and women more time grooming. Older men have about 5 more hours of free time than older women, almost all of it going to TV, with more time spent exercising and relaxing as well. Even with less free time, older women manage to find slightly more free time for religion, organizational activity, socializing/ talking and reading.

As with *race* differences among younger adults, older Blacks spend more time grooming, attending church, watching TV and relaxing than older Whites, who in turn spend more time doing housework, eating and reading than older Blacks.

In terms of *status* factors, higher education and income are associated with twice as much paid work as for those with lower levels, but no more (or less) housework, child care or shopping. College-educated and highest-income seniors spent 5 less weekly hours sleeping than those of lower education and income, offset by 2-3 more hours eating meals, with no notable difference in grooming time. As with adults under age 65, the biggest free-time activity difference was found for media use, with college-educated and highest income seniors watching about 5 less weekly hours of TV – offset by 4-5 more hours reading and about an hour more of computer use. Higher education and income groups also spend more of their free time traveling, as well as travel in general; that travel was apparently tied more to organizational meetings. They also spent less time relaxing.

In terms of *role* factors, the differences were less pronounced or in evidence than for pre-retirement groups. *Employed* seniors did spend almost 10 hours less weekly time watching TV, 3 hours less reading, and about an hour less time on hobbies and in home communication. *Married* seniors worked about 3 more hours, but they spent about 3 hours less time asleep or on TV than those not married, but there were no differences on housework or on other free-time activities. Those few seniors who had young *children at home* spent about 4 hours in weekly childcare, and they worked far longer hours (probably a function of their

younger age), but they did no less housework; in free time, these parents went to organizational meetings and events more, offset by 3 hours less TV.

As with those under 65, differences among seniors by region or by city size were not associated notably or consistently with differences in activity.

2.4 Historical trends

As noted above, national diary data collections for seniors only began in 1975, and their sample sizes number less than 300-500 seniors with which to compare to the more than 8000 seniors represented in Table 1. Nonetheless, some fairly clear patterns emerge and these generally parallel those in Table 1; these were also noted in analyses conducted on these earlier diary studies of seniors (Robinson, 1993).

The trends since 1975-85 from these earlier studies are concentrated in a few activities, such as the increase in sleep of 2 hours for senior women and 5 hours (for senior men) a week, along with the 3-5 hour increase in TV viewing. The increases were offset by smaller decreases in a number of personal and free-time activities such as eating, grooming, visiting, fitness activity, hobbies and home communication. Here again, then, the results largely mirror those trends found among those of working age – with the one important exception of no decline in housework time among seniors.

3 Conclusions

The data in Table 1 and elsewhere in this article run counter to the many media and AARP stories about "gray panthers" and other active lifestyles of those over 65. They lead to the more somber conclusion that, unlike Andy, few seniors are taking advantage of the new time (and probably increased income) that becomes available to them post retirement. The finding that retirees only use their free time bonus of 20+ hours per week for such mainly passive activities of TV, reading and rest may represent a squandering of a great national resource, given these seniors' skills, talents and experience.

Readers and active leisure advocates may be particularly alarmed at so much of seniors' free time going to TV, making them an ideal target for the 'Turn off your TV' movement that has designated one week a year when people leave their sets off and find more concentration, challenge and gratification in other activities; yet diary research suggests that, while people rate TV in general as relatively low on a 'fun meter', the programs they watched on the diary day rated far higher in enjoyment – actually above the levels for other free-time activities. Thus, viewing hours do rise dramatically for seniors. However, putting that increase in historical context, it is still less of an increase than found among younger adults between 1965 and 1975 – when their viewing time consumed virtually all of their increased free time.

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How many days? A comparison of the quality of time-use data from 2-day and 7-day diaries

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Abstract

Time budget studies differ in the number of diary days. The 'Guidelines on Harmonized European Time-Use Surveys (HETUS)' issued by EUROSTAT recommend a two-day diary with both one weekday and one weekend day. In this contribution we examine whether the number of diary days has an effect on the quality of time-use indicators. A lot of time-use researchers plead for a longer period of observation; some of them even argue that one- or two-day diaries are not very valuable since the high demands of scientific research cannot be accomplished unless multi-day cycles are captured. Longer periods of observation offer better prospects for analyses, especially for the study of rhythms and activity patterns which typically follow cycles of multi-day duration, and which are part of daily life. Other authors however point out that longer periods of observation cause fatigue or diminished motivation and thus will lead to more inaccuracies. In this contribution we use the pooled Flemish time budget data from 1999 and 2004 to compare 7-day diaries with the 2-day diaries as recommended by the EUROSTAT-guidelines. The respondents of the Flemish time use surveys all filled in diaries for 7 consecutive days. To simulate the 2-day registration, we randomly selected one weekday and one weekend day for each respondent. The 2-day selection was compared with the original 7-day registration. The aim of this comparison is to inventory the advantages and disadvantages of the 2-day and 7-day registration method. To do that, we compare different indicators, such as the averages and the standard deviations of the duration of several activities. We further examine whether certain types of activities are more affected by the method of registration than others. Finally we examine whether a longer period of registration negatively affects the quality of the data (less detail and less accurate).

JEL-Codes: C81

Keywords: Time-budget studies, time-use indicators, methodology

1 Introduction

1.1 From Halifax to Luxembourg

20 years ago, in September of 1989, the airport of Sophia (Bulgaria) was closed down for reasons of maintenance. During the entire week there were no domestic flights in the country and all international air traffic was handled by the military airport of Plovdiv. That same week, from the 11th till the 15th of September, the International Association for Time-Use Research (IATUR) had its annual conference in Varna. After the conference Andy Harvey, Jonathan Gershuny and I (i.g.), together with a Bulgarian researcher, hired a car to travel from Varna to Sophia. We were on the road the whole day, in bad weather conditions. When we left Varna Andy was driving and Jonathan and I were sitting in the back. We had a lively discussion on the 'Multinational Longitudinal Time Budget Archive' Jonathan was collecting and on the many difficulties of comparative time-use research. Since Andy was more focused on the discussion going on in the back – he turned his head all the time and forgot about the road – we convinced him to leave the steering wheel to Jonathan. When he joined me in the back he took out his laptop, a very impressive gadget at that time, and showed me different kinds of comparative tables and data. At the same time he kept hammering on the importance of harmonizing the collection of time-use data. It was not the first time I heard Andy Harvey's plead for harmonizing the data collection.

A year before the conference in Varna I had met Andy Harvey for the very first time. It was at the meeting of the then called 'International Research Group on Time Budgets and Social Activities' held at the Karl Marx University in Budapest. There were 35 participants, of which 11 from the guest country itself. At this meeting in 1988 it was decided to change the name of this research group into the 'International Association for Time Use Research'. Andy Harvey was the Secretary-Treasurer of IATUR and had a keynote paper on 'International Co-operation in Time Budget Research: Guidelines'. In this paper he not only pleaded for harmonizing the collection of time-use data, but he already made a nice overview of the different aspects that needed to be harmonized in order to have more or less comparable national data sets that could be merged for comparative analyses.

The first and to this day, the most important milestone in comparative time-use research is of course the Multinational Time Use Study directed by Alexander Szalai. Results and the methodology of this cross-national time-use survey were reported in the bible of time-use research 'The Use of Time' (Szalai, 1972). This book was the first to outline a number of conventions with regard to the methodology of time budget research. More than 40 years after the field work for this multinational study was conducted (1965-1966) in 12 countries, these methodological guidelines are still the main reference in time-use research and therefore its influence can hardly be overestimated. Andy Harvey realised that the chances to ever replicate a big scale international study like that were very small. He saw two alternative scenarios for inter-

national co-operation in time-use research and comparative analysis: (1) merging existing national data sets into one common data base and (2) the co-ordination of the design and conduct of future national studies to afterwards facilitate merging them into a common data set (Harvey, 1993). The first scenario was the one Jonathan Gershuny followed when he started the 'Multinational Longitudinal Time Budget Archive'. Andy Harvey promoted the second option which of course could also contribute to the amelioration of the first option.

In stead of simultaneously collecting time-use data in the context of a central project, Andy Harvey and many other IATUR-members thought it to be more fruitful and realistic to develop guidelines to harmonize future national data collections and to convince other researchers and statistical offices to follow the approved guidelines. It is a little ironic that the vision and initiative of a Canadian from Halifax, a decade later, after extensive discussions on IATUR-meetings and in a special task force, finally cumulated in the first 'Guidelines on Harmonized European Time-Use Surveys (HETUS)' issued by EUROSTAT (European Commission, 2004). By means of these Guidelines EUROSTAT not only promoted the organization of time-use surveys among its member states and the candidate states of the EU, as was intended by the very first start of this initiative in the context of IATUR, but by the start of the new century, it also resulted in dozens of new national data sets that were more or less comparable as a result of the harmonization of the data collection. This was really a new boost in time-use research.

1.2 How many days?

The guidelines Andy Harvey had in mind were related to many issues: sampling issues (sample size, age of respondents, time of the year, …), collection issues (yesterday or leave-behind diary, number of diary days, timing of diary day, interview modes, open or fixed interval diary, …) and content issues (content variables in the diary, own words or pre-coded, coding schemes, minimal socio-demographic and background information, …) (see Harvey, 1993). Andy Harvey not only provided an extensive list of relevant issues that had to be settled to harmonize international time-use surveys, on basis of his and other researchers' experiences and methodological literature he also developed arguments for recommendations on all these issues.

Concerning the number of days a respondent should keep a diary, he recommended 'one or two days per respondent for general studies', although for specialized studies longer periods may be appropriate (Harvey, 1993). The Guidelines on Harmonised European Time Use surveys generally followed his recommendation, since it was recommended "…to use two diary days, i.e. one weekday (Monday-Friday) and one weekend-day (Saturday and Sunday). The use of only one diary day will also be acceptable, but with only one diary day it is impossible to get any idea of the intra-personal variation. The general rule from this point of view is that the more diary days the better. Considering also the problem of increasing non-response with increasing respondent burden a reasonable choice is two or three diary days." (European Commission, 2004).

In this contribution we want to discuss this recommendation concerning the number of diary days. We will argue that it would have been better to recommend a 7-day diary.

1.3 The weekcycle

Time is structured by cycles. Although in Western modern societies we generally conceive time from a linear perspective – Newtonian neutral time flowing from some infinite past to some infinite future (see, Sorokin and Merton, 1937) – we need cycles to organize and structure time (Zerubavel, 1979). We measure durations using cycles: seconds, minutes, hours, days, weeks, years, … To specify the timing of an event we also do it in terms of cycles: Wednesday morning, 19 August 2009 at 10 o'clock is in fact a very specific location in terms of multiple cycles: the 10th hour of the 19th day of the 8th month of the 2009th year since the (hypothetical) birth of Jesus Christ. If we specify it as a Wednesday then it is the 4th day of the week (although some will say it's the 3rd day of the week). Furthermore, we also use cycles to count the number of times something happens. Saying that you eat 3 times, means nothing without a denominator which is, again, a cycle. We eat 3 times 'a day', we go to the fitness twice 'a week', we receive our salary 'every month', we go on holiday 'every year', ….

Activity patterns can be structured in terms of socially relevant cycles of which the day, the week, the year and the life cycle seems to be the most important ones in modern Western cultures (Zerubavel, 1979). The day has a certain structure and the timing of activities in the daily cycle is socially relevant. Most people sleep at night, get up in the morning, eat at noon, work between 9 a.m. and 5 p.m., spend the evening in leisure, … So, if we want to get a picture of daily life, we literally need to have a view on the whole 24-hours or an entire day. But given the difference between days (especially the week-weekend contrast in Western societies) a person's activity pattern may vary depending on the day of observation (intra-personal variation). Therefore, it is recommended in the EUROSTAT-guidelines to have at least one weekday and one weekend day. However a large proportion of intra-personal variation still remains untouched. Because of the very different character of Saturdays and Sundays, one weekend day is not very representative for the whole weekend. Although the intra-variation between weekdays is much smaller than between both weekend days, a lot of activities follow a weekly rhythm. Activities like visiting family, doing sports, shopping, cleaning the house or other household tasks or odd jobs, going to the pub, going to a club, watching football, … are often done on specific days of the week (Zerubavel, 1985).

Besides the day-to-day variation, there is variation in time-use between different months or seasons of the year and even throughout the whole lifespan. Therefore, the best option would be to keep a diary covering a whole year, or even for a whole life. It is obvious however, that it is not very realistic to ask a large sample of people to keep a time-use diary for a year or more. But why not ask respondents to keep a diary for 7 consecutive days?

1.4 Pro and cons of a 7-day diary

In his guidelines-article, Andy Harvey clearly sees the advantages of increasing the number of diary-days: "… (it) reduces the important dimensions of measurement error, costs and the usefulness of the data for the analysis of subgroups …" (Harvey, 1993). He refers to Gershuny's argument that "… due to intra-person variance longer diaries (…) give significantly more accurate time estimates than shorter diaries do" (Harvey, 1993). After some statistical tests Gershuny (in Harvey, 1993) concluded that for some activities and some particular social groups the seven-day data give much more precise estimates. This is supported by Hill (1984) who suggests that one-day-diaries provide good estimates of time use over long spans of time for activities with little day-to-day variation (sleeping, eating, …) but they give a lesser representation of individual time use over longer spans for activities with considerable day-to-day or intra-personal variation (home maintenance, attending meetings, …).

The kind of activities and the intra-personal variability is also relevant in reference to the specific time-use parameters. Aggregated analyses on large samples of respondents who filled in one or two day-diaries covering all the seven days of the week, generally yield good estimates concerning the duration per respondent (i.e. average duration of activities for all respondents, irrespective if they did this activity during the period of registration or not). Hedges (1986) and Gershuny and Robinson (1988) found no real differences in the durations per respondent calculated on basis of a one-day and a seven-day data set. On the aggregated level and measured for a whole group (doers or not), the intra-personal variation does not matter much.

This is totally different for estimates of the participation rate (proportion of doers) and the duration per participant (i.e. average duration of activities for the doers of this activity). Participation rates (and thus the related estimate for the duration per participant) are very dependent on the window of observation. Activities mainly following a daily rhythm are captured well by a one-day diary, but the participation rates of activities following a weekly rhythm will be much lower in a one-day data set compared to a multi-day or seven-day data set. So, the participation rates (and the related durations per participant) for visiting friends, doing sports, going to the movies, … will be much lower in a sample of respondents who filled out a one-day diary as compared to a seven-day diary sample. Of course there are activities that follow a monthly rhythm, a yearly rhythm … but given the burden of keeping a diary for a longer period it is important to consider at least the shorter cycles fundamentally structuring daily life, i.e. the day and the week cycle (for arguments, see Zerubavel, 1985).

In general we can conclude that almost all researchers definitely see the advantages of a longer period of observation and the seven-day diary. Critics even argue that one- or two-day diaries are not very valuable. Scheuch (1972), Goodwin (1981) and Pas and Sundar (1995) argue that the high demands of scientific research cannot be accomplished unless multi-day cycles are captured. Evidence for this is found in a number of studies (see Arentze et al., 1997; Glorieux et al., 2008). Longer periods of observation offer better prospects for analyses, especially for the study of rhythms and activity patterns which typically follow cycles of multi-day duration, and which are part of daily life (Gärling, 1998).

If a seven-day diary has so many advantages, why did the EUROSTAT task force not recommend a seven-day diary? What are the main contra arguments? The main objections for enhancing the number observation days have to do with the validity of the data. More concretely, it is argued that a longer period of registration will negatively affect the response rate and the quality of diary-keeping.

In 1983-1984 Hedges (1986) performed an extensive methodological experiment where one-day and seven-day data were gathered in the same study. He did find a much higher response rate for the one-day survey. Gershuny and Robinson (1988) came to the same conclusion for different datasets in the UK, as well as Harvey for various international datasets (1993). Rydenstam (1995) as well as Bagatta (1995) reported a higher non-response in a Swedish and Italian pre-test for the Harmonized European Time-Use Survey as a result of the heavy burdens on the respondents when more than two days were recorded. The same conclusion was found in a pre-test in Korea (Shon, 1999) and in Australian research (Australian Bureau of Statistics, 1988). So, generally it is found that extending the window of observation lowers the response rates.

A second element of importance in the discussion on the number of diary-days is the quality of diary-keeping. Generally it is believed that the longer respondents have to keep a diary, the poorer the quality of these data. One indicator for this is the number of registered activities. Niemi (1983) found in Finish time-use data that the same amount of primary activities were reported on the first two registration days but from the third day on it dropped sharply. Väisänen (2009) used the data of the participating countries in the HETUS-project and found a decline between the first and second registration day (in the HETUS-project the diary days are not necessarily consecutive days).

Some point out that longer periods of observation cause fatigue or diminished motivation (Szalai, 1972; Brög and Meyburg, 1980; Axhausen et al., 2002; Backor et al., 2007). So the increase of the number of diary days will lead to more inaccuracies. Golob and Meurs (1986) among others show evidence of a reduced quality after the second registration day.

Arentze et al., (1997) on the other hand advocate that time-use literature is still not conclusive on this. Specialized transportation surveys show that respondents even report more trips once they are familiarized with the diary recording (Ampt and Richardson, 1994). Gershuny et al (1986) and Harvey (1993) found no real change in more general studies, indicating that there is no strict evidence at hand to conclude that the data quality reduces along the diary days.

Using the Flemish time-use data of 1999 and 2004, in which respondents filled out a diary during 7 consecutive days, we examine some of the advantages of a 7-day diary in comparison to a 2-diary as is recommended in the EUROSTAT-guidelines. We also will investigate whether a longer registration period is harmful for the quality of the data. It is however not possible with our data to test whether a longer period of registration negatively affects the response rate.

2 Data

In 1999 and 2004 the research group TOR of the Vrije Universiteit Brussel conducted a time-use survey in Flanders/Belgium. In 1999 (TOR'99) 1.474 respondents filled in a diary during 7 consecutive days, the 2004 survey (TOR'04) included 1.780 respondents (for more details, see Glorieux et al., 2000; Glorieux et al., 2005).

To test the differences between a 2-day and a 7-day registration, we selected 2 days, one weekday and one weekend day, out of the seven collected diary days. The selection of the 2 days was done with the EUROSTAT-guidelines in mind. The selection of the weekday (Monday till Friday) was not random. If the first day of registration was a weekday, we took this day as the weekday in the dataset. By doing this we created the same conditions for all respondents, i.e. they all have the same difficulties (i.e. learning) at the start of the registration. During the field work, the first registration day was allocated by a controlled random procedure, so the starting days were spread more or less evenly along the entire week (Monday till Sunday). This means that about 2/7 of the respondents started their diary during a weekend day. For them we randomly selected a weekday. The weekend day was randomly selected for all respondents. Using this procedure we constructed a data set containing information on 2 diary days (one week and one weekend day) fully comparable with the original data set covering diaries of the same respondents for a whole week. To enlarge the statistical options the datasets of 1999 and 2004 were pooled. The dataset was weighted (post-stratification) for sex, age and educational level.

2.1 More days, better estimates?

In Table 1 we compare the duration of activities for a 2-day (one weekday and one weekend day) and continuous 7-day registration. None of the differences is statistically significant, which clearly illustrates that the number of diary days does not affect the duration per respondent (doers or not) for these activity clusters on an aggregated level. The standard deviation however is smaller for almost all the estimates based on a 7-day registration (only for 'education' and 'waiting' the difference is not statistically significant), which points to a lower inter-person variance and lower level of measurement error for these calculations.

In Table 2 we compare the participation rates for weekdays, Saturdays and Sundays. The number of registration days does not really affect the participation rates for Saturdays and Sundays. The only difference between both measures is that the estimates in the 7-day data set contain both weekend days and as such the number of observations for both weekend days is double that of the 2-day data set. The participation rates for one weekday as compared to 5 weekdays show large differences. The participation rates for the activity clusters rise alongside the increase of the registration days. This is clearly illustrated in Table 3 showing the cumulative participation rates for a 1 to a 5-day registration (weekdays).

Table 1
Duration per respondent and standard deviation – 2-day vs. 7-day registration (n=3.096)

	Time/resp. 2-day registr.	Time/resp. 7-day registr.	Diff.	S.D. 2-day registr.	S.D. 7-day registr.	Diff.
Paid work	2:59	2:58	-0:01	3:19	2:56	-0:23 *
Housework	2:46	2:44	-0:02	2:13	1:50	-0:23 *
Childcare	0:21	0:21	0:00	0:51	0:45	-0:06 *
Personal care	2:12	2:13	+0:01	0:53	0:43	-0:10 *
Sleep and rest	8:42	8:44	+0:02	1:32	1:15	-0:17 *
Education	0:22	0:22	0:00	1:17	1:11	-0:06
Social participation	1:23	1:23	0:00	1:30	1:07	-0:23 *
Leisure	3:51	3:52	+0:01	2;16	1:54	-0:22 *
Waiting	0:01	0:01	0:00	0:07	0:05	-0:02
Travel	1:02	1:01	-0:01	1:01	0:45	-0:16 *
Other	0:16	0:15	-0:01	0:37	0:23	-0:14 *

* $p < 0,05$

Source: Pooled data of TOR'99 and TOR'04.

Table 2
Participation rates (%) – 1 weekday, 5 weekdays, Saturday and Sunday (n= 3.096)

	Workweek (Mon-Fri)			Saturday	Sunday
	1 day	5 days	Diff.	Diff.	Diff.
Paid work	49.8	62.7	+12.9	+0.2	-0.2
Housework	82.7	95.3	+12.6	-0.9	+1.3
Childcare	21.0	33.1	+12.1	-0.6	-0.2
Personal care	99.0	100.0	+1.0	+0.4	+0.6
Sleep and rest	99.8	100.0	+0.2	+0.2	+0.2
Education	10.8	22.4	+11.6	+0.1	-0.6
Social part.	52.9	86.7	+33.8	+0.1	-1.2
Leisure	93.3	99.7	+6.4	-0.6	+0.2
Waiting	5.0	16.4	+11.4	+0.1	-0.4
Travel	71.6	89.2	+17.6	+2.0	-1.7
Other	35.8	64.8	+29.0	-2.9	-1.8

Source: Pooled data of TOR'99 and TOR'04.

For some activities the increase of the participation rate along a longer registration period is very moderate, as such it does not matter very much whether the participation rate is based on a 1-day or 5-day observation. This is clearly so for 'sleeping and rest', since this is an activity almost everybody does every day. For 'social participation', on the other hand, we observe a clear increase alongside the extension of the period of observation. Of course things are different if we analyse activities more detailed. For the general category 'leisure', the difference

in the participation rate for a 1-day registration and a 5-day registration is relatively small. Almost everybody has some leisure on a daily basis. This does not apply to more specific leisure activities. Sports are a good example. Most athletes do not practice sports every day, but only once or a few days a week, as can be seen in the last row of Table 3.

Table 3
Cumulative participation rates for 1 to 5 weekdays (n=3.096)

	1	2	3	4	5
Paid work	49.8	56.9	59.3	61.2	62.7
Housework	82.7	89.2	91.9	94.1	95.3
Childcare	21.0	25.8	28.9	31.3	33.1
Personal care	99.0	99.9	100	100	100
Sleep and rest	99.8	100	100	100	100
Education	10.8	15.1	18.0	20.8	22.4
Social participation	52.9	69.6	77.7	82.7	86.7
Leisure	93.3	98.7	99.4	99.6	99.7
Waiting	5.0	9.4	12.5	14.1	16.4
Travel	71.6	80.5	84.8	87.2	89.2
Other	35.8	43.6	53.6	59.5	64.8
Sports	6.6	11.4	15.5	18.1	18.8

Source: Pooled data of TOR'99 and TOR'04.

Table 4 gives more examples of activities that do not follow a daily cycle. Even for 'watching T.V.', which is an activity that almost everybody does at least once during the week, the participation rate based on a 1-day diary is much lower. On a random weekday there is a substantial proportion of the population (about 20%) that does not watch T.V.

Table 4
Participation rates – 1 weekday vs. 5 weekdays (n=3.096)

	Workweek (Mon-Fri)		
	1 day	5 days	Diff.
Shopping	30.4	70.6	+132.2%
Sports	6.6	18.8	+184.8%
Recreation	15.7	41.8	+166.2%
Cultural Participation	3.3	13.1	+297.0%
T.V.	79.3	96.3	+ 21.4%

Source: Pooled data of TOR'99 and TOR'04.

Our figures clearly point to the advantage of having estimates based on multiple-day diaries. The longer the observation, the lower the level of measurement error and the more stable the estimates, which is most important for more detailed analyses on specific activities for specific social categories. Due to the lower variance, the R-squares in multi-variate models are

generally higher with data based on 7-day diaries as compared to 2-day diary data. This illustrates clearly some of the advantages of multi-day diaries most researchers we referred to in the previous section, agree on. But what about the quality of the data? Although the evidence on that is less conclusive, a lot of time-use researchers fear that a longer registration period lowers the quality of the registration. In the next paragraph we examine 3 indicators of quality: the number of registered activities, the amount of unregistered time and the proportion of activities starting at exactly the beginning or on the half hour.

2.2 Seven days … less quality?

In general it is believed that a higher number of activities in a diary points to a more accurate registration and as such it is expected that the number of activities declines the longer respondents have to report their activities. Table 5 gives the number of activities registered per day. In the columns the average number of activities is given for the different days of the week, the rows give the averages split up by the starting day of the registration. So, 18,9 in the first cell of the first row means that the respondents who started to report their activities on a Monday, on average registered 18,9 activities on Mondays. Those who started on a Tuesday registered on average 19,6 activities on Mondays, while those who started their diary on a Monday, registered on average 17,0 activities on Sundays (last cell of the first row). The last row gives the average number of activities reported for the 7 different days of the week, pointing out that there are fewer registrations on weekend days. The last column gives the average number of activities registered for the 1st till the 7th day of registration. This is the most important parameter to see whether the quality declines as the registration period continues. Although the differences between the first day and day 3, 4 and 5 are statistically significant ($p < 0,05$), the differences between the number of reported activities from the first to the sixth day remain very small. Only on the 7th day the average number of activities is substantially lower. The differences between the number of activities on day 7 and all the other days, except day 4, are statistically significant ($p < 0,05$). However, the lower number of reported activities on the last day can be attributed to instructions that were unclear to some respondents. All the respondents in the Flemish time-use survey were asked to start their diaries on 8 p.m. on the evening before the first day of registration. The first 4 hours were considered as a sort of learning period and were not included in the data set. Since the instruction was to register activities for 7 days, a part of the respondents believed they had to stop at 8 p.m. of the 7th day, while in fact it was expected to keep the diaries till midnight of this last day (and report the ending time after midnight of the activity that started on the last day). For them, the 7th day only contains 20 hours and thus fewer activities. Apart from this, we see no substantial decline in the number of reported activities in the 7-day time-use data.

Table 5
From day 1 to day 7 – Number of reported activities

Starting day	Mon. n=274	Tues. n=480	Wed. n=558	Thur. n=599	Fri. n=533	Sat. n=458	Sun. n=352	Day	Mean/day
Monday	18,9	19,0	18,5	18,1	18,4	17,5	17,0	*1st*	19,5
Tuesday	19,6	20,3	20,4	20,3	19,7	18,9	18,1	*2nd*	19,3
Wednesday	18,9	18,4	19,5	19,4	19,2	17,9	17,3	*3rd*	19,1
Thursday	19,4	19,7	19,1	19,7	19,5	18,4	17,5	*4th*	19,0
Friday	19,9	19,7	19,8	18,9	19,8	18,9	17,9	*5th*	19,1
Saturday	19,5	19,9	19,9	19,5	18,5	18,6	17,7	*6th*	19,2
Sunday	20,3	20,4	20,3	19,9	20,2	18,5	18,9	*7th*	18,7
Mean/day	19,5	19,6	19,7	19,5	19,4	18,4	17,8		

Source: Pooled data of TOR'99 and TOR'04.

Table 6 gives the amount of unspecified time (periods with no primary activities in the diary) and is organised the same way as the previous Table. The amount of unspecified time is generally interpreted as an indicator of inaccuracy, although it can also be a result of the refusal to report some activities. In the last column of Table 5, we clearly see a higher amount of unregistered time on the first day of registration. The amount of unspecified time is significantly higher ($p < 0,05$) on day 1 as compared to all the other days, which is a clear argument for multi-day diaries. On the other hand, there is also a tendency of increased unspecified time on the 6^{th} and the 7^{th} day (the amount of unregistered time is significantly lower ($p < 0,05$) on day 6 and 7 as compared to both day 3 and 4). For the last day of registration, the amount of unspecified time is overestimated in the Flemish time-use data due to the already mentioned indefinite instruction about ending the registration.

Table 6
From day 1 to day 7 – Unspecified time in minutes

Starting day	Mon. n=274	Tues. n=480	Wed. n=558	Thur. n=599	Fri. n=533	Sat. n=458	Sun. n=352	Day	Mean/day
Monday	23	10	16	9	14	17	15	*1st*	24
Tuesday	16	28	9	8	15	12	17	*2nd*	13
Wednesday	15	18	28	14	5	9	16	*3rd*	11
Thursday	10	23	10	25	16	13	8	*4th*	11
Friday	15	11	13	16	20	14	13	*5th*	12
Saturday	10	10	8	14	18	24	14	*6th*	16
Sunday	12	11	11	14	10	11	18	*7th*	15
Mean/day	18	23	23	24	22	16	13		

Source: Pooled data of TOR'99 and TOR'04.

The Flemish time-use surveys use open interval diaries. This means that respondents report the starting and ending time of the activities themselves. Although part of the daily activities

are strictly scheduled to start at the beginning of a new hour (XX:00) or at half an hour (XX:30), most activities do not start at exactly round hours. Rounding time in the registration of activities can be interpreted as an indicator of lower quality.

In Table 7 (organized the same way as Tables 5 and 6) gives the proportion of activities of which the starting and/or ending time is exactly the round hour or half hour. We see no indication for a decline of the quality of the registrations as the number of diary days increases (see last column of Table 7). There are no statistically significant differences ($p < 0,05$) between the diary days for the proportions of activities starting and/or ending at exactly the round or half hour.

Table 7
From day 1 to day 7 – % activities starting and ending at XX:00 or XX:30

Starting day	Mon. n=274	Tues. n=480	Wed. n=558	Thur. n=599	Fri. n=533	Sat. n=458	Sun. n=352	Day	Mean/day
Monday	22,0	17,3	20,4	21,6	20,5	22,1	19,2	*1st*	20,8
Tuesday	20,5	19,4	19,9	16,2	19,4	21,4	20,4	*2nd*	20,8
Wednesday	21,0	19,9	21,0	19,7	20,4	16,3	20,2	*3rd*	21,0
Thursday	17,2	20,0	20,7	20,4	20,7	20,0	20,0	*4th*	21,3
Friday	20,8	20,1	16,5	19,4	22,0	20,2	21,6	*5th*	21,3
Saturday	22,3	24,6	23,6	22,6	19,0	22,0	24,2	*6th*	20,9
Sunday	22,4	22,4	20,4	24,1	23,2	24,2	18,8	*7th*	20,2
Mean/day	20,5	19,8	19,9	20,0	20,3	22,8	23,0		

Source: Pooled data of TOR'99 and TOR'04.

3 Conclusion

Our analyses clearly confirm the alleged advantages of multi-day diaries. Longer periods of observation clearly lead to better data and to more accurate estimates. They are also more suited for the study of rhythms and activity patterns of activities that do not follow a daily rhythm. On the other hand we did not find many indications that extending the period of registration leads to a deterioration of the quality of the data. The amount of unspecified time might be somewhat higher on the 6^{th} and 7^{th} registration day, but this is equally true for the first day of registration. We did not find less reported activities as the period of registration continues, nor a decrease in the accuracy of the registration of the beginning and ending time of the reported activities. In general, we see more arguments for changing the recommendation concerning the number of days into 7 consecutive days than to keep it to two diary days. To be able to capture the socially relevant week cycle, we would recommend 7-day diaries. There is only one argument left not to follow this recommendation, i.e. the increase of non-response rates. With our data, it is not possible to investigate the effect of longer registration periods on non-response rates. Therefore, we think it would be good to examine the effects of multi-day diaries on non-response further and to test procedures and formats to reduce non-

response rates and to make longer periods of observation feasible. We strongly believe Andy would agree on this.

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