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contents

Jutta M. Joesch and Katharina Spiess: European mothers' time spent looking after children - Differences and similarities across nine countries 1

Mette Deding and Mette Lausten: Choosing between his time and her time? Paid and unpaid work of Danish couples 28

Jay Stewart: Assessing alternative dissimilarity indexes for comparing activity profiles 49

Lyn Craig: Do time use patterns influence fertility decisions? A cross-national inquiry 60

Mary Fraire: Muliway data analysis for comparing time use in differentcountries - Application to time-budgets at different stages of life in six European countries 88

Jorge Gonzalez-Chapela: On measuring heterogeneity in the use of time 110

Time-pieces 120

- New developments in time-technology – Projects, data, computing, services 120
- Book notes by Kimberly Fisher 123

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European mothers' time spent looking after children - differences and similarities across-nine countries

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Abstract

We describe and compare how many hours per week mothers reported looking after children in nine European countries in 1996. In addition, we explore to what extent cross-country differences in socio-demographic characteristics and parental employment contribute to differences in maternal time spent looking after children. The data are from the 1996 wave of the European Community Household Panel for mothers with children under 16 years of age. We find cross-country differences in the mean number of hours mothers reported looking after children. Only a small portion of these differences is explained by variation in socio-demographic characteristics and employment status. Country-specific policies aimed at reconciling parenthood and employment appear to explain some of the differences.

JEL-Codes: D13, J13, J22

Keywords: Time allocation, time with children, cross-national analysis

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1 Introduction

Few studies have investigated how much time parents in Europe spend with their children. Fewer studies have investigated whether the amount of time differs from country to country. As more mothers have entered the labour force and more children are living with single parents, there is concern with how children are cared for. Time with parents is considered an investment in children and is thought to be crucial for children's cognitive and social-emotional development and educational outcomes. Indeed, some regard the time parents devote to children an important form of intergenerational transfer of wealth (e.g. Hill and Stafford, 1985).

In this paper, we document and compare how many hours per week mothers of children less than 16 years of age reported looking after children in nine European countries in 1996[1]. Developing policies aimed at supporting families and women's employment will be aided by knowledge of the amount of maternal time spent looking after children. Additionally, understanding what socio-demographic factors and employment factors are related to the amount of time mothers spend with children is important. Finally, investigating differences in maternal time with children across countries is a step towards understanding the impact of policies aimed at supporting families and employment.

The data for the study are from the 1996 wave of the European Community Household Panel (ECHP). The European Community Household Panel collects information from nationally representative samples of households in 14 European countries. We use data from 9 countries and from households in which all children were under 16 years at the time of the survey.

We find considerable differences across the nine European countries in the amount of time mothers reported looking after children. However, only a very small amount of these differences is explained by differences in socio-demographic characteristics and employment status.

2 Mothers' time with children

Most empirical investigations on the allocation of parental time to children have been conducted with national data sets from single countries and mostly for countries other than those in Europe. Some recent examples include a study for Australia by Miller and Mulvey (2000), a study for Canada by Gauthier et al. (2001), and studies for the United States by Bryant and Zick (1996a/b), Bianchi (2000), Sandberg and Hofferth (2001), and Sayer, Bianchi and Robinson (2004). For Europe, studies with a focus on time spent in domestic tasks are available

[1] We focus on mothers' time with children, as in all European countries mothers are typically children's primary caregivers.

for Finland (Kirjavainen and Barclay, 1990), Sweden (Gustafsson and Kjulin, 1994, Klevmarken and Stafford, 1999, Hallberg and Klevmarken, 2002), Switzerland (Sousa-Poza, Schmid and Widmer, 2001), and the United Kingdom (Jenkins and O'Leary, 1995). The European studies are based on data gathered with a variety of instruments, at different points in time, and from samples with different compositions. The studies also use different definitions of domestic work, not all of which include the care of children. As such, these studies are not well suited to describe and compare how much time European mothers spend caring for children and to examine why the amount of time may differ from country to country. However, previous time-use studies provide useful information to guide our cross-country comparison.

Only recently has it become possible to examine time spent caring for children across countries due to new data sets, such as the European Community Household Panel (ECHP), the Multinational Time Use Study (MTUS), and the European Harmonized Time Use Survey[2]. The MTUS combines national time-use data collected in industrialized countries since the 1960s. Gauthier, Smeeding and Furstenberg's (2004) analysis of the trend in parental time is based on the MTUS. The authors report mothers continue to devote more time to childcare than fathers, but the gender gap has become smaller. Eurostat has undertaken efforts to harmonise European time use studies conducted between 1998 and 2002 resulting in the European Harmonized Time Use Survey. Descriptive results based on their collection of national time use surveys can be found in Eurostat (2004). Ten countries are included in this analysis. It is reported on an average day mothers spent six to eight ½ hours with children. While both studies are based on time diaries, they are limited in that they were not collected with exactly the same instrument for each country in the studies.

The ECHP is based on a harmonized survey concept. Studies based on the time use information available in the ECHP include an analysis of paternal time by Smith (2004), and an examination of the correlation between self-employment and caring for children by Hildebrand and Williams (2003). The latter test the hypothesis whether self-employed workers spend more time caring for children than others. Their results provide little support for this hypothesis. Smith (2004) examines the time fathers spent looking after children. Her results show some socioeconomic characteristics are positively associated with paternal time, namely, education level, a working spouse, the number of children, and working part-time. Working in the private sector and working in small- and medium-sized businesses are negatively associated with paternal time.

The goal of our cross-country comparison is to gain insights into reasons for differences in maternal time spent looking after children. We conduct a multivariate analysis with correlates of time use that may differ across countries to examine to what extent these correlates are associated with cross-country differences. For instance, infants require more time than older children. Thus, if the age distribution of children varies from country to country, we would

[2] The ESRC Research Centre on Micro-social Change provides an overview of national and international time use studies that are comparable (http://www.iser.essex.ac.uk/misoc/timeuse/)

expect to observe country differences in the average amount of time spent by mothers looking after children.

Our selection of correlates of maternal time with children is guided by the neoclassical microeconomic model of the household (e.g. Becker, 1981) and extant empirical time use studies. The microeconomic model of the household is premised on the notion that individuals attempt to generate well-being for themselves and their family by allocating limited financial and time resources in accordance with their preferences and available technology. In the specific focus of this study, mothers are thought to derive satisfaction from bringing up and enjoying well-ladjusted children, from consuming market- and home-produced goods and services, and from non-work time. Realizing these goals requires mothers to make decisions about the amount of time spent caring for children versus earning money, and about the type and amount of goods and services to purchase versus produce at home. Making these decisions involves trade-offs, since limited resources compete for alternative uses. According to this framework, how much time a mother spends with her children depends on the price of her time, the prices of goods and services used, technology, the family's financial resources, and the mother's preferences. We next present the correlates of mothers' time spent looking after children that are included in our multivariate analysis.

3 Correlates of time with children

Number and ages of children. How old her children are plays a central role in a mother's decision on how much time to spend with them. A small child greatly enhances the value of a mother's time spent at home by creating more opportunities for joint production and economies of size. As children grow up, they become more goods- rather than time-intensive. This influences the trade-off between working at home and employment. While children are young and more time-intensive, they reduce women's incentive to engage in paid work and find substitute care until the children are more independent (Bryant, 1990). In addition, most parents' preferences are such that they want to do what is best for their children. Children's physiological, cognitive and socio-emotional needs vary by age, and their changing needs influence the kind of care that is most appropriate. There is evidence that parents select different types of child care depending on the child's age (Blau, 1991; Leibowitz, Waite and Witsberger, 1988; Ondrich and Spiess, 1998; Veum and Gleason, 1991). For example, young children are more likely than older children to be cared for exclusively by their parents. Thus, we expect a negative relationship between the amount of time a mother spends looking after children and the age of her children, all else equal. Several earlier time use studies report that the amount of time parents spend with child care decreases as children become older (e.g. Douthitt, 1989; Gustafsson and Kjulin 1994).

Further, the more children in a family, the more opportunities there are for joint production and economies of size, enhancing the value of the mother's time spent at home. In addition,

the more children, the more financial resources parents have to give up to use substitute care. Thus, we expect a positive relationship between the number of children in a household and the amount of time the mother spends with children. This expected relationship has been reported in previous empirical time use studies on domestic work (e.g. Jenkins and O' Leary, 1995; Miller and Mulvey, 2000; Sousa-Poza, Schmid and Widmer, 2001).

Several factors address the availability of substitutes for the mother's time: the number of adults in the household other than the partner, the mother's marital status, and her partner's employment status. By considering the father's employment status as a correlate of mothers' time use, we follow the literature in assuming that the father's employment decision is exogenous to the mother's child care and employment decisions (e.g. Blau and Hagy, 1998; Michalopoulos and Robins, 2000; Michalopoulos et al., 1992). This assumption may be inappropriate for some households. Empirical evidence from the U.S. suggests that it was adequate in national data (Mroz, 1987) in the past.

Adult family members. Adults who share a household with a family are a potential source of child care. Thus, one might expect mothers to spend less time with children, the more adult family members there are. At the same time, not every adult is a qualified provider in the eyes of the parents or is available as a caregiver. Women tend to be called upon more for child care duties than men, but many women are now in the labor force, and thus not available. While grandparents may be less likely to have employment responsibilities, they may have other restrictions that limit their ability to help with child care, such as health problems.

Mother's marital status. Single mothers do not have a partner with whom to share household tasks. One, might, therefore, expect single mothers to have less time for their children, than otherwise similar mothers who live with a partner. There is some evidence of a negative relationship between being a single parent and the amount of time spent with domestic work. However, estimates of the relationship between being a single parent and amount of time spent caring for children are mixed. The relationship is not statistically significantly different from zero in some studies (Miller and Mulvey, 2000; Sousa-Poza et al., 2001), and negative in another (Sandberg and Hofferth, 2001). According to Gauthier et al. (2001), single mothers who have at least one child under five spent more time with children than married, employed mothers, but less time than married, non-employed mothers.

Father's employment status. When an employed father lives in the household, he obviously has less time available to take care of children, or share other domestic tasks, than when he is not employed. Gustafsson and Kjulin (1994) report that women whose husband works spend more time with child care, ceteris paribus.

Mother's education level. The mother's education level may affect time use through its impact on productivity in generating home produced goods and services, lifestyle preferences, and attitudes and values. Mothers with different educational backgrounds may also bring different aspirations to child rearing. Some extant time use studies found more highly educated

mothers to spend more time with their children (e.g. Hill and Stafford, 1985; Leibowitz, 1974; Sandberg and Hofferth, 2001), holding other factors constant.

Mother's age. Older mothers' preferences towards time with children may differ from those of younger mothers, due to differences in values and knowledge influenced by different and additional life experiences. In addition, more experience with household tasks is likely to increase household productivity, which may, in turn, influence the amount of time spent looking after children, ceteris paribus.

Evidence on the relationship between mother's age and time with children is mixed. According to at least one study, there is a negative relationship between mother's age and time spent with children (Gustafsson and Kjulin, 1994). Others find an inverted U-shaped pattern that indicates that younger and older women allocate less time to child care than women between 25 and 34 years of age (Miller and Mulvey, 2000). Yet others do not find a relationship that differs from zero (Sousa-Poza et al., 2001). All three studies took into account the ages of children who live in the household. As such, the mixed findings are unlikely the result of a life-cycle effect.

Mother is "foreign". There are cultural differences in attitudes towards child rearing. Thus, mothers who are not native to the country in which they reside may have different attitudes than native mothers towards spending time with children. In the case of Switzerland, Sousa-Poza et al. (2001) find that foreign women tend to spend more time on housework than Swiss women. However, with respect to time spent caring for children, their estimate distinguishing foreign and Swiss mothers is not statistically significantly different from zero.

Family financial resources. If child care time is a normal good, it increases with increasing income; it decreases if child care time is an inferior good, all else constant. Thus, if a mother considers caring for children herself more appropriate or desirable, we would expect her to spend more time with children, the more financial resources her family has, ceteris paribus. In addition to taking into account family income other than the mother's, we include the mother's earnings in our empirical model. As in the case of family income other than the mother's, a mother who earns more money than an otherwise comparable mother has more opportunity to spend time with children. She may, for example, opt to free up the time she spends with household chores by getting help cleaning the house or relying on other time saving devices.

Household technology. Housework-related technology provides mothers with the opportunity to free up some of their time from household chores and have it available to spend with their children, instead. However, according to Gustafsson and Kjulin's (1994) results for Sweden, owning a dishwasher was not statistically significantly related to the amount of time mothers spent caring for children.

Mother's employment status. Considering the concern and interest in the impact of mothers' employment on time spent looking after children, we include measures of the mother's employment status in our empirical analysis. Since there are only 24 hours in a day, otherwise comparable mothers, who are employed, have less time to devote to the care of their children

than mothers who do not work for pay. Self-employment can offer more flexibility with respect to arranging one's schedule. A mother who is self-employed may, for example, choose to do some of her work while her children sleep, to have more time with them during the day, than a mother who works a standard schedule, everything else the same. Nevertheless, even a self-employed mother has fewer hours in the day available to care for her children than a mother who is not employed.

Not surprisingly, employment status is, indeed, a significant correlate of child care time in, for instance, Douthitt's (1989) study of Canadian data, Kirjavainen and Barclay's (1994) comparison of Finish and U.S. households, Bryant and Zick's (1996a) study of historical trends in the time spent caring for children in the U.S., and Sandberg and Hofferth's (2001) analysis of changes in children's time with parents in the U.S. between 1981 and 1997. At the same time, Gershuny and Robinson (1988) report for the U.S., that although employed mothers spend less time in child care than non-employed mothers, between the 1960s and 1980s there has been an increase in the amount of time employed mothers spend with their children. Bryant and Zick (1996a) also conclude that, even after taking into account mothers' increased attachment to the work force, U.S. mothers in two-parent families spent more time on child care per child by the early 1980s than in the mid-1920s.

The economic model sketched above suggests that the amount of time a mother spends in market work versus looking after her children are simultaneously determined. In contrast, estimating a model of time with children as a function of the mother's actual employment status implicitly assumes that the employment and child care time decisions are not made simultaneously, but that instead the mother decides how much time to spend in paid employment first before she decides how much time to devote to caring for children.

4 Methods

4.1 Analysis sample

Our analysis is based on data from the European Community Household Panel. The ECHP is a large-scale survey organized and funded by the European Union[3]. The purpose of the ECHP is to gather individual-level information comparable across European countries. Topics of interest include: employment and unemployment experiences, earnings, household wealth, household expenditures, and household living conditions. The first wave of ECHP data was collected in 1994 in twelve countries of the European Union. Additional waves covering up to 15 countries were conducted annually in subsequent years. The most current wave of data available at the time we conducted our analysis was collected in 1996. In 1996, the following countries participated in the survey: Austria, Belgium, Denmark, Finland, France, Germany,

[3] For further details see EUROSTAT (1996a,b), Clémenceau and Verma (1996), Wirtz and Mejer (2002), http://forum.europa.eu.int/Public/irc/dsis/echpanel/library.

Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, and the United Kingdom.

The ECHP data have several advantages. One, in each country, the ECHP sample is nationally representative of the same population of interest, namely, all private households in the national territory. Two, the country-specific samples are relatively large. The number of households, who participated in the 1996 survey, range from 933 in Luxembourg to 7,132 in Italy. Three, information on time spent looking after children is collected from all mothers, rather than a subset of mothers, such as employed women. Finally, and most importantly, it was intended to conduct the interviews with standardized questionnaires to make the data directly comparable across the participating countries.

For the analysis sample, we selected households in which all children were under 16 years at the time of the survey. From the remaining sample we excluded a small number of cases (less than five per country) in which more than one mother or more than one father resided in the household, to avoid an ambiguity in the data on how parents and children in the household are related.

Missing data reduced the sample usable for analysis. Specifically, 175 cases had incomplete information on time spent looking after children. A total of 259 additional cases had missing data on one or more of the following: income, work hours, self-employment status, education level, marital status, and number of adults living in the household.

In a few countries, a considerable portion of mothers in the ECHP reported not spending any time looking after children under 16 years of age as part of their normal daily activities. These countries are: Belgium, Finland, France, and Portugal. The ECHP is not the first European survey to find such a result. Sousa-Poza, Schmid and Widmer (2001) report 14% of females with children under the age of 14 did not spend any time on child care, according to the 1997 Swiss Labour Force Survey. Gustafsson and Kjulin (1994) note that more than 50% of the households in their Swedish sample have a value of zero for time spent on child care[4]. While it is possible that some mothers spend very little time looking after children, especially when the children are older, we were, nevertheless, concerned about the relatively large percentage of mothers who reported not spending any time looking after children in these four countries. Further investigation revealed that, despite intentions to the contrary, the ECHP time-use questions were not equivalent across all countries. We therefore excluded from the analysis the four countries for which the survey questions on time spent looking after children did not appear comparable[5]. In addition, in Italy time spent looking after children was top-coded at 70 hours/week rather than 96 hours/week, as in all other countries. As this top-coding impacts

[4] However, it is not clear from Gustafsson and Kjulin's manuscript whether the percentage is this large for households with at least one child under the age of twelve years. We note that survey design and interview questions influence how many survey respondents report spending no time with a particular activity. The results reported in Sousa-Poza, Schmid, and Widmer and Gustafsson and Kjulin are mentioned to illustrate that other studies have found zero time spent on child care. The percentages of no responses in these studies are not comparable with ECHP data results.

[5] The English working of the question on time spent looking after children is provided in Table 1.

the mean time spent looking after children, we also had to exclude Italy from the analysis. Our final sample consists of 7,186 cases.

4.2 Measure of time reported looking after children

Information on time use is typically collected in one of three ways: with time sampling, with time diaries, or with retrospective survey questions. In time sampling, study participants are asked to record the activities they are engaged in when a beeper or similar device goes off. While time sampling provides valid information on how individuals spend their time, the data collection approach is costly and intrusive. In the case of diaries, study participants are asked to record in detail in time diaries that cover 24-hour time periods how they spend their day, including activities that may take as little as five minutes. Diaries have been shown to provide valid and reliable information on time use (Gershuny and Robinson, 1988; Juster and Stafford, 1991). However, cost considerations have limited the use of time diaries for data collection. Retrospective survey questions are the most common method for collecting time use information. In this approach, respondents are asked to recall how much time they spent during a particular time period in certain activities. In some cases this approach has been shown to generate inaccurate time use information (Juster and Stafford, 1991).

The ECHP collected information on time spent looking after children through retrospective survey questions. Each household member 16 years of age and older was asked whether their normal daily activities, apart from any job or business, includes looking after children without pay, and the weekly amount of time spent in this activity. The questions did not distinguish between the physical and non-physical care of children, or between direct care or adult-child shared time. Adult-child shared time refers to activities other than the direct care of children, such as children helping parents with household tasks. In addition, the ECHP survey did not collect information on the amount of time each adult spent looking after each child in the household, but rather on the total amount of time each adult spent caring for children per week. Thus, the measure of mothers' time with children in the ECHP is not optimal, as far as time use researchers are concerned. On the other hand, to the best of our knowledge the ECHP is the only data source with ex ante input harmonized time use information based on recent, nationally representative samples from several European countries. The additional European time use data mentioned earlier provide ex post harmonised time use information, and differ in their approaches to measuring time use. Because we focus on a cross-country comparison of mothers' time with children, it should be possible to explore differences in time use, as long as the survey questions regarding time-use are comparable.

4.3 Measures of correlates of time reported looking after children

As noted, in addition to describing how much time mothers in nine European countries reported looking after children, we explore possible reasons for observing differences. We begin this exploration by comparing the average amount of time mothers in different countries spent looking after children, after controlling for country differences in socio-demographic

factors. To the extent that socio-demographic population characteristics differ from country to country, these characteristics may contribute to observing differences in maternal time use in the nine countries. We address the number and ages of children in the household, the number of adults who live in the household, family financial resources, the father's employment, the mother's marital status, education level and age, whether the mother is "foreign", and whether the household has a dishwasher. The variables are summarized in Table 1. Descriptive statistics can be found in Appendix 1.

Table 1
Definition of variables

Variable	Definition
DEPENDENT VARIABLE	
Mother's Time with Children	Hours/week mother reported looking after children without pay, as part of her normal, daily activities apart from any job or business. The English version of the ECHP questions on time spent looking after children is as follows: "*Apart from any job or business, normal activities may include other tasks such as looking after children or other persons. I would like to ask a few questions on such activities. Do your present daily activities include looking after children, whether your own or other, without pay? Roughly how many hours per week do you spend looking after children?*"
COVARIATES	
Mother	
Age	
17-24 years	1 if mother is between 17 and 24 years old, 0 otherwise
25-29 years	1 if mother is between 25 and 29 years old, 0 otherwise
30-34 years	Omitted reference category for mother's age
35-39 years	1 if mother is between 35 and 39 years old, 0 otherwise
40-44 years	1 if mother is between 40 and 44 years old, 0 otherwise
45-67 years	1 if mother is between 45 and 67 years old, 0 otherwise
Education	
Low	Omitted reference category for mother's education
Medium	1 if mother has completed secondary education (ISCED 3) that began when she was 14-15 years old and that lasted about 3 years, 0 otherwise
High	1 if mother has completed secondary education (ISCED 5-7) that began when she was 17-18 years old, and either (1) lasted at least 3 years and lead to university or postgraduate degree; or (2) lasted about 4 years and lead to an award not equivalent to first university degree, 0 otherwise

Table 1 (cont.)
Definition of variables

Variable	Definition
Employment Status	
Not in labour force	Omitted reference category for mother's employment status
Employed part-time	1 if mother works 29 hours/week or less, 0 otherwise
Employed full-time	1 if mother works 30 or more hours/week, 0 otherwise
Self-employed	1 if mother is self-employed, 0 otherwise
Foreign	1 if mother's nationality differs from the country of residence, 0 otherwise
Single Parent	1 if mother does not live with a partner, 0 otherwise
Variable	Definition
Father	
Employment Status	
Hours worked/week	Number of hours father worked per week
Self-employed	1 if father is self-employed, 0 otherwise
Household Characteristics	
Youngest Child	
< 1 years	1 if youngest child in household is less than 1 year old, 0 otherwise
1-2 years	1 if youngest child is between 1 & less than 3 years old, 0 otherwise
3-5 years	1 if youngest child is between 3 & less than 6 years old, 0 otherwise
6-12 years	1 if youngest child is between 6 & less than 13 years old, 0 otherwise
13-15 years	Omitted reference category for youngest child's age
Number of children	
Beyond 1 child	0 if HH has 1 child, number of children minus 1 otherwise
Beyond 2 children	0 if HH has 1 or 2 children, number of children minus 2 otherwise
Household Size	No. of persons 18 years of age or older, other than parents, who live in household
Income	
Work Income	Yearly household income from work, net of mother's earned income
Non-work Income	Yearly household income from sources other than employment
Dishwasher	1 if household has dishwasher, 0 otherwise

Source: Own definitions.

We represent the number and ages of children who live in the household with several variables, to allow for joint production and economies of size, as well as for differences in care intensity by the child's age. The variables measure whether the youngest child is less than 1 year, between 1 and 2, 3 and 6, or 6 and 12 years old, 1 minus the number of children in a family beyond 1 child, and 2 minus the number of children in a family beyond 2 children. The latter two measures address economies of size with splines. With this specification it is possible, for instance, that a second child in the family has a different effect on mother's time spent looking after children than a third child.

Marital status is measured with a dummy variable that indicates whether the mother is a single parent. The number of adults includes adults who live in the household other than the parents. We account for the mother's education level with two dummy variables: whether the mother has a "high" education level and whether the mother has a "medium" education level. The measures of education available in the ECHP are based on the categories developed by ISCED (the International Standard Classification of Education)[6]. We measure the mother's age with 6 dummy variables that cover the age groups 17-24, 25-29, 35-39, 40-44, and 45-67 years; the age group 30-34 years is the reference category. Whether the mother is "foreign" is represented with a dummy variable that reflects whether the mother's nationality differs from the country in which she resides. Similar to Gustafsson and Kjulin (1994), we measure household technology with a dummy variable that indicates whether the household has a dishwasher. Family financial resources measure: (1) yearly household income from work net of the mother's, and (2) yearly non-work household income. Both figures are expressed in Euro. We address the father's employment status with a measure of the number of hours he worked per week and whether he is self-employed.

After we present information on the average amount of time mothers reported looking after children in the nine countries, controlling for socio-demographic factors, we expand the multivariate model with measures of the mother's employment status. Mothers' employment decisions are influenced by policies related to parental leave regulations, the tax treatment of the "wife's" earnings, the availability and price of child care, children's school schedules (e.g. Gornick, 1997), to name a few. In our analysis, we are not able to disentangle these effects. However, we include in the multivariate model measures of her employment status, namely whether she works part-time (< 30 hours/week), full-time, and whether she is self-employed. We opted for dummy variables, rather than a continuous measure of work hours, because a considerable number of the mothers were not employed at the time of the interview.

4.4 Estimation approach

A small number of mothers reported not spending any time with children. In addition, time spent looking after children is top-coded at 96 hours per week. As a result, the outcome measure for the multivariate analysis is a limited-dependent variable. Consistent with prior anal-

[6] See http://www.uis.unesco.org/en/act/act_p/isced.html

yses of time use (e.g. Gustafsson and Kjulin, 1994; Sousa-Poza, Schmid and Widmer, 2001), we estimated Tobit models of the time mothers reported looking after children. To account for left- and right-censoring, we estimated two-limit tobit models. We estimated a separate model for each country, after we estimated and rejected joint models with country-unique intercepts and common slope parameters.

To compare the amount of time mothers reported looking after children across the nine countries, controlling for differences in socio-demographic and employment characteristics across countries, we predicted average times for a "synthetic" sample of mothers. For each country, the predicted mean represents the average amount of time mothers in country i would spend looking after children, if they had socio-demographic and employment characteristics representative of the mothers from the nine European countries. To construct the synthetic sample, we first pooled the country-specific ECHP data. We then randomly selected 200 households from each of the nine countries, for a total of 1,800 households. In the next step, we predicted for each country, based on its multivariate results, time reported looking after children based on data from the 1,800 households in the synthetic sample.

5 Results

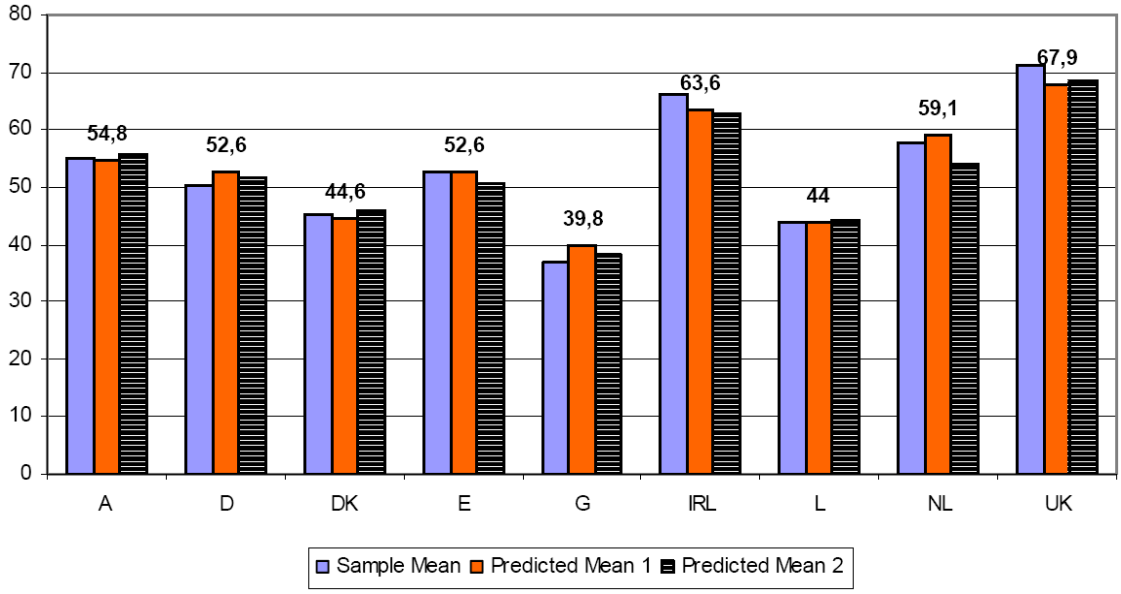
5.1 Mean hours/week European mothers reported looking after children

The first row of numbers in Appendix 2 represents the mean amount of time per week mothers reported looking after children in 1996 by country. The means in the nine countries range from a minimum of 37 hours per week to a maximum of 71 hours a week. This is a considerable difference, even when one considers that these estimates do not take into account differences in the number of children across countries, or how old the children are, two factors central to the amount of time spent looking after children.

5.2 Predicted mean hours/week looking after children: synthetic sample

Figure 1 displays the sample means together with two predicted means. Predicted mean 1 represents the average amount of time mothers in each country would have spent looking after children in 1996, had they had the socio-demographic characteristics of a sample of mothers representative of the nine European countries. Predicted mean 2 includes, in addition, mothers' employment status. The three sets of means and standard deviations for each country are also reported in Appendix 2.

Figure 1
Hours/week reported looking after children in 1996:
sample and predicted means from 9 European countries



Source: European Community Household Panel (ECHP), own illustration.

Several results of interest emerge from a comparison of the sample and predicted mean values. One, the first predicted means do differ somewhat from the sample means, that is, controlling for socio-demographic characteristics makes a difference. The differences range from less than one minute per week to over 3 hours per week. For instance, if mothers in Ireland had socio-demographic characteristics representative of mothers in the nine European countries, on average, they would spend an estimated 2.7 fewer hours per week with children, than the mothers who lived in Ireland in 1996.

Two, adjusting for mothers' employment status changes the differences across countries some. To continue the earlier example of Ireland, the gap in the difference in time spent looking after children by mothers in Ireland versus mothers in the nine countries increases to an estimated 3.6 hours after mothers' employment status is considered. In contrast, for mothers in the U.K., the time gap decreases from 3.3 to 2.7 hours per week compared to mothers with characteristics of the nine countries.

5.3 Multivariate tobit results

Appendix 3 shows two sets of Tobit results for each country: estimated coefficients and standard errors for socio-demographic characteristics (Model 1), and for socio-demographic and maternal employment characteristics (Model 2). According to these results, the estimated coefficients for the age of the youngest child have the largest absolute values. The coefficients are consistently significantly different from zero and positive. In addition, the younger the youngest child, the larger the estimated coefficient. The estimates for whether the mother is employed part-time or full-time are negative and significantly different from zero, with the

exception of one estimate. Moreover, the estimates are more negative for full-time employment. There is no consistent pattern for the coefficient estimates of the remaining variables and many are not statistically significantly different from zero.

6 Discussion

In this paper, we present and compare the amount of time mothers in nine European countries reported looking after children under 16 years of age in 1996. The findings suggest there are differences across the nine countries. When we take into account differences at the micro-level, that is, socio-demographic characteristics and parental employment status, the cross-country differences in time mothers reported looking after children are not well explained.

There are several reasons why the differences across countries may not be well explained. Beginning with the measure of time spent looking after children, it is still possible that the ECHP interview questions used to elicit time use information are interpreted differently by respondents from different countries, despite extensive effort by Eurostat to achieve "input harmonization". Related to this point is the possibility that social desirability influenced mothers' reports of time spent looking after children. If there are cultural differences in attitudes about child rearing, it is likely that the extent of social desirability differs systematically across countries, influencing the time reported spent looking after children. According to the European Harmonized Time Use Survey (Eurostat, 2004), mothers in the UK also spent more time with their children than mothers in Germany (about 58 versus 46 hours per week. We are not aware of any other study that covers a reference year close to the one analysed here and that includes more than two of the nine countries represented in the current analysis.

If the measure of time spent looking after children is comparable across countries, the socio-demographic and employment characteristics we considered in the multivariate model are not well suited to explain differences in the amount of time mothers reported looking after children. There are two obvious domains that are not captured by our multivariate models: cultural differences with respect to child rearing and differences in policies that may impact parents' employment and child care decisions.

The nine European countries do in fact differ with respect to such policies. For instance, Germany and Austria are both countries that offer relatively extensive parental leave periods (Missoc, 2006; Gornich and Meyers, 2003). However, as the percentage of mothers with children in the appropriate age groups is relatively small in the countries considered in this analysis (see Appendix 1), differences in parental leave policies can hardly explain the differences in time reported looking after children across the countries.

Another policy explanation might be the provision of child care. Among the countries included in our analysis, child care provision rates are highest in Denmark (this is true for children in all age groups); whereas countries such as Ireland, Greece and Spain are characterized by substantially lower child care provision rates (OECD, 2001). To the extent that the avail-

ability and cost of child care influence mothers' employment status, this effect is included indirectly in our analysis. However, if parents who have the option to use child care do so when the mother is not employed, it could explain some of the variation in time reported looking after children across the countries[7]. For mothers with older children, differences in school schedules might play a role in explaining cross-country differences. In Germany and Austria, for instance, children usually go home for lunch (Gornick and Meyers, 2003), which most probably increases the time mothers reported looking after children.

Working time regulations also differ across Europe. While we control for the mother's fulltime and part-time work status, we do not have information on the extent mothers can arrange their work hours during the day due to flextime policies (Gornick and Meyers, 2003). Mothers with more flexible schedules can more easily combine work and family life. Among working mothers, we would expect that those with access to more flexible work hours spend more time looking after children. However, to the extent that flextime induces women to enter the labor force, it will decrease the amount of time mothers spend with children. Countries with relatively "family-friendly" work schedules are the Netherlands and the Scandinavian countries. Mothers' labour force participation rates are much higher in the Scandinavian countries, and mothers are also considerably more likely to work full-time in the Scandinavian countries than in the Netherlands.

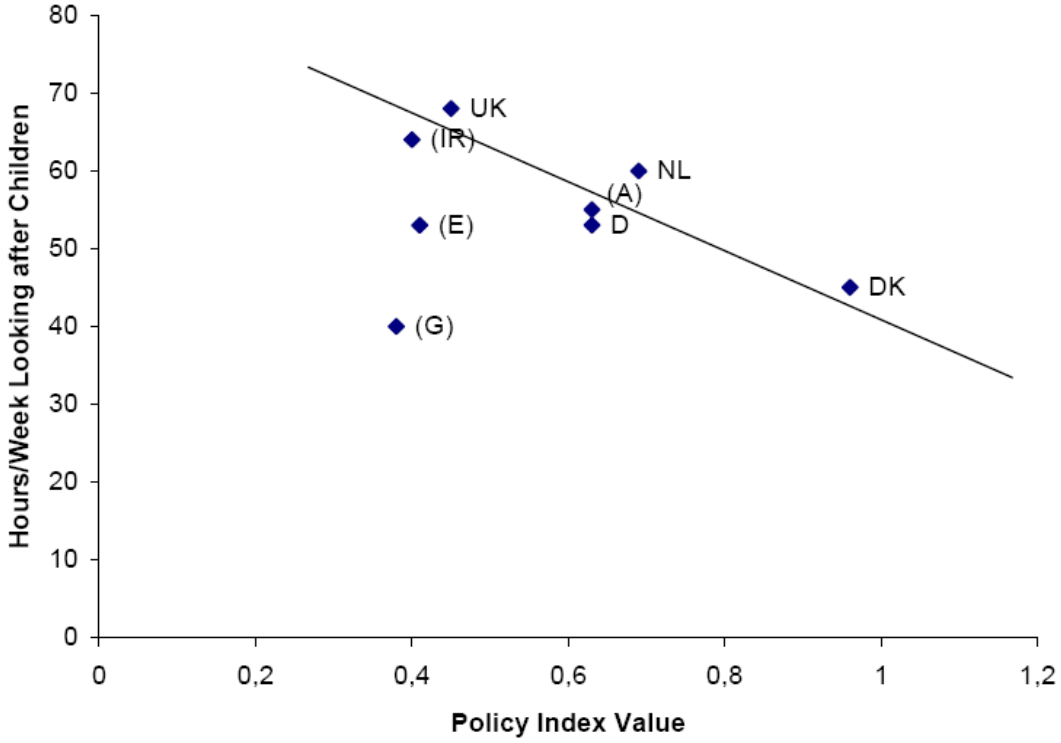
As these examples demonstrate, one particular policy directed at combining parenting and employment is unlikely to explain the observed differences in time spent looking after children across the nine countries. What is needed instead is a measure that captures the mix of policies available in each country aimed at reconciling employment and parenthood. Welfare state regimes as defined by Esping-Andersen (1990 and 2002) represent one approach that captures such a policy mix. Smith (2003) examines whether fathers' time spent looking after children can be explained by these welfare regimes. She concludes "no immediate patterns were evident, suggesting that the idea of different country types cannot be easily applied to these results" (Smith, 2004, p.23).

To examine the role of policy mix, we built on work by Gornick and Meyers (1997 and 2003), who developed an index based on policies for family leave, work time, care and education of young children, and school scheduling. To our knowledge, theirs is the only index that measures numerically to what extent government policies address combining family and work in different countries. This index does not include Austria, Ireland, Spain, and Greece, however. After comparing policies on parental leave, child care, and work time (Cizek and Richter, 2004; Immervoll and Barber, 2005; Missoc, 2006; OECD, 2001 and 2002), we concluded that there are likely to be small differences in the index for Austria versus Germany and the United Kingdom versus Ireland. For Greece and Spain, we constructed index values following Gornick and Meyer.

[7] In earlier versions of the models, we included a measure of the provision of publicly funded child care. This information did not change our results, and the variable itself was not statistically significant.

Figure 2 shows mean hours mothers reported looking after children and the value of the policy index for eight of the nine countries represented in our analysis. A higher value on the index indicates a country has more policies for combining parenthood and employment. Figure 2 suggests that mothers reported spending less time looking after children when it is easier for them to reconcile motherhood and paid work. However, there are two countries where this conclusion does not apply: Spain and Greece. Although Greece has a relatively low value for the policy index, Greece mothers reported the lowest average amount of time looking after children. For these two countries additional explanations are needed to explain differences in the time mothers reported looking after children.

Figure 2
Hours/week mothers reported looking after children in 1996 and policies to reconcile parenthood and employment for 8 European countries



Note: The policy index value for countries shown in parentheses was constructed by the authors
Source: European Community Household Panel (ECHP), own illustration.

Apart from policies that offer substitutes for the mother's time, differences in informal care arrangements, in particular care by relatives, may provide one explanation. For instance, if a grandmother lives in or close to the household with grandchildren, she may provide care for the grandchildren in lieu of the mother. For Europe, it is difficult to test this hypothesis empirically due to a lack of appropriate data[8]. Analyses by Iacovou (2002 and 2004) on the living

[8] While our analysis controls for the number of adults other than the parents in the household, it does not address the number of care providers per se. For example, we do not know whether a grandmother or grandfather in the household provides care.

arrangements of older Europeans are suggestive, however. Her results show a higher percentage of older women provide care in southern than northern European countries. Thus, informal care arrangements may take the place of mothers in Greece and Spain. This conclusion is consistent with first results from the new SHARE data. These results show that grandmothers in Greece, Italy and, to a lesser extent, Spain spend more time caring for grandchildren than grandmothers in central and northern European countries (Croda and Gonzalez- Chapela, 2005).

In conclusion, this paper provides a first comparison of the amount of time mothers in nine European countries reported looking after children under 16 years old. In addition, it offers a first step towards explaining observed differences in this use of time. Our results indicate differences in socio-economic composition are insufficient to explain differences across the nine countries. We present empirical evidence that country-specific policies to reconcile parenthood and employment may help to explain some of the differences. Further research may want to examine whether the amount of time fathers spend with children, variation in the living arrangements of families, question wording, social desirability, and differences in culture related to child rearing provide explanations for the observed differences. This is of interest, as the time parents spend with their children is considered important for children's development.

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Appendix

Appendix 1
Descriptive statistics by country

	A Austria		D Germany		DK Denmark		E Spain		G Greece		IR Ireland		L Luxemburg		NL Netherlands		UK United K.	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Mother																		
Age																		
- 17 to 24 years	0.05	(0.22)	0.02	(0.15)	0.04	(0.20)	0.04	(0.19)	0.07	(0.26)	0.07	(0.25)	0.01	(0.12)	0.01	(0.11)	0.04	(0.21)
- 25 to 29 years	0.18	(0.38)	0.12	(0.32)	0.15	(0.36)	0.14	(0.35)	0.20	(0.40)	0.13	(0.34)	0.15	(0.36)	0.11	(0.32)	0.17	(0.38)
- 30 to 34 years	0.37	(0.48)	0.32	(0.47)	0.33	(0.47)	0.33	(0.47)	0.31	(0.46)	0.26	(0.44)	0.30	(0.46)	0.27	(0.45)	0.33	(0.47)
- 35 to 39 years	0.25	(0.43)	0.33	(0.47)	0.28	(0.45)	0.32	(0.47)	0.24	(0.43)	0.33	(0.47)	0.30	(0.46)	0.36	(0.48)	0.28	(0.45)
- 40 to 44 years	0.11	(0.31)	0.15	(0.36)	0.13	(0.34)	0.12	(0.32)	0.11	(0.31)	0.14	(0.34)	0.20	(0.40)	0.19	(0.39)	0.12	(0.33)
- 45 to 67 years	0.04	(0.20)	0.05	(0.22)	0.06	(0.25)	0.05	(0.21)	0.07	(0.25)	0.07	(0.26)	0.02	(0.16)	0.05	(0.21)	0.05	(0.22)
Education																		
- Medium	0.66	(0.48)	0.58	(0.49)	0.40	(0.49)	0.21	(0.41)	0.33	(0.47)	0.48	(0.50)	0.31	(0.47)	0.60	(0.49)	0.42	(0.49)
- High	0.09	(0.29)	0.17	(0.38)	0.42	(0.49)	0.22	(0.41)	0.28	(0.45)	0.13	(0.34)	0.14	(0.35)	0.19	(0.39)	0.22	(0.41)
Employment																		
- Part-time	0.26	(0.44)	0.32	(0.47)	0.11	(0.31)	0.07	(0.26)	0.10	(0.29)	0.23	(0.42)	0.29	(0.46)	0.48	(0.50)	0.33	(0.47)
- Full-time	0.40	(0.49)	0.28	(0.45)	0.66	(0.47)	0.29	(0.45)	0.35	(0.48)	0.25	(0.44)	0.34	(0.48)	0.10	(0.30)	0.28	(0.45)
- Self-employed	0.10	(0.29)	0.03	(0.18)	0.03	(0.16)	0.06	(0.23)	0.08	(0.27)	0.03	(0.17)	0.04	(0.21)	0.05	(0.21)	0.07	(0.26)
Foreign	0.07	(0.26)	0.04	(0.20)	0.03	(0.17)	0.01	(0.10)	0.02	(0.12)	0.02	(0.13)	0.40	(0.49)	0.02	(0.13)	0.03	(0.18)
Single Parent	0.09	(0.29)	0.11	(0.31)	0.12	(0.33)	0.03	(0.17)	0.03	(0.16)	0.06	(0.25)	0.07	(0.26)	0.06	(0.24)	0.17	(0.37)

Source: European Community Household Panel (ECHP), own calculation.

Appendix 1 (cont.)
Descriptive statistics by country

	A Austria		D Germany		DK Denmark		E Spain		G Greece		IR Ireland		L Luxemburg		NL Netherlands		UK United K.	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Father																		
Employment																		
- Hours/week	39.13	(21.6)	37.58	(18.7)	34.35	(18.6)	37.38	(20.8)	42.81	(18.4)	35.63	(23.7)	37.39	(15.9)	38.14	(16.6)	35.83	(24.4)
- Self-employed	0.12	(0.32)	0.08	(0.27)	0.07	(0.25)	0.18	(0.38)	0.38	(0.48)	0.21	(0.41)	0.09	(0.28)	0.07	(0.26)	0.14	(0.35)
Household																		
Youngest Child																		
- < 1 year	0.07	(0.25)	0.03	(0.16)	0.03	(0.17)	0.07	(0.25)	0.09	(0.29)	0.11	(0.31)	0.06	(0.24)	0.04	(0.20)	0.11	(0.31)
- 1 to 2 years	0.19	(0.39)	0.12	(0.33)	0.28	(0.45)	0.21	(0.41)	0.18	(0.38)	0.26	(0.44)	0.19	(0.39)	0.24	(0.43)	0.20	(0.40)
- 3 to 5 years	0.25	(0.43)	0.26	(0.44)	0.28	(0.45)	0.27	(0.44)	0.24	(0.43)	0.30	(0.46)	0.29	(0.45)	0.23	(0.42)	0.26	(0.44)
- 6 to 12 years	0.41	(0.49)	0.50	(0.50)	0.33	(0.47)	0.39	(0.49)	0.40	(0.49)	0.29	(0.45)	0.40	(0.49)	0.43	(0.50)	0.38	(0.48)
No. of Children																		
- Beyond 1 child	0.84	(0.82)	0.78	(0.84)	0.76	(0.77)	0.70	(0.66)	0.79	(0.66)	1.26	(1.08)	0.84	(0.76)	0.99	(0.80)	0.93	(0.85)
- Beyond 2 children	0.22	(0.53)	0.19	(0.55)	0.17	(0.46)	0.10	(0.33)	0.12	(0.37)	0.53	(0.83)	0.21	(0.44)	0.26	(0.54)	0.26	(0.57)
Household Size	0.29	(0.77)	0.03	(0.21)	0.01	(0.08)	0.24	(0.75)	0.32	(0.70)	0.20	(0.70)	0.13	(0.43)	0.01	(0.09)	0.04	(0.27)
Income (1,000 Euro)																		
- Work income	18.43	(13.25)	20.95	(15.78)	18.42	(11.95)	10.89	(8.60)	10.10	(6.52)	14.58	(17.55)	27.59	(17.51)	18.74	(16.99)	13.76	(13.07)
- Non-work income	1.04	(3.87)	1.02	(3.67)	0.57	(2.34)	0.38	(2.33)	0.62	(1.77)	0.24	(1.59)	0.88	(2.69)	0.34	(1.89)	0.55	(2.39)
Dishwasher	0.67	(0.47)	0.64	(0.48)	0.62	(0.49)	0.21	(0.41)	0.33	(0.47)	0.35	(0.48)	0.73	(0.45)	0.40	(0.49)	0.32	(0.47)
Sample Size		697		794		552		1,272		1,030		747		204		1,055		835

Source: European Community Household Panel (ECHP), own calculation.

Appendix 2

Hours/week mothers reported looking after children in 1996: ECHP sample and predicted means for 9 European countries

	A Austria	D Germany	DK Denmark	E Spain	G Greece	IR Ireland	L Luxem-burg	NL Nether-lands	UK United K.
Sample Mean	54.88	50.45	45.27	52.71	36.79	66.28	43.97	57.77	71.17
	(28.38)	(24.63)	(29.61)	(27.38)	(18.72)	(27.50)	(24.71)	(25.08)	(28.02)
Predicted Mean 1	54.80	52.56	44.55	52.62	39.76	63.58	43.96	59.08	67.86
	(14.70)	(12.79)	(17.04)	(14.01)	(7.70)	(14.11)	(16.91)	(13.46)	(13.32)
Predicted Mean 2	55.63	51.66	45.91	50.84	38.14	62.69	44.23	53.95	68.44
	(15.50)	(13.77)	(18.26)	(15.91)	(8.48)	(16.45)	(17.26)	(18.55)	(14.47)

Source: European Community Household Panel (ECHP), own calculation.

Appendix 3

Mother's time spent looking after children in 1996: tobit estimates

Variable	A Model 1	A Model 2	D Model 1	D Model 2	DK Model 1	DK Model 2	E Model 1	E Model 2	G Model 1	G Model 2
Mother										
Age										
- 17-24 years	-1.65	-.66	14.70 *	12.88 *	7.72	5.54	7.92	4.21	1.92	.98
	(5.08)	(4.98)	(5.82)	(5.55)	(7.84)	(7.69)	(4.51)	(4.23)	(2.50)	(2.43)
- 25-29 years	.93	.10	3.25	2.43	5.62	3.20	1.75	.52	-1.47	-1.44
	(3.01)	(2.94)	(2.84)	(2.71)	(4.47)	(4.41)	(2.62)	(2.46)	(1.6)	(1.61)
- 35-39 years	-1.54	-1.65	-4.39 *	-4.73 *	-5.89	-6.06	-.61	-.004	1.16	1.69
	(2.62)	(2.56)	(2.15)	(2.05)	(3.78)	(3.72)	(2.06)	(1.94)	(1.52)	(1.48)
- 40-44 years	-7.44 *	-8.30*	-3.67	-4.91	-11.81 *	-11.12 *	-5.33	-3.72	-.75	.03
	(3.61)	(3.53)	(2.77)	(2.65)	(5.26)	(5.17)	(2.89)	(2.72)	(2.09)	(2.01)
- 45-67 years	-6.01	-7.05	-1.01	-6.10	-16.23 *	-15.92 *	-14.32 **	-14.20 **	-1.26	-1.53
	(5.23)	(5.16)	(4.28)	(4.13)	(7.22)	(7.10)	(4.38)	(4.11)	(2.54)	(2.45)
Education										
- Medium	-3.65	-2.53	-.55	.02	-3.11	-1.77	-3.64	-.14	1.51	2.56 *
	(2.38)	(2.34)	(1.98)	(1.90)	(4.10)	(4.05)	(2.10)	(2.00)	(1.38)	(1.34)
- High	-1.63	.87	-6.79 **	-2.67	1.21	4.29	-6.96 **	1.79	-3.20 *	.39
	(3.90)	(3.88)	(2.62)	(2.58)	(4.21)	(4.20)	(2.24)	(2.24)	(1.55)	(1.58)
Foreign	-3.86	-5.60	-2.64	-6.04	.94	1.01	2.17	2.20	-.13	-2.53
	(4.04)	(3.96)	(4.20)	(4.02)	(8.76)	(8.71)	(8.28)	(7.75)	(4.47)	(4.33)
Single Parent	4.39	4.85	4.37	3.12	12.07 *	12.55 *	7.47	11.76 *	-1.19	1.04
	(4.51)	(4.41)	(3.96)	(3.77)	(6.26)	(6.15)	(5.10)	(4.79)	(3.90)	(3.79)
Employment										
- Employed part-time		-7.04 **		- 9.16 **		-7.80		-12.36 **		-7.85 **
		(2.57)		(1.98)		(5.36)		(2.98)		(2.00)
- Employed full-time		-11.47 **		-18.35 **		-14.55 **		-21.93 **		-8.57 **
		(2.44)		(2.13)		(3.61)		(2.00)		(1.29)
- Self-employed		-5.00		.79		-19.00 *		-4.95		-4.51 *
		(3.70)		(4.48)		(9.35)		(3.60)		(2.10)
Father										
- Work hours/week	.04	.06	.03	.01	.20	.25 *	.19 **	.16 **	-.03	-.01
	(.07)	(.06)	(.07)	(.07)	(.12)	(.12)	(.05)	(.05)	(.04)	(.04)
- Self-employed	-8.99 *	-6.71	-2.42	.04	-1.02	-3.48	-10.73 **	-9.10 **	-1.98	-1.48
	(3.59)	(3.53)	(3.36)	(3.22)	(6.02)	(6.04)	(2.32)	(2.20)	(1.34)	(1.30)

Appendix 3 (cont.)
Mother's time spent looking after children in 1996: tobit estimates

Variable	IR Model 1	IR Model 2	L Model 1	L Model 2	NL Model 1	NL Model 2	UK Model 1	UK Model 2
Mother								
Age								
- 17-24 years	.89	-2.46	-.92	-5.84	5.38	6.77 *	22.11 *	14.17
	(7.03)	(6.72)	(12.59)	(12.19)	(7.47)	(6.98)	(9.90)	(9.67)
- 25-29 years	4.56	3.58	-4.05	-2.52	4.22	2.39	13.01 *	10.68 *
	(4.71)	(4.48)	(4.89)	(4.70)	(2.87)	(2.68)	(5.26)	(5.12)
- 35-39 years	-7.41 *	-6.37	-5.77	-6.42	-1.49	-2.70	6.71	7.87
	(3.59)	(3.42)	(4.10)	(3.97)	(2.14)	(2.00)	(4.39)	(4.27)
- 40-44 years	-5.97	-5.33	-.40	-1.41	-5.73 *	-7.43 **	-.56	1.30
	(4.68)	(4.45)	(5.01)	(4.82)	(2.67)	(2.49)	(5.86)	(5.72)
- 45-67 years	-19.62 **	-17.33 **	-11.65	-12.96	-11.02 *	-14.84 **	-7.97	-6.76
	(5.91)	(5.63)	(10.33)	(10.08)	(4.28)	(4.00)	(8.89)	(8.62)
Education								
- Medium	.43	4.63	.77	1.66	.46	1.38	.33	3.12
	(3.17)	(3.08)	(3.44)	(3.32)	(1.98)	(1.86)	(3.92)	(3.83)
- High	-5.50	2.09	-9.70 *	-4.21	-7.83 **	-3.37	-5.66	-.08
	(4.64)	(4.54)	(4.85)	(4.83)	(2.56)	(2.45)	(4.85)	(4.82)
Foreign	-10.14	-10.98	-10.20 **	-7.15 *	6.45	8.23	-25.77 **	-23.94 **
	(10.22)	(9.70)	(3.44)	(3.37)	(5.87)	(5.48)	(8.91)	(8.64)
Single Parent	25.39 **	24.48 **	14.88	15.30 *	14.46 **	11.03 **	21.79 **	18.57 **
	(6.32)	(6.02)	(7.78)	(7.45)	(4.15)	(3.89)	(6.24)	(6.09)
Employment								
- Employed part-time		-9.46 **		-8.38 *		-6.82 **		-21.15 **
		(3.31)		(3.57)		(1.60)		(4.09)
- Employed full-time		-25.64 **		-16.04 **		-31.68 **		-26.51 **
		(3.30)		(3.90)		(2.66)		(4.52)
- Self-employed		7.13		.13		5.99		.80
		(7.50)		(7.02)		(3.61)		(6.43)
Father								
- Work hours/week	.01	.02	.25	.16	.15 *	.07	.19	.27 **
	(.08)	(.08)	(.15)	(.15)	(.06)	(.06)	(.10)	(.10)
- Self-employed	-3.85	-1.72	-16.08 *	-8.61	-2.51	2.00	-6.76	-6.87
	(3.89)	(3.72)	(6.05)	(6.07)	(3.31)	(3.15)	(4.90)	(4.85)

Appendix 3 (cont.)
Mother's time spent looking after children in 1996: tobit estimates

Variable	A Model 1	A Model 2	D Model 1	D Model 2	DK Model 1	DK Model 2	E Model 1	E Model 2	G Model 1	G Model 2
Household										
Youngest Child										
- < 1 year	52.73**	53.28**	39.42**	30.03**	81.93**	78.92**	62.56**	61.69**	26.10**	25.26**
	(5.71)	(5.57)	(6.19)	(6.00)	(10.83)	(10.62)	(5.09)	(4.78)	(3.02)	(2.93)
- 1-2 years	46.40**	45.47**	31.19**	24.59**	56.60**	55.39**	47.48**	45.88**	21.61**	20.46**
	(4.65)	(4.55)	(4.21)	(4.09)	(7.36)	(7.24)	(4.23)	(3.97)	(2.72)	(2.63)
- 3-5 years	33.00**	31.11**	27.73**	22.83**	43.36**	43.51**	42.94**	42.55**	16.28**	15.96**
	(4.36)	(4.28)	(3.62)	(3.50)	(7.10)	(6.98)	(4.02)	(3.77)	(2.50)	(2.41)
- 6-12 years	20.43**	20.29**	13.92**	11.47**	36.28**	36.82**	34.21**	33.59**	10.43**	10.44**
	(3.89)	(3.81)	(3.24)	(3.10)	(6.44)	(6.34)	(3.80)	(3.57)	(2.23)	(2.16)
Number of children										
- Beyond 1 child	3.30	2.46	4.86*	3.11	8.17*	5.97	2.23	.94	.93	1.02
	(2.34)	(2.30)	(1.92)	(1.84)	(3.28)	(3.25)	(1.82)	(1.71)	(1.31)	(1.27)
- Beyond 2 children	-.80	-.24	-.99	.12	-8.77	-6.09	-.13	-.58	.63	.20
	(3.40)	(3.33)	(2.77)	(2.65)	(5.21)	(5.16)	(3.38)	(3.17)	(2.21)	(2.14)
Household Size	-4.87**	-3.93**	-.51	-1.77	-10.86	-15.76	-2.50*	-2.34*	-4.63**	-3.82**
	(1.34)	(1.34)	(3.87)	(3.70)	(17.04)	(16.66)	(1.14)	(1.08)	(.83)	(.81)
Income										
- Work Income	.17*	.12	.10	.03	-.06	-.08	-.11	-.16	.14	.10
	(.09)	(.08)	(.07)	(.06)	(.17)	(.17)	(.11)	(.11)	(.09)	(.09)
- Non-work Income	.22	.20	.13	.14	-.26	-.24	-.07	-.007	-.20	-.15
	(.25)	(.25)	(.23)	(.22)	(.71)	(.69)	(.36)	(.34)	(.33)	(.32)
Dishwasher	-.02	.16	3.92*	3.81*	2.67	5.22	2.74	5.63**	-1.05	-.79
	(2.23)	(2.19)	(1.85)	(1.78)	(3.22)	(3.21)	(2.22)	(2.09)	1.29)	(1.25)
Constant	24.34**	31.17	24.91**	39.76**	-7.61	.74	11.13**	18.30**	24.54**	26.56**
	(5.21)	(5.29)	(4.62)	(4.73)	(8.42)	(8.46)	(4.20)	(3.97)	(2.84)	(2.76)
Log likelihood	-3087.0	-3071.6	-3404.6	-3367.8	-2187.6	-2176.5	-5291.4	-5218.8	-4306.8	-4273.7
Pseudo R^2	.037	.042	.032	.042	.042	.047	.032	.045	.022	.030
Observed mean	54.88	54.88	50.45	50.45	45.27	45.27	52.71	52.71	36.79	36.79
	(28.38)	(28.38)	(24.63)	(24.63)	(29.62)	(29.62)	(27.38)	(27.38)	(18.72)	(18.72)
Predicted mean	53.64	53.68	50.65	50.66	45.54	45.55	52.27	52.38	36.75	36.76
	(14.44)	(15.18)	(12.24)	(13.86)	(15.99)	(16.80)	(13.50)	(15.72)	(7.82)	(8.88)
N	697	697	794	794	552	552	1272	1272	1030	1030

Appendix 3 (cont.)
Mother's time spent looking after children in 1996: tobit estimates

Variable	IR Model 1	IR Model 2	L Model 1	L Model 2	NL Model 1	NL Model 2	UK Model 1	UK Model 2
Household								
Youngest Child								
- < 1 year	55.47**	56.37**	38.27**	38.93**	39.25**	40.33**	63.01**	61.58**
	(8.07)	(7.68)	(9.16)	(8.85)	5.68)	(5.31)	(10.77)	(10.48)
- 1-2 years	47.74**	50.79**	38.93**	34.94**	31.25**	27.95**	34.44**	31.00**
	(7.20)	(6.87)	(7.86)	(7.62)	(4.15)	(3.88)	(9.45)	(9.18)
- 3-5 years	43.15**	45.76**	29.37**	26.96**	21.76**	18.66**	29.80**	27.10**
	(6.95)	(6.62)	(7.29)	(7.04)	(4.03)	(3.77)	(8.92)	(8.68)
- 6-12 years	36.62**	39.28**	12.74*	10.35	12.35**	10.43**	12.86	13.63
	(6.63)	(6.31)	(6.52)	(6.30)	(3.62)	(3.38)	(8.14)	(7.90)
Number of children								
- Beyond 1 child	5.06	1.33	9.41**	7.32*	5.17*	3.31	10.15**	7.74*
	(3.58)	(3.44)	(3.39)	(3.29)	(2.01)	(1.89)	(3.89)	(3.83)
- Beyond 2 children	1.00	2.39	-5.77	-4.88	.25	1.20	-3.30	-3.12
	(4.47)	(4.25)	(5.63)	(5.41)	(2.80)	(2.61)	(5.87)	(5.76)
Household Size	-2.97	-2.84	-8.01*	-6.91*	7.54	2.49	-12.37	-11.06
	(2.31)	(2.19)	(3.59)	(3.45)	(8.81)	(8.23)	(6.72)	(6.53)
Income								
- Work Income	.25*	.13	.07	.09	.11*	.08	-.08	-.16
	(.13)	(.11)	(.12)	(.11)	(.05)	(.05)	(.16)	(.16)
- Non-work Income	-.03	-.31	-.95	.91	-.13	-.35	-.88	-.93
	(.81)	(.77)	(.55)	(.53)	(.42)	(.39)	(.70)	(.66)
Dishwasher	-9.48**	-7.86**	10.24**	10.82**	3.38*	-1.56	-.26	-.04
	(3.23)	(3.06)	(3.53)	(3.38)	(1.64)	(1.54)	(3.95)	(3.86)
Constant	27.90**	34.94**	8.45	21.13*	30.45**	43.14**	40.80	54.95
	(7.15)	(6.90)	(9.30)	(9.43)	(4.85)	(4.67)	(9.75)	(9.72)
Log likelihood	-2672.0	-2642.8	-845.8	-837.4	-4399.0	-4332.5	-2567.4	-2546.4
Pseudo R^2	.032	.042	.061	.071	.028	.043	.030	.038
Observed mean	66.28	66.28	43.97	43.97	57.77	57.77	71.17	71.17
	(27.50)	(27.50)	(24.71)	(24.71)	(25.08)	(25.08)	(28.01)	(28.01)
Predicted mean	66.77	66.79	43.64	43.63	58.26	58.29	71.76	71.74
	(13.27)	(15.11)	(15.98)	(16.89)	(11.79)	(14.07)	(11.90)	(13.15)
N	747	747	204	204	1055	1055	835	835

Source: European Community Household Panel (ECHP), own calculation.

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Choosing between his time and her time? Paid and unpaid work of Danish couples

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Abstract

In terms of paid and unpaid work, Danish men and women work the same number of hours per week. But while men do most paid work, women do most unpaid work. We investigate the interaction between paid work and unpaid work for Danish working couples, using the 2001 Danish Time Use Survey. We test several competing theories regarding the intra-individual and intra-household allocation of paid and unpaid work: comparative advantage, bargaining, assortative mating and 'doing gender'. In addition, we divide unpaid work into ordinary housework and childcare and analyse whether these two activities interact differently with paid work hours. In general, the results favour the assortative mating and 'doing gender' theories, but do not support the bargaining or comparative advantage theories. Furthermore, results clearly show that housework and childcare are separate activities with different interaction effects.

JEL-Codes: D13, J22,

Keywords: Labour supply, paid and unpaid work, intra-household allocation of time

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1 Introduction

Since the early 1970s, Danish women have increased their paid working hours dramatically, while men's paid working hours have decreased (Lausten and Sjørup, 2003). According to paid working hours, the gap between Danish men and women is therefore closing. However, several analyses have shown that men and women are still far from equal in wages and career opportunities (Datta Gupta and Rothstein, 2001, and Lausten, 2001). A suggested explanation for this inequality is that women are mainly responsible for the unpaid work. Looking at the combined workload of both paid and unpaid work, Danish men and women work approximately the same number of hours, as the difference in paid work hours is almost exactly offset by the difference in unpaid work hours (Lausten and Sjørup, 2003). Hence, equality in the labour market cannot be separated from equality within families.

The purpose of this paper is to study the allocation of working time in Danish couples. To gain more insight into the mechanisms driving the distribution of time, we use data from the Danish Time Use Survey 2001. When looking at working time, we consider the total workload, i.e. both paid and unpaid work. In the econometric analysis, we estimate the time used on the different work activities. In particular, we examine the interactions between the different work activities, both for the individual and within the couple. The time budget constraint is by nature very strict (a day and a night consists of 24 hours), and for many working couples making the 'time ends' meet – especially if they have young children – is difficult. However, being in a couple also implies that more combinations for the intra-household allocation of work tasks are available – concerning paid work, housework, and childcare.

Our focus here is to investigate the predictions from different theories about the intra-household division of work: comparative advantage, bargaining, assortative mating, and 'doing gender', using the actual time use distribution of Danish couples. We estimate a model that includes three different types of interactions for individuals and for couples, and name the three 'own-time substitution', 'cross-spouse/same activity substitution', and 'crossspouse/ different activity substitution'. As our data is cross-sectional, we are not able to analyse effects and changes over time; rather, we offer a description of the situation at one point in time. However, the observed correlations are named substitutions for the sake of expositional clarity.

We analyse two different sets of intra-household work distributions. First, we study the interaction between paid and unpaid work, defined as all work taking place within the household. Second, we split the unpaid work into housework and childcare and investigate whether a structural difference exists between housework and childcare. The rationale behind this split is that the utility associated with childcare is different from the utility generated by ordinary housework. Whereas many analyses combine housework and childcare, we distinguish b tween the two and analyse whether this distinction affects the results.

Not much previous work has combined labour supply outside and inside the household. Hochschild has characterised the relationship between working time and family time as 'the time bind', i.e. the phenomenon of working schedules gradually coming to characterise all parts of life, especially when both parents are working (Hochschild, 1997). Hessing (1994) analyses the ways in which women organise their lives around their many tasks. Presser (1994) shows that variations in employment schedules are significant determinants of a husband's share in traditional female household tasks. Glick (1999) shows that women's working time in the labour market and in home production activities is affected by human capital, household income and demographics, and community factors. The effect of housework on wages earned in the market has been studied by Hersch and Stratton (2002) and Bonke, Datta Gupta and Smith (2003). In contrast to these studies, our study simultaneously considers both spouses and both the paid and unpaid work. Thus, besides looking at the individual time allocation between paid and unpaid work, we also look at the intra-household allocation of time.

The paper is organised as follows: Section 2 introduces the theoretical framework and the specification of the interactions of interest. Section 3 sets up the econometric framework, and section 4 discusses the data. Results from the empirical analysis on market and unpaid work appear in section 5. Section 6 presents analyses dividing unpaid work into housework and childcare. Concluding remarks are in section 7.

2 Theoretical background and specification

The starting point for every time allocation analysis is the time budget constraint that each individual faces - the 24 hours of a day that needs dividing among work, leisure and sleep. The typical utility maximising problem thus includes the maximisation of utility from leisure as well as maximisation of utility from goods produced either in the market or at home subject to this 24-hour time budget constraint. Because time is a limited resource, a negative trade-off for the individual between work outside the home and work within the home is a natural co sequence of this traditional Becker time-allocation model (Becker, 1965).

Apart from the basic time budget constraint, a number of theories offer explanations for the intra-household allocation of time. In this paper, we consider the suppositions of bargaining, comparative advantages, assortative mating, and 'doing gender'. Each of these theories implies a certain behaviour concerning the interaction between the spouses' time uses for different work activities.

A common model for the intra-household allocation of time is the collective bargaining model with sharing rules – 'bargaining' for short (Chiappori, 1997). In this model, spouses bargain about the division of labour tasks in a way that gives the spouse with the highest bargaining power the lower share of housework. In practice, bargaining power is often proxied by position in the labour market, so that the spouse with the highest 'labour market value' is expected to have the highest bargaining power. For instance, Bittman et al. (2003) uses relative wages

as an indicator of bargaining power; and, because men on average have higher wages, this indicator explains why women do relatively more housework.

Another possibility is that comparative advantages play a role in the intra-household division of labour. According to this theory, the spouses specialise, with each doing the largest relative share of the work where he or she has the highest relative productivity. Thus, if the man is more productive in the labour market and the woman is more productive in the home, then the optimal choice is for the household to allocate its resources so that the man does the largest share of the paid work while the woman does the largest share of the unpaid work (Becker, 1994; Fafchamps and Quisumbing, 2003).

Although the arguments in the bargaining theory and in the comparative advantage theory are not the same, the two theories produce the same predictions about the interaction between the spouses' paid and unpaid work. In both cases, one spouse will do relatively more paid work and relatively less unpaid work compared to the other spouse. Consequently, we cannot distinguish empirically between the two theories.

According to the theory of assortative mating, people tend to marry someone who is similar in characteristics such as educational background (Becker, 1973 and 1974; Ermisch and Francesconi, 2002). The more the spouses are alike, the more similar we expect their preferences to be, e.g. in one couple both spouses may have high preferences for paid work and low preferences for a tidy house, while in another couple the reverse is true. Contrary to the comparative advantage explanation, work tasks for an assortative mated couple are expected to be positively correlated.

Finally, a possible explanation for the intra-household allocation of time is 'doing gender' (West and Zimmerman, 1987). Couples 'doing gender' reproduce and sustain cultural norms for the gender division of household tasks in everyday social interactions and relationships. Gender thus becomes the master identity that overrules other mechanisms of the allocation of work. The consequence of this theory is that women do the major share of the household tasks while men do the major share of paid work – not because of natural gender differences but as an enactment of cultural norms (West and Zimmerman, 1987; Bittman et al., 2003; Álvarez and Miles, 2003).

The different theories have different implications for the interactions between female and male labour supply and between the different work tasks. To make the analysis operational, we define three types of interactions between tasks and between spouses. The first interaction is the 'own-time substitution', i.e. the interaction between (for instance) paid work and unpaid work for the individual. Clearly, this correlation is expected to be negative due to the binding time budget constraint, because the more a person works in the labour market, the less time will be available for other things including housework and vice versa.

The second interaction we call the 'cross-spouse/same activity substitution', i.e. substitution between both spouses' paid work or between both spouses' unpaid work. Depending on whether this correlation is positive or negative, it will support either the theory of assortative

mating or the theories of comparative advantages and bargaining. We therefore expect the correlation between the spouses' paid work hours or between the spouses' unpaid work hours to be positive if the spouses are assortative mated but negative if the spouses specialise according to comparative advantages or bargaining.

The third interaction is the 'cross-spouse/different activity substitution', i.e. the correlation between a work task for one person and another work task for the spouse - for instance, the relationship between his paid work and her unpaid work or vice versa. Although we could view a positive 'cross-spouse/different activity substitution' as support for the theory of comparative advantages, it also could support the bargaining theory. Working more hours in the market could thus be viewed as a proxy for higher bargaining power and will consequently make the spouse do more housework. We interpret a negative 'cross-spouse/different activity substitution' as support for the theory of assortative mating.

Finally, a finding of no significant cross-spouse interactions would support the 'doing gender' theory. In such a case, the working hours of each spouse would be primarily determined by cultural norms (which are not household-specific), rather than being a function of intrahousehold mechanisms. Therefore, we would expect the cross-spouse correlations to decrease. Table 1 summarizes the predictions based on the different theories:

Table 1
Summary of prediction

	Own-time substitution	Cross-spouse/same activity substitution	Cross-spouse/ different activity substitution
Bargaining	-	-	+
Comparative advantage	-	-	+
Assortative mating	-	+	-/0
Doing gender	-	0	0

Source: Own definitions.

3 Econometric framework

We investigate hours worked for women and men in couples. Total hours worked for an individual is equal to hours worked in the market (paid work) plus hours worked at home (unpaid work). A special concern is the work connected to children in the household. In traditional time use analyses, childcare is included in the unpaid work, and in the first part of the analysis we take this approach. However, many will argue that time spent caring for children is structurally different from time spent doing housework. Thus, in the second part of the analysis, we divide unpaid work into two components: housework and childcare.

In the econometric analysis, we estimate the level of time use on the different work activities. We allow time used on different work activities to be interdependent, both for the individual and between spouses. Not only hours but also timing of work activities may be important, e.g. night work or irregular working hours (e.g. Presser, 1994). However, this analysis takes only actual working hours into account.

A special feature of the time activities is that they are censored distributions – negative hours cannot occur – and therefore a tobit specification is applied. Consider the estimation of time used on paid work and unpaid work. Let H_p^m and H_p^w be paid hours for the man and the woman, respectively, and H_{up}^m and H_{up}^w be the unpaid hours. Defining H_p^{m*}, H_p^{w*}, H_{up}^{m*} and H_{up}^{w*} as the latent variables corresponding to H_p^m, H_p^w, H_{up}^m and H_{up}^w the model is as follows (where x_p^m, x_p^w, x_{up}^m and

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$$
\begin{aligned}
H_p^{m*} &= \gamma_1^2 H_p^w + \gamma_1^3 H_{up}^m + \gamma_1^4 H_{up}^w + \beta_1 x_p^m + u_1 \\
H_p^{w*} &= \gamma_2^1 H_p^m + \gamma_2^3 H_{up}^m + \gamma_2^4 H_{up}^w + \beta_2 x_p^w + u_2 \\
H_{up}^{m*} &= \gamma_3^1 H_p^m + \gamma_3^2 H_p^w + \gamma_3^4 H_{up}^w + \beta_3 x_{up}^m + u_3 \\
H_{up}^{w*} &= \gamma_4^1 H_p^m + \gamma_4^2 H_p^w + \gamma_4^3 H_{up}^w + \beta_4 x_{up}^w + u_4
\end{aligned} \qquad (1)
$$

and

$$
\begin{aligned}
H_p^m &= H_p^{m*} \quad \text{if} \quad H_p^{m*} > 0 \\
&= 0 \quad \text{if} \quad H_p^{m*} \le 0
\end{aligned}
$$

$$
\begin{aligned}
H_p^w &= H_p^{w*} \quad \text{if} \quad H_p^{w*} > 0 \\
&= 0 \quad \text{if} \quad H_p^{w*} \le 0
\end{aligned} \qquad (2)
$$

$$
\begin{aligned}
H_{up}^m &= H_{up}^{m*} \quad \text{if} \quad H_{up}^{m*} > 0 \\
&= 0 \quad \text{if} \quad H_{up}^{m*} \le 0
\end{aligned}
$$

$$
\begin{aligned}
H_{up}^w &= H_{up}^{w*} \quad \text{if} \quad H_{up}^{w*} > 0 \\
&= 0 \quad \text{if} \quad H_{up}^{w*} \le 0
\end{aligned}
$$

From (1), the interaction terms that we are especially interested in are identified as follows: the 'own-time substitution' is given by ${\gamma_1}^3$, ${\gamma_3}^1$, ${\gamma_2}^4$ and ${\gamma_4}^2$; 'cross-spouse/same activity sub-

stitution' is given by γ_1^2, γ_2^1, γ_3^4 and γ_4^3; and the 'cross-spouse/different activity substitution' is given by γ_1^4, γ_2^3, γ_3^2 and γ_4^1. Table 3.1 summarises the interaction terms:

Table 2
Summary of interaction terms

	H_p^m	H_p^w	H_{up}^m	H_{up}^w
H_p^m	-	Cross Spouse / Same Activity	Own Time	Cross Spouse / Diff. Activity
H_p^w	Cross Spouse / Same Activity	-	Cross Spouse / Diff. Activity	Own Time
H_{up}^m	Own Time	Cross Spouse / Diff. Activity	-	Cross Spouse / Same Activity
H_{up}^w	Cross Spouse / Diff. Activity	Own Time	Cross Spouse / Same Activity	-

Source: Own definitions.

In the estimation of (1) and (2), we apply Amemiya's Generalised Least Squares (AGLS) for tobit models with endogenous regressors (Amemiya, 1974 and 1979). The AGLS estimator treats the endogenous regressors as linear functions of the instruments and the exogenous variables, while correcting for the censored distribution of the dependent variable. In essence, the AGLS is a variant of the traditional GLS estimator. For details of AGLS, see Maddala (1983). In practice, applying this method means that in each equation the coefficients of the endogenous regressors are estimated by instrumental variables. The method uses all the variables in the model as instruments and then correctly adjusts standard errors according to the tobit specification.

In the second part of the analysis, we split the unpaid work into housework and childcare. The implication for the time use model is straightforward: the unpaid work equations in (1) and (2) are replaced by two equations, one for housework and one for childcare, and the number of endogenous regressors in the equations increase accordingly. The estimation method, however, remains unchanged. We use STATA8 for all estimations.

4 Data: the Danish time use survey 2001

To analyse the interaction between paid work and unpaid work, we use the Danish Time Use Survey from 2001. The design of the survey follows the guidelines developed by an expert group in Eurostat (2000). Two diaries – one for a weekday and one for a weekend day – and a preceding questionnaire was given to approximately 4,700 representative Danish households. In households with a married or cohabiting couple, both spouses received time use diaries.

The interviewees completed the time use diaries by stating the main and secondary activity for each 10-minute interval of the day, in addition to where the activity took place and what other people were present. The questionnaire includes information about income, sociodemographic variables, family background, educational background, and relation to the labour market. Furthermore, the data have been merged with register information from Statistics Denmark.

Because we want to analyse the relationship between paid and unpaid work, the analysis is restricted to couples where both spouses work. On the other hand, we do not restrict by age, so the couples can be aged 18-74. An additional requirement is that the couple completes all four time use diaries – two for each spouse. The inputs from these four diaries are then weighted together to give us the average weekly time for paid work, housework, and childcare for the man and the woman[1]. Considering working hours over the full week is important especially because men tend to do relatively more housework on weekends. Thus, considering only a weekday would underestimate male housework hours relative to female housework hours.

We do not distinguish between married and cohabiting couples. As usual in time use surveys, non-response is relatively high, especially given the binding requirement of four completed time use diaries for each couple. Thus we end up with a sample of 718 couple households. Table 4.1 to 4.4 give the sample means of the variables in the analyses. The individualspecific variables have means for men and women separately, whereas the couple-specific variables are joint variables. Our definitions of time use for the different activities – paid work, unpaid work, housework, and childcare – are:

- Time used for paid work is defined as time spent performing a job, either at the workplace or at home, and time spent commuting to and from work.
- Time used for unpaid work is defined as time spent in or around the house doing one of the following:
  - Housework (preparing food, washing dishes, cleaning, doing laundry, gardening, handcrafting, caring for pets, or shopping)
  - Childcare (active child caring such as feeding or bathing the child; educating the child; reading out loud to, talking to, or playing with the child, or accompanying the child to child-related activities).

Consequently, the analysis does not include time spent sleeping and time spent on leisure activities. Furthermore, secondary activities are excluded.

In Table 3, we present the weekly time use averages for women and men. We see that men and women in Danish couples work the same amount of hours – about 60 – during an average week. Dividing this time into paid and unpaid work, women spend 33 hours on paid work and

[1] The weekday diary enters with the weight 5 and the weekend diary enters with the weight 2 in the weekly time use measure.

27 hours on unpaid work, whereas men spend 42 hours on paid work and 18 hours on unpaid work. Thus, the data indicates a substantial division of labour between spouses, where men do the major share of paid work and women do the major share of unpaid work.

Table 3
Weekly time use in Danish couples 2001

	Hours per week			
	Women		Men	
	Mean	Std. Dev.	Mean	Std. Dev.
Total time-use for work	60.35	(16.30)	60.74	(15.55)
Paid work	32.98	(18.26)	42.03	(17.63)
Unpaid work	27.37	(15.08)	18.71	(13.49)
· House work	21.58	(11.14)	15.57	(11.54)
· Child care	5.79	(9.55)	3.14	(6.00)

Source: Danish Time Use Survey 2001, own calculations.

Dividing the unpaid work into housework and childcare, we find that women on average spend 22 hours on housework and 6 hours on childcare. Men on the other hand spend 16 hours on housework and 3 hours on childcare. Hence, Danish men spend about two-thirds of the time Danish women spend on housework and about half as much time on childcare. This average, however, is of the sample as a whole, whether or not the couples have children. Interestingly, if we look at time use only for couples with children aged 0-17 years, the result is unchanged. The only difference is that women with children on average spend 11 hours on childcare per week, while men with children on average spend 5½ hours of childcare per week. Although the total childcare workload is larger for couples with children, the distribution of the work between the spouses thus remains.

Table 4
Share of zeroes

	Women	Men
Paid work share	14.21%	6.55%
Unpaid share	0.14%	1.67%
· Housework share	0.14%	1.67%
· Childcare share	50.28%	58.08%

Source: Danish Time Use Survey 2001, own calculations.

On any given day of a time use diary, not all individuals spend time on all time use activities. For instance, although all individuals selected have jobs, they may not be working on this particular day. Consequently, the diaries include a lot of zeroes. Although the weekday and the weekend day are weighted together, thereby reducing the number of zeroes, a relatively large share of individuals still do not do any paid work in the given diary week (see the share

of zeroes for each time use activity in Table 4). Especially for both male and female childcare, the share of zeroes is large – reflecting that half the couples do not have children aged 0-17 years. On the other hand, the share is very low for unpaid work and housework – only 1 woman and 12 men in the sample do neither housework nor childcare in the given week. To take account of the censored distributions, we use a tobit specification in the estimations.

Descriptive statistics for the individual-specific variables are found in Table 5. The average age in the sample is 40 years for the women and 43 years for the men. Education is classified in 6 categories following the traditional classification of the Danish educational system. The short post-secondary education is 1-2 years of education following high school, e.g. ITtechnician; medium post-secondary education is 3-4 years of education following high school, e.g. nursing qualifications; and long post-secondary education is 5 or more years of education following high school, i.e. post-graduate studies.

Table 5
Individual-specific variables

	Women		Men	
	Mean	Std. Dev.	Mean	Std. Dev.
Age	40.522	(10.573)	42.864	(11.062)
Basic education	0.178	(0.383)	0.160	(0.367)
High School	0.085	(0.279)	0.072	(0.259)
Vocational education	0.344	(0.475)	0.436	(0.496)
Short post-secondary education	0.057	(0.2329	0.061	(0.240)
Medium post-secondary education	0.223	(0.416)	0.155	(0.362)
Long post-secondary education	0.113	(0.317)	0.116	(0.320)
Level of responsibility at work:				
No subordinates	0.812	(0.391)	0.673	(0.470)
1-20 subordinates	0.171	(0.377)	0.256	(0.437)
21-50 subordinates	0.011	(0.105)	0.046	(0.210)
51+ subordinates	0.006	(0.074)	0.025	(0.156)
Flexible working hours	0.365	(0.482)	0.543	(0.498)
More than a 1-hour commute to and from work	0.258	(0.438)	0.325	(0.469)
Disposable income (DKr.)	143,460	(51,838)	177,202	(117,250)

Source: Danish Time Use Survey 2001, own calculations.

There are some differences between men's and women's educations, in particular that more men have vocational education, while more women have medium post-secondary education.

We find relatively large gender differences in the job variables. No matter the number of subordinates, more men than women have managerial responsibilities (about 32% vs. 19%). Men are more often able to vary their daily working hours than women (54% vs. 37%). Furthermore, men commute more than women – here measured by more than a 1-hour commute to and from work (33% vs. 26%). Finally personal annual disposable income shows an average of 177.000 DKr. a year for men compared to 143.000 DKr. a year for women.

Table 6 shows the couple-specific variables. Roughly speaking, the sample is split evenly between the Copenhagen metropolitan area, other urban areas, and rural areas.

Table 6
Couple-specific variables

Couple-specific variables:	Mean	Std. Dev.
Area of living:		
Copenhagen	0.326	(0.469)
Urban area	0.340	(0.474)
Rural area	0.334	(0.472)
Education gap	-0.007	(0.763)
Housing conditions:		
Single family house	0.740	(0.439)
Apartment	0.212	(0.409)
Other kind of residence	0.049	(0.215)
Number of rooms	4.656	(1.693)
Remodelling	0.270	(0.444)
Percentage having children	0.508	(0.500)
Average number of children:		
0-2 year olds	0.153	(0.401)
3-6 year olds	0.181	(0.430)
7-17 year olds	0.585	(0.879)
Number of couples	718	

Source: Danish Time Use Survey 2001, own calculations.

The education gap is a dummy taking the value 1 if the man is more educated than the women; -1 if the woman if more educated than the man; and 0 if they have educations at the same level, which is the case for the majority of the sample. The predominant housing mode is the single family house. A relatively large percentage – about one-quarter of the couples –

state that they are currently working on a remodelling or renovation project with their property. Finally, half of the couples have children, mostly aged 7-17 years.

We expect the individual-specific and couple-specific variables to affect the couple's time use behaviour through different channels. Factors such as number of children and housing conditions thus affect the amount of work to be done in and around the home: childcare depends on children present in the households, and similar housework is expected to depend on the size of the dwelling, the presence of a garden, current remodelling projects, etc. Other factors affect the ability to be flexible in the timing of the different work activities – being able to vary working hours is self-explanatory. In addition, we expect long commuting hours to imply less flexibility. The individual-specific factors – age, education, manager responsibilities and personal income – can all be indicators of personal bargaining power within the couple. Although income may be pooled for consumption purposes that potential bargaining power depends on actual income is still likely. Likewise, we expect the education gap to matter for the potential bargaining power. Finally, we expect that the geographical area can matter, because of different traditions relating to the distribution of paid work and housework/childcare in urban and rural areas.

5 Paid work and unpaid work

The results discussed in this section (see Table 7) are from the estimation of time spent on paid work and unpaid work, while the next section focuses on estimations on time spent on paid work, housework, and childcare.

The first two columns show the estimated coefficients for the paid work equations for women and men, and the last two columns show the corresponding estimated coefficients for the unpaid work equations. In all four columns, three types of variables are included: first, the endogenous variables; second, the individual specific variables; and third, the couple-specific variables. For instance, in the estimation of male paid work, female paid work, female unpaid work, and male unpaid work are all endogenous variables. The instruments used for the endogenous variables are all variables in the model, i.e. both those included in the specific equation and those included in the other equations. The identification of the model relies on the principle of excluded variables. Due to the identification restriction it is nor possible to include all explanatory variables in all equations. Consequently, although e.g. children may affect paid work the child variables are not included in that specific equation. The interpretation of the model, however, is that the effects of the non-included explanatory variables are indirect, i.e. through the endogenous regressors.

Generally, we find the 'own-time substitution' between time use activities very important. Other things being equal, a man has fewer paid work hours the more he works at home, and likewise for a woman – a natural consequence of the time budget constraint. Similarly, a man has fewer unpaid work hours the more paid work he does, whereas this interaction term is

insignificant for women. This result suggests that women's determination of housework is less subject to the time budget constraint or – to put it another way – that women use leisure as a time buffer more than men. In total, however, data indicates a significant negative interaction between paid work and unpaid work both for men and for women.

The second interaction term – the 'cross-spouse/same activity substitution' – denotes substitution between spouses within the same time use activity. For paid work, we find a strong positive correlation between husband and wife: either they both tend to work more, or they both tend to work less. The positively correlated working hours indicate that spouses are 'alike', which favours the assortative mating theory. In the unpaid work equation, a positive but insignificant correlation is also found. The assortative mating pattern thus appears to be stronger for paid work values than for home values, e.g. preferences for home-making or childcare. On the other hand, the significant correlation for the unpaid work supports the 'doing gender' theories. However, the findings regarding the 'cross-spouse/same activity substitution' do not support the bargaining/comparative advantage theories.

Finally, we look at the 'cross-spouse/different activity substitution'. Interestingly, this substitution is positive and significant for women but insignificant for men. Thus, the more paid work he does, the more unpaid work she does; and the more unpaid work he does, the more paid work she does – but the same is not true for the reverse.

Table 7
Paid work and unpaid work

	Paid work				Unpaid work			
	Women		Men		Women		Men	
Intercept	-21.242		37.281	***	14.763		12.388	
Endogenous variables:								
Female paid work			0.333	**	-0.222		0.095	
Male paid work	0.802	***			0.341	***	-0.269	**
Female unpaid work	-1.154	***	0.316				0.295	
Male unpaid work	1.019	***	-0.612	**	0.184			
Individual-specific variables:								
Age	-0.058		0.020		0.112	*	-0.022	
High School	1.536		-3.430		-2.967		0.826	
Vocational education	-0.193		-0.015		-1.935		1.142	

Source: Danish Time Use Survey 2001, own calculations.

Table 7 (cont.)

	Paid work		Unpaid work	
	Women	Men	Women	Men
Short post-secondary education	-1.430	-0.873	-2.702	0.342
Medium post-secondary education	-0.775	-2.420	-1.537	2.857 *
Long post-secondary education	-0.259	-0.183	-1.443	5.354 ***
Disposable income	2.834 *	-0.707 *	-0.653	0.054
1-20 subordinates	1.982	0.850		
21-50 subordinates	9.264	7.451 **		
51+ subordinates	4.484	0.728		
Flexible working hours	2.603 *	3.601 **		
More than a 1-hour commute to and from work	3.125 *	-0.994		
Couple-specific variables:				
Living in Copenhagen	-2.765	2.636 *	-1.824	-0.353
Living in rural area	-1.485	3.792 **	-1.270	-1.317
Education gap	0.027	0.554	-0.658	-1.276 **
Single-family house			1.822	2.376 *
Other residence			3.165	4.389 *
Number of rooms			0.240	0.185
Remodelling			1.893	4.053 ***
Number of 0-2 year olds			12.995 ***	3.699
Number of 3-6 year olds			6.542 ***	2.619
Number of 7-17 year olds			2.701 ***	0.881

Note: *** Statistically significant at the 0.01 level, ** at the 0.05 level, and * at the 0.10 level.
Number of observations 718. Estimated by AGLS (Amemiya's GLS), Source: Danish Time Use Survey, 2001

Although this finding partially supports the bargaining/comparative advantage theory – for women, but not for men – a better explanation is probably the 'doing gender' theory: that gender norms dictate that women react to male labour supply but not the other way around.

Overall, the estimation of time spent on paid and unpaid work is in favour of the assortative mating and 'doing gender' theories, whereas we do not find much support for the bargaining and comparative advantages theories. Even though Denmark is a modern society where almost all women work and men do housework more than men in other countries (Lausten and Sjørup, 2003), the division of paid and unpaid work seems to result more from cultural norms than from bargaining or comparative advantages. The coefficients of the other explanatory variables show not many significant coefficients, a finding that we can view as a natural co sequence of the small sample size. Age matters significantly only for female unpaid work. Nor is the effect of education very strong, as the only significant coefficients are found for male unpaid work. Relative to men with only basic schooling, men with medium or long post-secondary education do more unpaid work. An explanation for this finding may be that the men with higher educations are less traditionally oriented than other men. However, this effect is partly offset by an education gap in favour of the men, i.e. if the husband is better educated than the wife, he will do less unpaid work, other things being equal. But, contrary to findings in other countries, we find no effect of education on paid work hours, not for women or for men (e.g. Eberharter, 2001, for non-poor German families; Euwals and Soest, 1999, for the Netherlands).

Annual personal disposable income is positively correlated with female paid work and negatively correlated with male paid work. An explanation for the somewhat contra-intuitive result for the men may be that many are on the backwards-bending part of the labour supply curve, where higher income reduces working hours (an income effect). Looking at unpaid work, however, income has no significant effect. This finding suggests that income does not play an important role as a proxy for bargaining power.

Whether increased flexibility in the labour market is primarily benefits the employers or the employees is the subject of an ongoing debate. The results here indicate that the ability to vary working hours makes both men and women do more paid work. This finding is in line with other studies showing how increased workplace flexibility makes workers work more (Czonka, 1999; Hochschild, 1997). In addition, men work more if they have 21-50 subordinates, as opposed to none, while women work more if they have more than 1 hour of commuting time. The reason may be that the job must be more important for the women for her to accept the long commuting time, while for men there is a trade-off between working hours and commuting.

Compared to men in urban areas, men living in Copenhagen and in rural areas have more paid work. One explanation could be that both in the metropolitan area and in the country-side, the norm prescribes longer working hours. Another explanation, however, could be the simple one that we included commuting time in the paid working hours, and the positive coefficient

then simply reflects that these men commute longer than men in urban areas. Interestingly, though, in both cases the significant coefficients are found only for men.

Living in a single-family house as opposed to an apartment has a positive effect on males' unpaid work but no effect on females' unpaid work. The same holds for living in another type of residence. An explanation for this result could be that living in a single-family house (or 'other residences' such as a farm) typically implies having a garden and thus relatively more outside work. The result suggests a traditional division of labour within the households, where the existence of outside work increases male housework hours. The remodelling variable confirms this finding, which clearly indicates that the man's unpaid work increases if the couple has a remodelling project, while this coefficient is insignificant for the women.

Finally, we find that the number of children matters for women's unpaid work hours but – surprisingly – not for men's. For women, children increase unpaid work significantly, and the younger the children the more the unpaid work increases. This finding shows that the extent of child-related work declines as the children grow older. However, there is no significant effect of children on male unpaid work. Thus, that Danish fathers are active participants in childrearing (Lausten and Sjørup, 2003) does not show up in the estimation of their unpaid work. The reason may be that they cut down on non-child related work when they do child related work, causing the net effect to be zero. We return to this issue in greater detail in the next section.

6 Paid work, house work and childcare

The findings in the previous section primarily point to assortative mating and 'doing gender' as the best explanations for the intra-household distribution of paid and unpaid work. However, unpaid work is a rather crude category of different housework chores on the one hand and childcare on the other. Thus, in this section we investigate whether – and, if so, how – dividing unpaid work into the two categories, housework and childcare, makes a difference.

Dividing the unpaid work into housework and childcare implies that three sets of equations are estimated: one set for paid work (men and women), one set for housework (men and women), and one set for childcare (men and women). In doing so, we split the couple-specific variables so that the housing variables are included in the housework equations, while the number of children is included in the childcare equations.

The results for the six time use equations appear in Table 8. The interaction effects show an interesting pattern. If childcare is disregarded, we find that exactly the same interaction terms are significant for paid work and housework in Table 8 as for paid work and unpaid work in Table 7. Thus, whether we look at housework or unpaid work we find that (1) the 'own-time substitution' is significant except for the effect of female paid work on female housework/ unpaid work; (2) the 'cross-spouse/same activity' interactions are significant for paid work but not for housework/unpaid work; and (3) the 'cross-spouse/different activity substitutions'

are significant for women (both concerning paid work and housework/unpaid work), but not for men. However, the results for childcare are very different. The only significant interaction coefficient is from female childcare to female paid work ('own-time substitution'). Thus, the more time the women use on childcare, the less time they use on paid work, reflecting that mothers of young children often work part-time. But, interestingly, no significant interactions are found between childcare and male paid work or between childcare and male or female housework.

Table 8
Paid work, housework, and childcare

	Paid work		Housework		Childcare	
	Woman	Man	Woman	Man	Woman	Man
Intercept	-24.061	30.522 **	10.468	11.337 *	-24.120	9.229
Endogenous variables:						
Female paid work		0.402 **	-0.162	0.094	0.017	-0.050
Male paid work	0.674 ***		0.359 ***	-0.232 *	0.249	0.062
Female housework	-0.922 **	0.737		0.251	-0.227	-0.154
Male housework	0.942 ***	-0.848 **	0.233		0.343	0.027
Female childcare	-1.038 **	0.051	-0.009	0.204		-0.178
Male childcare	0.703	-0.146	0.142	-0.257	0.284	
Individual-specific variables:						
Age	-0.094	-0.070	0.151 **	-0.015	-0.032	0.048
High School	3.084	-2.903	-2.433	0.142	-6.148 **	1.910
Vocational education	0.742	0.873	-2.086	0.879	-0.794	1.097
Short post-secondary education	0.013	-0.092	-3.276	-0.166	-2.264	2.173
Medium post-secondary education	0.175	0.139	-1.786	2.297	-0.189	2.026
Long post-secondary education	1.207	1.404	-2.921	3.963 **	-1.415	4.748 **
Disposable income	3.272 **	-0.504	-0.728	0.101	0.547	-0.015
1-20 subordinates	2.123	0.578				
21-50 subordinates	9.448	6.696				
51+ subordinates	5.461	0.131				
Flexible working hours	2.343	2.920 *				
More than a 1-hour commute to and from work	2.861 *	-1.299				

Table 8 (cont.)

	Paid work		Housework		Childcare	
	Woman	Man	Woman	Man	Woman	Man
Couple-specific variables:						
Living in Copenhagen	-2.119	2.985 *	-1.891 *	-0.521	-0.166	0.189
Living in rural area	-1.359	3.809 **	-1.081	-0.711	-0.040	-2.425 **
Education gap	0.293	-0.218	-0.458	-1.118 *	-0.619	-0.836
Single-family house			1.882	2.764 **		
Other residence			3.674	4.316 *		
Number of rooms			0.133	0.043		
Remodelling			1.433	4.467 ***		
Number of 0-2 year olds					18.622 ***	14.417 **
Number of 3-6 year olds					9.753 ***	9.936 ***
Number of 7-17 year olds					5.708 ***	5.292 ***

Note: *** Statistically significant at the 0.01 level, ** at the 0.05 level, and * at the 0.10 level.
Number of observations 718. Estimated by AGLS (Amemiya's GLS), Source: Danish Time Use Survey, 2001

Furthermore, none of the endogenous regressors in the childcare equations are significant. According to the predictions based on the different theories, the results concerning childcare thus largely favour the 'doing gender' explanation. This finding is interesting, because public opinion in Denmark generally views today's fathers as being just as involved in childrearing as today's mothers. However, this analysis of the actual time use does not support this view. Apparently, the childcare time use is determined by other factors than time used on other work tasks; therefore, the determination of childcare time is more gendered than the determination of paid work and housework. Although 'doing gender' is also present in the determination of housework (and especially female labour supply) childcare appears different, because the allocation of time spent on this specific task is independent of the other work tasks.These findings lead to the conclusion that the determination of childcare is structurally different from the determination of housework and, consequently, we should not analyse the two together. Furthermore, it is striking that the results for unpaid work and housework are so similar. However, the estimations in Table 8 include the full sample (i.e. 718 couples), regardless of children's presence. Although we have also carried out the estimations for the reduced sample of couples with children (365 couples), the results were basically identical with a slightly lower number of significant coefficients.

For the other explanatory variables, there are relatively few differences between the results in Table 8 and in Table 7. For the paid work equations, the only difference is that fewer variables are significant in Table 8, i.e. male disposable income, men having 21-50 subordinates, and women having flexible working hours. Otherwise, the findings are similar.

The explanatory variables for the unpaid work equation in Table 8 are divided between the housework and the childcare equations, with the child variables in the childcare equations and the housing variables in the housework equations. As mentioned in the discussion of the time interaction effects, housework and unpaid work appear very much alike, a finding also evident in the coefficients for the explanatory variables. Apart from the fact that the child variables do not enter the housework equations in Table 8, the only difference from Table 7 is that male medium post-secondary education becomes insignificant, whereas the coefficient for women living in Copenhagen becomes significantly negative.

The major new finding in the childcare equations is that the coefficients of children are significant in both the female and the male childcare equation, suggesting that the insignificant coefficients for males in Table 7 are results of the pooling of housework and childcare. In addition, we find that women with high school education do less childcare than women with basic education, while men with long post-secondary education do more childcare than men with basic education. Finally, we find that men living in rural areas do less childcare than men living in urban areas, perhaps because those in rural areas are less accepting of fathers taking care of children. In general however, the variable in this model do not capture childcare time use very well.

7 Concluding remarks

In this paper, we have analysed the interrelations between different work activities for Danish couples. In addition to considering paid and unpaid work, we further divided unpaid work into housework and childcare.

The sample included 718 working couples from the 2001 Danish time use survey. Average weekly time use on each work activity is a weighted sum of a weekday diary and a weekend day diary for each spouse. The time spent on the different time use activities are estimated using AGLS (Amemiya's GLS), thus taking the endogeneity between time uses and between spouses, as well as the censoring of the time use variables into account.

We tested predictions from four competing theories about the intra-household allocation of work: bargaining, comparative advantages, assortative mating, and 'doing gender'. We consider the findings concerning 'own-time substitution', i.e. the interaction between paid and unpaid work for the individual; 'cross-spouse/same activity substitution', i.e. substitution between his paid work and her paid work or between his unpaid work and her unpaid work; and 'cross-spouse/different activity substitution', i.e. the correlation between his paid work and her unpaid work or between his unpaid work and her paid work. We expect the 'own-time substitution' to be negative in all cases. A positive 'cross-spouse/same activity substitution' predicts bargaining or comparative advantages and a negative 'cross-spouse/same activity substitution' predicts assortative mating, whereas an insignificant 'cross-spouse/same activity substitution' predicts 'doing gender'. A positive, negative, or insignificant 'cross-spouse/ dif-

ferent activity substitution' predicts support for bargaining/comparative advantages, assortative mating, or 'doing gender', respectively. Distinguishing empirically between the comparative advantage theory and bargaining theory is not possible.

The analysis reveals interesting results for the interactions between paid work and unpaid work for individuals and within couples. We find negative 'own-time substitution' between paid work and unpaid work for both men and women. In addition, we find interaction between the spouses' paid work, through the positive 'cross-spouse/same activity substitution', whereas the 'cross-spouse/same activity substitution' is insignificant for unpaid work. Finally, we find 'cross-spouse/different activity substitution' for women, but not for men. The more paid work the man does, the more unpaid work the woman does; and the more unpaid work he does, the more paid work she does; but the reverse substitutions are insignificant.

As for the four theories, we find some evidence of assortative mating, especially for paid work, as we find a positive correlation between the spouses' paid work hours. In addition, results favour the 'doing gender' theory, because we generally find that men do not react to female labour supply, whereas women react to male labour supply. But the results do not support the theories of comparative advantages or bargaining.

When we extend the analysis to three types of working time (paid work, housework, and childcare) an interesting pattern appears. The interactions between paid work and housework are identical to the interactions between paid work and unpaid work, whereas only a single substitution term regarding childcare is significant. The finding of this 'own-time substitution' is that women's paid work hours are significantly lower, the more childcare they do, showing that women with young children often work reduced hours. This result indicates that the determination of childcare is even more gendered than housework and, therefore, analysing the two tasks together is unsound.

We draw two main conclusions from these analyses. First, the results show surprisingly little support for the bargaining theory. Gender equality is relatively high in Denmark in terms of working hours, where both men and women work about 60 hours per week when adding paid and unpaid work. The traditional self-perception among Danes is that spouses bargain over work tasks. However, this analysis does not support that view. Although our analysis is constrained by the linearity of the empirical model, this result is nevertheless surprising and needs further investigation.

Second, the results show significant differences in the determination of housework and childcare, although 'doing gender' is a major explanation for both. We find interaction between paid work and housework, but (almost) not between paid work and childcare or housework and childcare. This finding emphasizes the importance of analysing housework and childcare separately if we are to gain more insight into the determination of the two.

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Assessing alternative dissimilarity indexes for comparing activity profiles

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Abstract

When making between-group time use comparisons, it is often useful to have a single measure that summarizes the dissimilarity between the two groups. This paper examines the robustness of four alternative dissimilarity indexes. The main finding is that unweighted indexes, such as the Szalai T, are sensitive to the level at which activities are aggregated, while weighted indexes are robust to the level of aggregation.

JEL-Codes: C81, C43, J22

Keywords: Dissimilarity index, time allocation, time-use

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1 Introduction

When comparing time use across groups, researchers typically make activity-by-activity comparisons. However, there are times when it is more informative to measure between group differences using an index that summarizes the differences in "activity profiles," which are vectors of the time spent in each activity.

The usefulness of these indexes can be illustrated by two issues that arose while developing the American Time Use Survey (ATUS)[1]. The first issue pertained to the substitutability of different days of the week in data collection (see Stinson, 1999). The ATUS currently postpones an interview by one week if the respondent is unavailable on the interview day. For example, if the respondent is unavailable on Tuesday to be interviewed about Monday, he or she is called on the following Tuesday and interviewed about the following Monday. However, the development team considered allowing substitution of one weekday for another. Continuing the above example, if the respondent was not available on the Tuesday, he or she would be called on, say, the following Thursday and interviewed about the Wednesday. Such substitution only makes sense if Mondays are fairly similar to Wednesdays.[2] The second issue concerned the distribution of diary days over the days of the week. If weekdays are fairly similar to one another, then it is possible to reduce standard errors by oversampling weekends. Both of these issues required ATUS developers to assess the similarity of different days of the week, and I will use these day-of-week comparisons as examples when evaluating alternative indexes.

Several dissimilarity indexes have been proposed, but the most commonly used measure is the one proposed by Szalai (see Harvey, 1984)[3]. The Szalai index, TS, is written as:

$$T_S = \sqrt{\frac{\sum_{i=1}^{k}\left(\frac{a_i - b_i}{a_i + b_i}\right)^2}{k}} \qquad (1)$$

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1 These indexes have also been used by Converse (1972) to compare time use across countries and by Stewart (2004) to compare workers and nonworkers.

2 Although we found that weekdays are fairly similar to each other, the ATUS development team decided against allowing day-of-week substitution because field testing showed that it did not increase response rates over postponement.

3 Another index is the Ferge-Converse index, which is given by the following formula (see Harvey, 1984):

$$T_{FC} = \sqrt{\left[\sum_{i=1}^{k}\left(\frac{a_i - b_i}{24}\right)\Big/ k\right]^2} \times 100$$

However, Harvey (1984) points out that, unlike the Szalai index, the Ferge-Converse index does not take into account the length of the activity. Each term in the summation is a function of the difference in the time spent in an activity as a fraction of the 24-hour day. In contrast the Szalai T measures the difference in time spent in an activity as a fraction of the total time spent in the activity. For this reason, I focus on the Szalai index.

where a_i is the time (in minutes) spent in activity i by group a, b_i is the time spent in activity I by group b, and k is the number of activities. The Szalai index is scaled so that it equals zero if the activity profiles of the two groups are identical, and it equals one the two groups have no activities in common. There are two important properties of the Szalai index that affect its usefulness for comparisons.

The first property is that all activities are weighted equally. This implies that a proportional difference, measured as $(a_i-b_i)/(a_i+b_i)$, of 0.1 in the time spent in a 4-hour activity has the same impact on the value of the index as a 0.1 difference in a 2-minute activity. Thus, if two activities have the same absolute difference between groups, the shorter-duration activity will have a greater impact on the index value. This sensitivity to short-duration activities implies that the Szalai index will also be sensitive to the level of aggregation of activities. Time-use data typically show that there are large (in relative terms) between-group differences in the time spent in detailed, shorter-duration activities. When these activities are aggregated into a relatively small number of longer-duration activities, the variation decreases, because positive and negative differences tend to cancel each other out.

The second property is that each term in the summation is squared. Thus, activities that differ significantly (in percentage terms) across groups (days) have a disproportionately large impact on the index, although the impact of extreme values is bounded because the contribution of any one activity has a maximum value of one. However, if short-duration activities have the greatest proportional differences, then squaring the proportional difference for each activity will magnify the impact of short-duration activities on the value of the index.

The goals of this paper are to evaluate the robustness of this and alternative dissimilarity indexes and to make recommendations for researchers.

2 Alternative indexes

The discussion above suggests that weighted indexes, where the weights are equal to the fraction of total time spent in each activity, will be less sensitive to short-duration activities and the level of aggregation, and that absolute-deviation indexes will be less sensitive to extreme values. Below, I consider three alternative indexes.

2.1 The weighted Szalai index

(2) $$T_{WS} = \sqrt{\sum_{i=1}^{k}\left(\frac{a_i - b_i}{a_i + b_i}\right)^2 \frac{a_i + b_i}{\sum_{i=1}^{k} a_i + b_i}} = \sqrt{\sum_{i=1}^{k}\left(\frac{a_i - b_i}{a_i + b_i}\right)^2 \frac{a_i + b_i}{2880}}$$

This index is the same as the Szalai index, except that the squared term is multiplied by the fraction of total time spent in the activity instead of by 1/k.

2.2 The absolute-deviation index

$$T_{AD} = \sqrt{\frac{\sum_{i=1}^{k} \frac{|a_i - b_i|}{a_i + b_i}}{k}} \tag{3}$$

This index is the same as the Szalai index except that each term is the absolute value of the difference in time spent in the activity expressed as a fraction of the total time spent in the activity instead of the squared difference (expressed as a fraction of total time).

2.3 The weighted absolute-deviation index

$$\begin{aligned} T_{AD} &= \sum_{i=1}^{k} \frac{|a_i - b_i|}{a_i + b_i} \frac{a_i + b_i}{2880} \\ &= \sum_{i=1}^{k} \frac{|a_i - b_i|}{2880} \end{aligned} \tag{4}$$

This index is the same as the above absolute-deviation index, except that the difference term is multiplied by the fraction of total time spent in the activity instead of by 1/k.

2.4 Interpreting the indexes

Interpretation of the absolute deviation indexes is straightforward, because both of these indexes are, by definition, equal to the average proportional difference in the time spent in activities across the two groups. The weighted absolute deviation index, TWAD, also has the interpretation that it is the percent of time that must be reallocated to make the two groups identical. On the surface, it would appear straightforward to interpret the two versions of the Szalai index. Both are approximately equal to the average variation in the time spent in all activities expressed as a fraction of the total time spent in these activities.[4] However, this interpretation is not quite correct. By squaring the variation in time spent in each activity (and taking the square root of the sum of the squared terms), there is an asymmetric effect of proportional differences that are above the mean and those that are below the mean. Hence, both TS and TWS are generally greater than the average variation in the time spent in each activity.

[4] If the variation in the time spent in each of the k activities is equal to X, where $0 \leq X \leq 1$, then the index is exactly equal to the average proportional variation and TS = TWS = X. Thus a value of 0.1 would indicate that the variation in the time spent in each activity varies by approximately 10 percent across the two groups.

3 Comparing the indexes

In this section, I compare the four indexes using data from the 1992-94 EPA time-diary study conducted by the University of Maryland. As noted in the introduction, the "groups" that I compare are days of the week.

3.1 Benchmark estimates

All four indexes take on a value of zero if the activity profiles of the two groups (days) are identical and a value of one if they have no activities in common. In practice, however, we can never expect the T indexes to exactly equal zero because activity profiles will always contain some random noise, even if the two days truly are identical. Because of this randomness, it is useful to determine the values that these indexes would take if the two comparison days are identical except for random noise.

My strategy for generating identical-day index values is to obtain several activity profiles for each day of the week, compute indexes for each pairwise combination of these "identical" days, and compute the mean of these identical-day indexes. I use the mean of these identical day indexes as my estimate of the value the index would take if the days were identical except for random noise. If the value of the indexes are less than or approximately equal to the mean, then the two day's activity profiles should be considered identical.

My first step was to divide the full sample into three equal subsamples for each day of the week (21 groups total).[5] Next, for each day of the week, I computed the Ti index (where i = S, WS, AD, WAD) for each of the three pairwise combinations of subsamples.[6] This yielded a "sample" of 21 Ti indexes (3 pairwise combinations per day × 7 days). I then computed the mean of these Ti indexes over the 21-observation sample.

Summary statistics for the identical-day values of the four indexes (computed using both 2-digit and 1-digit codes) are shown in Table 1. The most notable feature of Table 1 is that the identical-day values of the two unweighted indexes, TS and TAD, are quite large (0.449 and 0.313) when activity codes are aggregated at the 2-digit level. When 1-digit codes are used, the benchmark values range from 0.037 for TWAD to 0.116 for TWS. All of these means have small standard errors indicating they are precisely measured.

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5 Individual observations were randomly assigned to the three subsamples. I experimented with three other random assignments to make sure that the assignment I used was representative. The means were virtually identical in each case.

6 I should point out that the benchmark values of the indexes (especially TS and TW) depend on the number of groups. When the sample is divided into more groups, each group is smaller, and there is more variation across groups. I divided the sample into three groups, because three is the smallest number of groups that results in a sample of means of at least 20 observations. When I divided the sample into 5 groups (resulting in a sample of 70 observations of means), the average values of the T indexes increased by between 12 and 37 percent.

Table 1
Benchmark estimates for identical-day indexes

	Szalai Index		Weighted Szalai Index		Absolute Deviation Index		Weighted Absolute Deviation Index	
	1-digit	2-digit	1-digit	2-digit	1-digit	2-digit	1-digit	2-digit
Mean	0.116	0.449	0.060	0.133	0.083	0.313	0.037	0.069
Std. Error	0.008	0.008	0.003	0.004	0.005	0.006	0.002	0.002
Median	0.113	0.454	0.063	0.130	0.081	0.313	0.035	0.069
10th percentile	0.065	0.407	0.042	0.115	0.048	0.287	0.029	0.055
90th percentile	0.167	0.487	0.074	0.159	0.115	0.337	0.051	0.085

Source: University of Maryland - EPA Time Diary Study, 1992-1994, own calculation.

3.2 Comparisons

Table 2 shows the values for the four alternative activity profile indexes for day-of-week pairs. For each pair-wise comparison of days, I computed the indexes using both 1-digit and 2-digit codes. The numbers in parentheses are the value of the index expressed as a percentage of the relevant benchmark value.[7]

Both unweighted indexes, the Szalai index, TS, and the absolute-deviation index, TAD, tell very different stories depending on whether 1-digit or 2-digit activity codes are used. For the most part, when 2-digit codes are used, the two indexes indicate that there is very little difference between the seven days of the week. For both indexes, the values for weekday-weekday comparisons are generally less than the benchmark values (except for the Tuesday-Friday comparison). Weekday-Saturday comparisons yield values of TS that are between 97 and 104 percent of the benchmark value that would be expected if the two days are identical, while weekday-Sunday comparisons have values of TS that range between 95 and 116 percent of the benchmark. Based on these index values, one would conclude that Saturday and Sunday are at best only slightly different from the weekdays. The TAD index tells a similar story for these weekday-Saturday and weekday-Sunday comparisons.

In contrast, when using 1-digit codes, sharp differences across the days emerge. Both indexes show that Monday through Thursday are identical. Fridays are moderately different from the other weekdays (except for the Monday-Friday comparison) with values of TS ranging b tween 85 and 144 percent of the benchmark value, and TAD ranging between 87 and 142 percent.

[7] These percentages are computed by dividing the value of T_i by the benchmark value for T_i (for i = S, WS, AD, WAD) and multiplying by 100. So for the Friday-Saturday comparison using TS (and 2-digit codes) is 104 (= (0.465/0.449) × 100). If this percentage is equal to 100 percent of the benchmark value, then the two days are identical.

Table 2
Comparison of alternative dissimilarity indexes using 1-digit and 2-digit activity codes

Comparison		Szalai Index		Weighted Szalai Index		Absolute Deviation Index		Weighted Absolute Deviation Index	
of:	to:	1-Digit Codes	2-Digit Codes	1-Digit Codes	2-Digit Codes	1-Digit Codes	2-Digit Codes	1-Digit Codes	2-Digit Codes
Monday	Tuesday	0.101	0.351	0.058	0.098	0.074	0.241	0.041	0.056
		(87.2)	(78.3)	(97.6)	(74.0)	(88.5)	(77.2)	(109.5)	(81.5)
	Wednesday	0.130	0.356	0.054	0.096	0.085	0.249	0.033	0.052
		(112.8)	(79.4)	(91.1)	(72.0)	(102.6)	(79.7)	(87.9)	(75.5)
	Thursday	0.105	0.334	0.053	0.091	0.073	0.221	0.036	0.053
		(90.6)	(74.5)	(89.3)	(68.2)	(87.5)	(70.7)	(98.4)	(77.6)
	Friday	0.098	0.442	0.061	0.130	0.072	0.317	0.043	0.070
		(85.2)	(98.5)	(101.7)	(97.9)	(86.7)	(101.5)	(115.0)	(102.0)
	Saturday	0.245	0.435	0.194	0.232	0.206	0.335	0.127	0.152
		(211.8)	(97.0)	(326.0)	(174.7)	(247.7)	(106.9)	(343.7)	(222.0)
	Sunday	0.375	0.485	0.274	0.297	0.272	0.379	0.169	0.190
		(324.5)	(108.1)	(460.6)	(223.7)	(327.2)	(121.0)	(455.3)	(276.1)
Tuesday	Wednesday	0.072	0.370	0.031	0.080	0.053	0.242	0.019	0.037
		(61.9)	(82.6)	(51.9)	(60.2)	(63.2)	(77.4)	(50.7)	(53.3)
	Thursday	0.083	0.358	0.044	0.088	0.054	0.240	0.021	0.040
		(71.7)	(79.8)	(73.6)	(66.3)	(64.7)	(76.8)	(56.3)	(58.0)
	Friday	0.152	0.462	0.073	0.013	0.103	0.345	0.030	0.053
		(131.4)	(102.9)	(122.0)	(99.8)	(124.3)	(110.4)	(79.9)	(77.3)
	Saturday	0.292	0.453	0.242	0.271	0.234	0.354	0.165	0.187
		(252.6)	(101.0)	(406.2)	(204.1)	(281.2)	(113.3)	(445.7)	(272.5)
	Sunday	0.395	0.523	0.313	0.336	0.302	0.414	0.205	0.220
		(341.5)	(116.7)	(525.6)	(252.9)	(362.8)	(132.2)	(554.0)	(320.9)
Wednesday	Thursday	0.108	0.337	0.049	0.089	0.075	0.229	0.021	0.039
		(93.6)	(75.2)	(81.6)	(66.8)	(90.7)	(73.2)	(56.9)	(57.2)
	Friday	0.155	0.439	0.070	0.127	0.118	0.326	0.035	0.062
		(134.6)	(97.8)	(117.0)	(95.9)	(142.1)	(104.3)	(94.2)	(89.6)
	Saturday	0.278	0.458	0.227	0.261	0.234	0.358	0.155	0.180
		(240.4)	(102.2)	(381.8)	(196.4)	(281.5)	(114.4)	(419.0)	(262.6)
	Sunday	0.361	0.487	0.295	0.321	0.281	0.381	0.191	0.212
		(312.5)	(108.7)	(494.4)	(242.2)	(338.4)	(121.6)	(516.8)	(308.8)
Thursday	Friday	0.166	0.391	0.077	0.132	0.108	0.271	0.036	0.055
		(143.7)	(87.2)	(129.2)	(99.3)	(129.4)	(86.7)	(96.5)	(80.2)
	Saturday	0.289	0.453	0.230	0.263	0.231	0.354	0.161	0.182
		(250.4)	(101.1)	(386.0)	(198.1)	(278.4)	(113.2)	(434.1)	(264.8)
	Sunday	0.388	0.428	0.301	0.326	0.289	0.322	0.198	0.218
		(336.3)	(95.4)	(505.0)	(245.9)	(347.2)	(102.8)	(534.3)	(317.3)

Table 2 (cont.)

Comparison		Szalai Index		Weighted Szalai Index		Absolute Deviation Index		Weighted Absolute Deviation Index	
of:	to:	1-Digit Codes	2-Digit Codes	1-Digit Codes	2-Digit Codes	1-Digit Codes	2-Digit Codes	1-Digit Codes	2-Digit Codes
Friday	Saturday	0.221	0.465	0.219	0.251	0.186	0.355	0.152	0.172
		(191.5)	(103.8)	(367.5)	(188.9)	(223.5)	(113.5)	(410.9)	(250.0)
	Sunday	0.351	0.462	0.296	0.325	0.261	0.341	0.195	0.215
		(303.8)	(103.0)	(496.7)	(244.7)	(314.3)	(109.1)	(527.7)	(313.2)
Saturday	Sunday	0.246	0.422	0.140	0.186	0.178	0.305	0.080	0.113
		(213.1)	(94.0)	(234.9)	(139.7)	(213.7)	(97.6)	(214.8)	(165.0)

Source: University of Maryland - EPA Time Diary Study, 1992-1994, own calculation.

Saturdays and Sundays are quite a bit different from the weekdays and from each other. Comparing Saturdays to the weekdays, we see that TS is between 191 and 253 percent of the benchmark value and T_{AD} is between 224 and 282 percent of the benchmark. The differences between Sunday and the weekdays are even greater. The Saturday-Sunday comparison indicates that these two days are different from each other (both T_S and T_{AD} are just over 210 percent of the benchmark value), but not as different as they are from the weekdays.

The most important thing to take away from this discussion is that both of the unweighted indexes are sensitive to the level of aggregation of activity codes. Someone looking at the indexes constructed using 1-digit activity codes would draw very different conclusions about the similarity of the days of the week than would someone who used indexes constructed using 2-digit codes. The reason for this difference is that there are many more short-duration activities when using 2-digit activity codes. To verify that this is the cause, I recomputed the T_S and T_{AD} indexes using 2-digit activity codes, but omitting any activity that lasted 5 minutes per day (on average) or less. I found that, although there are still differences, the indexes computed using the 1-digit and the modified 2-digit codes tell essentially the same story.

In contrast to the unweighted indexes, both of the weighted, T_{WS} and T_{WAD}, indexes tell the same story, regardless of whether activities are coded at the 1-digit level or the 2-digit level. Both weighted indexes, TWS and TWAD, show that the weekdays are identical to each other. The values of TWS and TWAD are slightly higher for comparisons to Friday and exceed then benchmark values for only a few comparisons at the 1-digit level (3 for T_{WS} and 1 T_{WAD}). Both indexes also show that Saturdays and Sundays differ from the weekdays, with Sundays differing the most. The difference between Saturdays and Sundays is larger relative to the benchmark value when 2-digit codes are used, but regardless of whether 1-digit or 2-digit codes are used it is clear that the differences are much smaller than between these days and the weekdays.

Table 3 further examines the sensitivity of these indexes to short-duration activities. The top panel shows the time spent in the ten 1-digit activities on Wednesday, Friday, Saturday, and the differences between Wednesday and the other two days. As noted above, the two unweighted indexes indicate a moderate difference between Wednesday and Friday, while the weighted Szalai index indicates a slight difference and the weighted absolute-deviation index indicates no difference. Casual inspection of the "Wednesday-Friday Difference" column confirms that the differences between Wednesday and Friday are small.

Table 3
The effect of selected activities on dissimilarity indexes

Activity	Time Spent in 1-Digit Activities (Minutes Per Day)			Wednesday- Friday Difference	Wednesday- Saturday Difference
	Wednesday	Friday	Saturday		
Leisure	211.2	206.8	239.5	4.4	-28.3
Sports	38.5	42.2	52.8	-3.7	-14.2
Entertaining & Socializing	39.6	61.9	110.2	-22.3	-70.6
Organizational Activities	17.3	9.2	13.5	8.1	3.8
Education & Training	22.7	14.5	11.7	8.3	11.0
Personal Care	617.9	619.5	666.2	-1.5	-48.3
Purchasing Goods & Services	44.1	50.5	76.6	-6.4	-32.5
Child Care	28.6	20.0	14.6	8.6	14.0
Household Work	110.5	89.6	140.0	20.8	-29.5
Paid Work	309.5	325.8	115.0	-16.3	194.6
	1440.0	1440.0	1440.0		

Source: University of Maryland - EPA Time Diary Study, 1992-1994, own calculation.

Table 4 shows how the index value changes when selected activities are omitted from the calculations.[8] Entertaining & Socializing and Household Work have similar absolute differences in the Wednesday-Friday comparison, but omitting Entertaining & Socializing, which is a shorter-duration activity, has a much larger impact on the unweighted indexes than omitting Household Work. For the Weighted Szalai index, the effect of omitting Entertaining & Socializing is slightly larger, mainly because the squaring of each term effectively places greater weight on shorter-duration activities. Finally, the change in the Weighted Absolute-Deviation index is the same whether it is Entertaining & Socializing or Household Work that is deleted.

[8] This was done by setting the term corresponding to the activity equal to zero.

To further illustrate the effect of short-duration activities, consider the effect of omitting Organizational Activities. This is a very short-duration activity that accounts for less than 1 percent of total time. Yet, omitting this activity decreases the two unweighted indexes by more than 0.030, compared with declines of less than 0.010 for the two weighted indexes.

The comparison of Wednesday to Saturday yields some different insights. Omitting Household Work has the same effect on all of the indexes as omitting Leisure, with the effects being almost zero for the two Szalai indexes. This result is somewhat surprising for unweighted indexes. One would expect the impact of deleting Leisure to be smaller for the unweighted indexes, because nearly twice as much time is spent in Leisure. This suggests that even moderate differences in the time spent in activities have little effect on the index when the total time spent in an activity is sufficiently large. Finally, omitting Entertaining & Socializing has about the same effect on the unweighted indexes as omitting Paid Work even though the absolute difference for Paid Work is nearly three times as large. Not surprisingly, the effect of omitting Paid Work is larger than the effect of omitting Entertaining & Socializing for the weighted indexes.

Table 4
The effect of selected activities on dissimilarity indexes

	Szalai Index	Weighted Szalai Index	Absolute Deviation Index	Weighted Absolute Deviation Index
Wednesday-Friday Comparison				
Original Index Value	0.155	0.070	0.118	0.035
Omitting Entertaining & Socializing	0.139	0.056	0.096	0.027
Omitting Household Work	0.152	0.064	0.108	0.028
Omitting Organizational Activities	0.121	0.063	0.087	0.032
Wednesday-Saturday Comparison				
Original Index Value	0.278	0.227	0.234	0.155
Omitting Household Work	0.275	0.225	0.222	0.145
Omitting Leisure	0.277	0.226	0.228	0.145
Omitting Entertaining & Socializing	0.234	0.200	0.187	0.131
Omitting Paid Work	0.237	0.144	0.188	0.088

Source: University of Maryland - EPA Time Diary Study, 1992-1994, own calculation.

4 Summary and recommendation

In this paper, I examined the robustness of four alternative dissimilarity indexes, and found that the two unweighted indexes, T_S and T_{AD}, are sensitive to the presence of short-duration activities. Small absolute differences in short-duration activities have a large impact on unweighted indexes, while large differences in long-duration activities have relatively little impact. Because disaggregating activity codes into more detailed activities results in more shortduration activities, the unweighted indexes are therefore also sensitive to the level of aggregation. Thus, these unweighted indexes can tell very different stories depending on whether they are constructed using 1-digit or 2-digit activity codes. For example, had we relied on either of the unweighted indexes computed using 2-digit activity codes, we would have erroneously concluded that weekdays and weekends are fairly similar to one another. Even if we had computed the indexes using 1-digit activity codes, we would have erroneously concluded that Fridays were moderately different from the other weekdays.

In contrast, the two length-of-activity weighted indexes, T_{WS} and T_{WAD}, are robust to the level of aggregation, because short-duration activities receive little weight. Although the actual values of the weighed indexes depend on whether activities are coded at the 1-digit level or the 2-digit level, they tell the same story regardless of the level of aggregation. The two absolute-deviation indexes, T_{AD} and T_{WAD}, are easier to interpret, because they are equal to the average proportional difference in the time spent in all activities. In contrast, it is not clear what interpretation to attach to the T_S and T_{WS} indexes.

Given its robustness and its natural interpretation, the weighted absolute-deviation index, T_{WAD}, clearly dominates the other indexes considered.

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Do time use patterns influence fertility decisions? A cross-national inquiry

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Abstract

Birth rates are falling throughout the western world. There is no definitive answer as to why this is so. This paper investigates whether time use analysis could offer a useful perspective. It explores the way parenthood affects time allocation in four countries with different work-family policies, using data from the Multinational Time Use Survey (MTUS) World 5 series to compare the impact of children on adult time in Italy, Germany, Norway and Australia. It considers whether fertility decisions may be influenced by i) the gap between parents and non-parents in total paid and unpaid work undertaken, ii) how paid and unpaid work is divided between mothers and fathers, and iii) the proportion of total male and female work time that is paid before and after parenthood, and conducts multivariate analysis to isolate the effects of nationality, sex and parenthood. The study is very preliminary, but the results suggest that domestic gender inequity and low female workforce participation are associated with lower fertility and may affect parity progression. Further research using more extensive and detailed time use analysis could make an important contribution to understanding of fertility decline.

JEL-Codes: J13, J16, J22

Keywords: time use, children, fertility decline, gender, work-family, comparative policy analysis

This document presents results drawn from the Multinational Time Use Study (MTUS), but the interpretation of this data and other views expressed in this text are those of the author. This text does not necessarily represent the views of the MTUS team or any agency which has contributed data to the MTUS archive. The author bears full responsibility for all errors and omissions in the interpretation of the MTUS data.

1 Introduction

Fertility rates are falling across the western world. There is no comprehensive or definitive answer as to why this is happening. Not only are the causes various and multifaceted, but also the dimensions and extent of the phenomenon vary from country to country. While the trend is ubiquitous, in some places, fewer people are having children (so there is increased childlessness), in others people are having fewer children (so there are smaller families), and in others both patterns are evident. Fertility decline is a serious national concern in some countries, while other countries are maintaining adequate birth rates. This cross national variation has led some to suggest that policy environments are implicated in fertility decline, because they can influence the costs of children, and how these costs are shared socially and by sex. One of the major costs of children is the time cost, which has historically received less attention than the monetary cost. This paper investigates whether foregrounding time has the potential to offer a useful perspective on fertility patterns. It undertakes a preliminary study into whether national fertility rates in any way correspond to variation in the way parenthood affects how men and women spend their time in paid and unpaid labour in four countries with contrasting policy approaches to work and family. Specifically, it uses the MTUS World 5 data to investigate parental versus non-parental time allocation in Germany, Italy, Norway and Australia.

2 Background and literature

The onset of fertility decline occurred across the developed world between 1870 and 1930, in what came to be termed "the demographic transition". In association with the changing economic and social conditions of modernisation, including the separation of work from home, improvements in health, mortality decline (including higher child survival rates), compulsory education and reduced economic contribution from children, the birth rate fell (Andorka, 1978; Caldwell, 1997; McDonald, 2001; Ricardo-Campbell et al., 1987). It was expected that as countries experienced the demographic transition, fertility would stabilise at around replacement level, with births and deaths remaining in approximate equilibrium (Caldwell, 1976; Notestein, 1953; Thompson, 1929). Instead, birth rates have continued to fall. At first it was thought that this continued decline was a temporary phenomenon resulting from transitory adjustments such as delayed childbearing (Bongaarts and Feeney, 1998; Lesthaeghe and Willems, 1999; Sobotka, 2004a). But it has persisted over time, increased in speed, and reached historical lows (Kohler et al., 2002; Sleebos, 2003).

It now appears that the decline is more than a temporary phenomenon, and many governments are identifying it as a crucial policy challenge (Kohler et al., 2006). In a reversal of earlier anxiety about overpopulation, there is general agreement that declining fertility, especially to

very low levels, is a serious problem threatening adverse economic and social consequences (McDonald, 2004a). It leads to structural aging of the population, which threatens economic growth through a shrinking workforce, increased demand for aged services, and raised dependency ratios (Adsera, 2004; Kohler et al., 2006; Sleebos, 2003). It could substantially weaken social cohesion and is a potential source of inter-generational conflict (Barnes, 2001; de Vaus, 2002; Martin, 2002).

There are many theories as to why fertility is falling. Explanations arise variously from economic, social, cultural, political and temporal factors (Bryson et al., 1999; Cannold, 2005; Davis, 1997; de Vaus, 2002; Easterlin, 1973; Hantrais, 1997; Hrdy, 1999; Lesthaeghe, 1998; McDonald, 2001; Quesnel-Valee and Morgan, 2002; Sleebos, 2003; Weston and Qu, 2001). Overviews of the suggested influences can be found in (Kohler et al., 2006; Sleebos, 2003; Sobotka, 2004a). While no explanation constitutes a single overarching theory, fertility decline is usually associated, at least implicitly, with the economic emergence of women. Time is an important element in this. In this paper, I concentrate on three somewhat overlapping theories of fertility decline, in which time is a central element.

2.1 Three time-related perspectives on fertility decline

Neoclassical economics puts fertility into a rational choice framework, conceptualising it as apersonal, active decision based on a calculation of costs and benefits (Becker, 1988). Fertility will fall as the costs of children rise, and the benefits fall. Under current social organisation, children are an economic drain (Caldwell, 1982), so the major benefit is seen as the pleasure or utility the parents derive from having them (Becker, 1988). "Parents choose optimal values of their own consumption, the number of children and capital transferred to each child while taking into account the cost of rearing children and the dependence of their utility on the presence of children" (Becker, 1988). The costs consist of both money and time. There is a large literature on the financial cost of children (see for example Rothbarth, 1943; Barten, 1964; Gronau, 1988 and 1991; Browning, 1992; Saunders, 1998; Valenzuela, 1999), and growing recognition that as more women are gaining an education and joining the paid labour force, another major component of the cost of children is the opportunity costs of mothers' foregone market wages (Apps and Rees, 2000; Becker, 1965, 1981 and 1988; Folbre, 2001; Joshi, 1990; Nelson, 1996). The neoclassical viewpoint contains two important assumptions. First, the individualistic focus sidelines the issue of whether social policies that redistribute or socialize the costs (including the time costs) of children could influence fertility decisions. Second, as has been thoroughly covered in feminist research (see for example England, 1993 and 2003; Nelson, 1996) the theory assumes joint household utility function. Thus there is no acknowledgement that if having children has a different time impact on men and women, which therefore the costs of children profoundly differ by sex.

Other theorists do highlight the gender disparity, and draw a link between social policy and fertility outcomes. Many note that there is a gap between achieved and desired fertility, and suggest that there are social barriers to optimal fertility (Bryson et al., 1999; de Vaus, 2002;

Quesnel-Valee and Morgan, 2002; Sleebos, 2003; Weston et al., 2004; Weston and Qu, 2001). The barrier most widely identified is the opportunity of mothers to participate in the workforce (Castles, 2002; Chesnais, 1996; McDonald, 1997). The economic theory outlined above predicts a negative correlation between female work force participation and fertility, which will be stronger the higher the maternal wage (Becker, 1981). In the middle of the twentieth century, this was borne out empirically, and fertility was negatively associated with female work force participation both at the household and national level (Mincer, 1985). "Many mothers have responded to the competing demands of employment and childrearing by loosening their attachment to the paid work force" (Gornick et al., 1996).

However, this is no longer the case. Since the 1980s the relationship between fertility rates and female labour force participation has reversed, and they are now positively correlated. Countries in which relatively high numbers of mothers are in the paid work force, have higher fertility rates than countries in which fewer mothers do market work (Ahn and Mira, 2002; Brewster and Rindfuss, 2000; Chesnais, 1996; Engelhardt and Prskawetz, 2002), implying that the more difficult it is for women to combine family responsibilities with paid work, the fewer children they will have, particularly when there is a mismatch between the opportunities of childless women and mothers (Castles, 2002; McDonald, 1997). This informs the second time-based fertility theory – the idea that social policies that facilitate mothers continued work force participation (i.e. that minimise the opportunity cost of having children) are those most likely to encourage fertility (de Laat and Sevilla Sanz 2004; McDonald 2000).

A third time-related view on fertility decline emphasizes the direct time and labour costs of children, and how these are allocated by gender. Having children brings with it a sizable work increase, which falls disproportionately to women (Craig, 2006a) Some argue that more equitable sharing of the labour time burden of children by gender is critical to higher fertility (Joshi and Davies, 1999). "If the issue of men's shared responsibility for their children is avoided, if childrearing becomes only mothers' business, it could be a business with a bleak future" (Joshi, 1998). Drawing from domestic bargaining theory, Widmalm argues that lack of fairness leads to non-cooperation and withdrawal from domestic labour. If the domestic labour of partners is very unequal, women will withdraw their contribution to the provision of household public goods that are created by unpaid work, even at the cost of not having something they value (Widmalm, 1998). It is possible that non-cooperation and withdrawal from household undertakings extends to unwillingness to have children. In other words, there may be a positive relationship between male contribution to domestic work and national birth rates (Craig, 2003; de Laat and Sevilla Sanz, 2004). Henneck (2003) argues that in the US, where the birth rate is comparatively high, the lack of state support forces parents to negotiate between themselves, and to make childcare and housework more equitable. Scandinavian data also tentatively indicate that involving fathers in childcare may stimulate fertility (Ronsen, 1998). On this view, domestic gender inequity is a barrier to fertility. If childcare is all left to women, they will limit their families or have no children.

These latter perspectives do not assume that all family members have the same interests, and distinguish between male and female welfare in fertility decisions. They also imply that the way children impact upon welfare is intertwined with institutional setting and social policy environment (Kohler et al., 2006).

2.2 Cross-national comparison

To test this assumption requires comparison across policy variation. This is somewhat problematic, as it is rarely possible to isolate the effects of particular policies. The most common way of testing the effects of alternative policy-settings is through comparative international research, which can be styled a quasi "natural experiment" on the effects of policy variation (Castles, 2002). The difficulty lies in how to compare particular countries. An established method has been to group them into policy regimes, or clusters of countries that have similar policy approaches. Esping-Andersen (1990) pioneered this approach, dividing westerns states into a three-way grouping; using de-commodification, (the degree to which social support can allow people to live independent of market work force participation) as a major distinguishing characteristic.

However, there was extensive feminist criticism of relying on de-commodification as a criterion, because it underplayed family inputs to the provision of welfare, and is profoundly gender-blind. It failed to recognise that an essential dimension of social risk for women is the freedom to provide or to not provide caring services (Arts and Gelissen, 2002; Lewis, 1997; O'Connor et al., 1999; Orloff, 1993; Sainsbury, 1996; Siaroff, 1994; Taylor-Gooby, 1991; Trifiletti, 1999). In response, Esping-Andersen (1999) developed the concept of "familialisation" (the degree to which citizens' welfare depends on family support) as a further criterion for categorising welfare regimes (Esping-Andersen, 1999). Greater theoretical acknowledgment of the family inputs to welfare opened up a fertile area of focus for international research: time spent in unpaid work. The unpaid work burden can yield important information on how social policy environment translates to reality in people's lives (Gornick et al., 1996; Land, 1995; Orloff, 1997; Plantenga and Hansen, 1999).

However, welfare regime classification remains a debated concept. Some suggest that cluster comparisons lack meaning (Sainsbury, 1996). A difficulty is that the groupings are ideal types only, and individual countries seldom perfectly represent the model. Inevitably each will in some respects be atypical of its nominal classification (Castles and Mitchell, 1993; Goodin et al., 1999; Ronsen, 1999; Sainsbury, 1996) Globalisation may mean that it is no longer meaningful to study policy regimes, as they rarely lie discretely within national borders (Hochschild and Ehrenreich, 2002; Williams, 2006), Some argue that social policies are too mutable to be compared, that regimes are converging to a common type, while others assert that convergence is only partial (Avdeyeva, 2006).

Even acknowledging these caveats, paying attention to both work and care is a more promising perspective. Inter alia, this broader view reveals that a major effect of policy regimes is in the type of household formation they encourage. Jane Lewis introduced the concept of the

"male breadwinner" model, in which policies assume and entrench female dependency on male earnings (Lewis 1992) and Rosemary Crompton identifies four household types, categorised according to how the adults within them allocate time to market work and home duties. These are male-breadwinner–female carer; male full-time–female part-time worker, part-time carer; dual-earner–substitute carer; and dual-earner–dual-carer Crompton (1999). Korpi (2000) builds on Esping-Andersen and incorporates some of these latter insights to suggest a grouping of countries according to the type of employment-care regime encouraged. His categories are dual earner support (exemplified by the Scandinavian countries) general family support (divided into Continental Europe and Southern European countries); and market oriented (exemplified by the English speaking countries) (Korpi, 2000).[1]

While acknowledging that any classification has flaws, this paper selects one country from each of the four regime clusters Korpi identifies. These are Germany, Italy, Australia and Norway. Since each country will have an individual profile that is not entirely commensurate with its ostensible grouping, a brief description of family policies, female workforce participation, economic circumstances, and fertility patterns follows. Key indicators are presented in Tables 5 and 6 in the Appendix.

2.2.1 Germany

Germany is a state in which policy, informed by the idea that children require maternal care, reinforces the breadwinner husband and female caregiver family model (O'Hara, 1998; Abrahamson, 1999; Trzcinski, 2000). The organization of social institutions reflects this expectation. There is an undersupply of childcare places, and fees are very high. Traditionally, the school day ends at 1.00 p.m. In 2000, 70% of all German women were employed with a very high proportion (85%) working part-time but the participation rate for mothers is significantly lower (Clearinghouse, 2005; OECD, 2002b). In Germany, forty six per cent of all married mothers with children under six are employed, almost all working short part-time hours (Abrahamson, 1999). The difference between the participation rate of childless German women and of German mothers of two or more children is over 20 percentage points (OECD,

[1] Dual earner support regimes have public policies that explicitly promote women's independence from family obligations by encouraging the sharing of childcare and household tasks, and supporting gender equality in workforce participation. Policies (including the provision of subsidised public day care services for children from infancy, paid maternity leave, paid paternity leave, and public home help to the elderly) are intended to shift provision of care from the unpaid to the paid sector (Korpi, 2000). Market oriented regimes largely leave work-family issues to private arrangement. These regimes are theoretically gender blind, and though they do not actively promote dual-earning families, tend to be open to their occurrence through private market arrangements (Esping-Andersen, 1999; O'Connor et al., 1999; Orloff, 1996). General family support regimes regard the family as the primary source of care and welfare, and public policy supports the 'bread-winner-father-stay-at-home-mother' household. Indicators include cash child allowances, family tax benefits and public day care services for children over three. Family benefits and taxation measures discourage mothers from working, especially full time. The principle of subsidiarity means that the state will only interfere if family resources are exhausted. (Andinach, 2002; Esping-Andersen, 1999; Thevenon, 2003). Southern European countries neither facilitate women's workforce participation, nor generously subsidise home care. The extreme lack of state intervention encourages even greater reliance on family resources (Arts and Gelissen, 2002; Hantrais, 1997; Leibfried, 1991; Siaroff, 1994).

2002b). It is less pronounced when there is only one child (see Table 6). Germany has one of the lowest birth rates in the European Union and one of the highest proportions of childless women. Thirty per cent of German women have not had children, although women who do have children are likely to have several (Kohler et al., 2006). The government has now lifted the birth rate to the top of the political agenda, and new policies, including tax breaks to families, eliminating fees for kindergarten and extending maternity and parental leave provisions, have been instituted or proposed. German economic indicators are generally sound, with GDP slightly above the OECD average, and poverty rate and income inequality slightly below. However child poverty, at 12.8%, is marginally above the OECD average (see Table 5)

2.2.2 Italy

The national constitution of Italy defines the family as a private domain with which the state should not interfere (Hantrais, 1997). Italy's family policies neither facilitate women's workforce participation, nor generously subsidise home care, which means it there is very heavy reliance on family resources. There is low female workforce participation, for both with little difference between the participation of childless women and mothers (see Table 6). There are few opportunities for part time work. The (predominantly private) nurseries charge high childcare fees, there are few childcare places for under three year olds, and daily hours are limited. So for women working fulltime, public childcare is not a ready option (OECD 2003). Economic indicators are mixed: GDP is above OECD average, but both general and child poverty rate, and income inequality are higher than the average (see Table 5). There is a chronic shortage of affordable housing for young people, and many stay at home until well into adulthood (Avdeyeva, 2006). Italy is in the lowest-low fertility range, defined as a TFR at or below 1.3 (Kohler et al., 2002). The projected age dependency ratios (see Table 5) show that Italy faces a very severe population downturn by 2050. Both increased childlessness and smaller family size are contributing to fertility decline, which the Italian government regards as extremely serious. It has introduced new measures, including a one-time payment of 1,000 Euros to couples who have a second child, and late last year a proposal that mooted paying women not to have abortions gained popular support in Parliament (OECD, 2003).

2.2.3 Australia

Although some argue that the US is actually the only true example of a liberal welfare state (Castles and Mitchell, 1993), Australia is usually included in this grouping. It conforms to the categorisation in some ways, and deviates from it in others (Bryson, 1992; Cass, 1994; Castles and Mitchell, 1993; O'Connor et al., 1999; Shaver, 1995). The welfare system is very targeted, and there are almost no universal benefits. There is no statutory maternity leave, and arrangements for work and care are a matter for private choice, at least rhetorically. However, measures tend to reinforce traditional gender roles (Forssen and Hakovirta, 2000, Charlesworth et al., 2002). In particular, the relatively generous family tax transfers prioritise assistance to single-earner couple families (McDonald, 2004b). Australia has relatively low female employment rate, even for childless women. It falls further with each child (see Table 6).

Australia shows a more marked decline in work force participation for mothers than other OECD countries (Campbell et al., 2005; Lee, 2005; Whitehouse, 2001), and the majority of employed Australian mothers work part-time (Charlesworth et al., 2002; Earle, 2002; OECD, 2002b). There is fairly substantial government funding for social services including health and education. Extra-household childcare arrangements are highly regulated and the standard is comparatively high (Brennan, 1998; Cass, 1994) but it is expensive, and places are insufficient, particularly for under-three year olds (Castles, 2004; Orloff, 1996; Pocock, 2003). Historically, Australia has provided comparatively generous support to sole parents who care for their own children (O'Connor et al., 1999; O'Hara, 1998) although recent welfare-to-work initiatives will change this (Brennan and Cass, 2005; Craig, 2005). The fertility rate is not very low by OECD standards. Australia is one of only three countries at sufficiently high birth rates to maintain current population in the medium term (Kohler et al., 2006) None-the-less fertility decline is a subject of concern to the government, and more generous family payments have been introduced. The norm is still two children, but one-child families are the fastest-growing family configuration (Kippen, 2001).

2.2.4 Norway

Nordic governments have a history of social policies aimed at helping people balance their work and family life, which are comparatively generous by OECD standards (OECD, 2003). Gender equality is an explicit (though not yet fully realised) aim. In Norway, mothers are entitled to 12 months off work with 80% pay or 10 months with full pay. Mothers must take the first six weeks after birth as maternity leave, but after that it is up to the parents to share the remaining leave as they wish. Also, fathers must take at least four weeks leave or else those weeks will be lost for both parents. The paid leave is financed through taxes, so the cost to both parents and employers is minimised. The generous family policies are credited with encouraging people to have children, and although following a slight increase in during the 1990s the birth rate has subsequently declined, it is still amongst the highest in the OECD (Kohler et al., 2006). So Norway has both a comparatively high birth rate, and a comparatively high female and maternal employment rate. Childless women and mothers have the same workforce participation rate (see Table 6). It has a GDP well above the OECD average, a poverty rate much lower than the other countries studied, and somewhat less pronounced income inequality (see Table 5). The child poverty rate is lower than that of the general population, the only country here studied for which that is the case.

2.3 Research focus

In summary, time is now a large part of the cost of having children, and some theories of fertility decline intimate a relationship between the time costs of children and birth rates. Social and cultural environments will exercise an effect over how the time cost of children manifests itself – how it is distributed socially, and in the private sphere. The theories give rise to the speculations that:

1. Birth rates will be higher where the time commitment of parents (both in total workload and in unpaid workload) is most similar to that of non-parents.
2. Birth rates will be higher where fathers' and mothers' time allocation to paid and unpaid work is most equitable.
3. Birth rates will be higher where mothers are able to allocate a higher proportion of their total work time to paid work.

This paper conducts a preliminary comparative study to explore these possibilities.

3 Data and method

The data used is from the Multi-national Time Use Study (MTUS) World 5.5 series. The MTUS began in the late 1980s when researchers initiated a project to collect time use data sets from 20 countries, and prepare a version of these data sets to allow cross-national comparability and harmonisation into a multinational file. The MTUS is constantly updated and added to as new surveys are completed. This paper analyses a sub-sample of the MTUS: individuals in families with or without children, in Australia (survey year 1992 N=5905), Germany (survey year 1992 N=7761), Italy (survey year 1989 N=13457), and Norway (survey year 1990 N=2644). The population age parameters are limited to those aged 25-54, as this is the life-course stage most involved in balancing work and family. Where children are present, they are under 12 years old. Households are limited to those in which the only adults were either a couple or a single parent, to avoid including households in which other adults could contribute to workload.

The MTUS records how respondents to the surveys spend time on a range of activities within a 24-hour period. This paper investigates daily hours spent in those activities that are work: specifically routine housework, food preparation and cooking, shopping, childcare, and related travel (combined into "unpaid work") and paid work. Paid work and unpaid work is combined into a measure of "total work". Using these measures, this paper explores how being a parent impacts upon paid and unpaid work time in each of the four countries. It compares childless people with parents of children aged 0-4 years, and with parents of children aged 5-11 years, by sex, in each country. The child age ranges are chosen because previous analysis has found that young children are much more demanding of adult time than older children (Craig and Bittman, 2005).

The analysis is in two stages. First, this paper presents three indications of the time impact of parenthood based on average time allocation in each population, and second, it conducts multivariate analysis to isolate the effects of nationality.

The presence of children brings with it a requirement to perform caring duties. There are several ways to deal with this new household obligation. Firstly, it could be added to the total work burden of paid and unpaid labour. Second, a new parent could divert time previously

spent in other activities towards caring activities. Thirdly, a household could assign the care to one of its members. In the absence of these adjustments, substitute carers must be found. These intertwined areas of the time impact of children will affect the amount of work involved in being a parent rather than remaining childless, the way work time is apportioned between work and home commitments, and the way the time demands of parenthood are divided between mothers and fathers. Therefore, this paper presents data on how the presence of children impacts in each of these ways.

It estimates the total extra workload associated with becoming a mother or a father, by calculating the relative gap between non-parents and parents (with youngest children either aged 0-4 or 5-11) in mean daily total paid and unpaid work undertaken. That is, parents' mean time in total work is calculated as a percentage of non-parents' mean time in total work. This is to show the average workload difference between having children (of different ages) and being childless within countries, for example, to see how daily work time differs for a Norwegian woman according to whether or not she has children under five.

It estimates the difference that the presence of children (of different ages) makes in how men and women individually allocate their time between paid and unpaid work. It does this by calculating the percentage of mean daily total work time that is paid. This indicates the effect of children in each age group on work family balance by sex and nationality.

It estimates how children (in each age group) affect the gender division of domestic labour, that is, the way couples divide unpaid work between themselves. In this instance, mothers' daily mean time in unpaid work is calculated as a percentage of fathers' daily mean time in unpaid work.

Because comparisons derived from means do not separate out the influence of factors such as age, income, employment status and educational level, which previous research has found to independently impact upon time in paid and unpaid work (Craig, 2005; Craig, forthcoming), and which may vary between countries, this paper conducts multiple regression analysis, with daily hours spent in total work and daily hours spent in unpaid work as the dependent variables. The independent variables of interest in the model are nationality, sex, parenthood and interactions between them. The intention is to isolate the effect of the policy environment by holding constant regional differences in demographic population profile. The series of regression models become increasingly specified, using a stepwise (forward) method progressively adding nationality, sex, age of youngest child and then interacted variables. The first model has dummy variables for nationality (Australia omitted, Germany yes=1 Italy yes= 1 and Norway yes =1) and female (yes=1). The second has dummy variables that combine sex and nationality. The third model introduces new dummy variables for "youngest child is under 5" (yes=1) and "youngest child is aged 5-11" (yes=1). The fourth model inserts interaction terms that combine the nationality and sex, and age of youngest child variables. The model holds constant age, income, level of education, number of children, day of the week and spouses' employment status. When the dependent variable is unpaid work, and therefore does not have time in paid work as part of the dependent variable, the model also controls for labour force

status, with employed full time as the default category. In all models the reference category is a childless Australian male aged 35-44, with secondary education, in the middle-income range, employed full time (when the dependent variable is unpaid work) on a weekday. The method used is OLS modelling, because statistical check (Heckman) for censoring bias using STATA 9 reported the dependent variables were never censored due to selection and the model would simplify to OLS regression. The models and results are in Appendix A.

Limitations: This study is subject to number of limitations. Each of the regime types is represented by a single case. A survey with more countries in each of the clusters would provide more grounds for a meaningful comparison of regime type. Also, although the range and quality of the MTUS World series is being constantly improved over time, it has internal limitations. It is necessary to sacrifice detail in order to obtain comparability across surveys. Demographic data is limited. In some countries important regional differences may be missed. Most surveys in the MTUS collect information from only one household member, so it is not possible to match the diaries of husbands and wives. Therefore the gender comparisons are between averages of the men and women in each country, not between individuals on actual households. Due to the time it takes to collate the surveys, the latest surveys of some countries were not included at the time of analysis. The MTUS draws on country time-use surveys of different quality, and which use different collection methods and coding. In some activities, differences of coding arise from differences of definition, which creates further comparability problems. This is especially so for childcare, as it is very variously defined (Folbre et al. 2005). Also, childcare will be underestimated as most of the surveys do not include secondary activity, an essential and time consuming aspect of care (Craig 2006a; Craig 2006b). The surveys were not all done in the same year. To minimise the impact of this, countries whose surveys fell within a three years of each other were selected for this study. This in turn led to a further limitation – the data are not very recent. These limitations mean that the results of this study should be interpreted with caution, and can be regarded as preliminary only. A more reliable study of greater depth may entail the comparison of individual countries' preharmonised time-use surveys and would certainly require the inclusion of many more countries in the sample.

4 Results

4.1 Descriptive analysis

Mean time spent in unpaid work, and in total paid and unpaid work by country, sex, and age of youngest child are set out in Table 7, Appendix A. The tables below draw on these data.

In each of the countries, being a parent is associated with a higher workload than being childless (see Table 1). With a youngest child under five years old, parents spend between eight (Norwegian women) and 24 (Italian women) percent longer working each day than non-parents do. The effect is less when the children are older. The effect is fairly similar by sex

within countries, with the exception of Norway, where the impact upon male time is markedly higher than upon female time. There are, however, differences between countries, with the effects of parenthood upon total workload most pronounced in Italy. Since it is Italy that has the lowest birth rate (see Table 6), this fits with the speculation that countries in which the birth rates are highest will be those in which the time commitment of parents (both in total workload and in unpaid workload) is most similar to that of non-parents. The result for Norwegian women also fit with this suggestion. However, the similarity between Australia and Germany in the average workload increase, despite the difference in their national birth rates, is not explained.

Table 1
Parents' mean total workload as a proportion of non-parents' mean total workload

	Youngest child under 5		Youngest child 5-12	
Nationality	Women	Men	Women	Men
Italy	124	123	116	115
Germany	114	111	dna	dna
Australia	116	114	105	109
Norway	108	120	102	111

Source: MTUS World 5.51, own calculation.

Table 2, which shows parents' unpaid work as a percentage of non-parents' unpaid work, reveals that much of the higher parental total workload arises from an increase in unpaid work. Again, there are cross-national commonalities. In all the countries, parents do a great deal more unpaid work than childless people. With a youngest child under five, mothers average between 45% (Italy) and 86% (Australia) more unpaid work than childless women do. The workload disparity between parents and non-parents continues, to a lesser extent, as children grow, with the effect on men declining more than the effect on women. In all countries, the effect on unpaid work is more pronounced upon women that men, but there are notable national differences. Interestingly, it is the low fertility countries Italy and Germany in which the change on motherhood is least marked. The biggest difference in unpaid workload between mothers and non-mothers within one country is in Australia. It is the higher fertility country Norway in which the change for men is highest. The least difference between fathers and non-fathers is in Australia and Germany. Again, the workload ratios do not entirely correspond to the birth rate ranking (see Table 6).

So the results in Tables 1 and 2 give only patchy support to the speculation that the birth rate will be highest in countries in which the time commitment of parents is most similar to that of non-parents of the same sex. This suggests that the extra total work and the large increase in unpaid work that comes with being a parent is not a clear disincentive to fertility.

Table 2
Parents' mean unpaid workload as a proportion of non-parents' mean unpaid workload

	Youngest child under 5		Youngest child 5-12	
Nationality	Women	Men	Women	Men
Italy	145	161	130	128
Germany	156	138	dna	dna
Australia	186	138	149	121
Norway	177	154	136	123

Source: MTUS World 5.51, own calculation.

Turning to the issue of division of domestic labour within households, Table 3 shows female unpaid work as a proportion of male unpaid work. Column 2 shows, for example, that childless Italian women average 464% of the amount of unpaid work childless Italian men do, and childless German women average 209% of the unpaid work childless German men do. The second and third columns show how the division of labour by sex is affected by the presence of children under 5 and aged between 5 and 12, respectively. So, for example, Column 3 shows that an Italian mother with a youngest child under five years old averages 417% of the unpaid workload of an Italian father with a youngest child under five years old.

Table 3
Female mean unpaid work as a proportion of male mean unpaid work

Nationality	No children	Youngest child under 5	Youngest child 5 to 12
Italy	464	417	469
Germany	209	236	dna
Australia	189	255	233
Norway	164	188	182

Source: MTUS World 5.51, own calculation.

In Italy, the presence of children is not associated with a marked deepening in the division of labour. It is already very unequal. It actually gets a little better when there is a child under five (see Table 3). It is still, however, the deepest division of labour cross-nationally, although parenthood does not make an inequitable situation worse. In all the other countries, the division of labour by sex is deepened by the presence of children, but to different degrees. Norway is the most equitable in childless households, with women averaging 164% of the amount of unpaid work that men average, and there is relatively moderate change associated with parenthood of under five year olds (when mothers do 188% of fathers' unpaid work). This is largely because the contribution of Norwegian fathers is high compared to that of fathers in other countries (see Table 7). Italy and Norway represent the extremes of birth rates in this study, as well as the extremes of absolute unpaid work and equity in the division of domestic

labour. So this supports the speculation that birth rates are highest in countries in which the division of labour following parenthood is most equitable. However, the Australian and German results again do not support the hypothesis. German ratios don't alter very much following parenthood (they go from 185% to 194%), yet Germany has low fertility, and the impact of parenthood on equity of unpaid work is the most profound in Australian (178% to 258%), which has a relatively high birth rate. Australia also continues to show a big gender gap in unpaid work as children mature.

The findings are similar regarding workforce participation. Table 4 shows the proportion of total work time that is paid for the childless (Columns 2 and 3), when a parent has a youngest child is under five (Columns 4 and 5), and when a parent has a youngest child is aged five to eleven years (Columns 6 and 7). The intention is to indicate how time is balanced between home and market before and after parenthood, and as children grow, in each of the four countries, by sex.

Table 4
Proportion of mean total work time that is paid

	No children		Youngest child under 5		Youngest child 5-11	
Nationality	Women	Men	Women	Men	Women	Men
Italy	28	78	16	72	19	76
Germany	43	74	22	68	dna	dna
Australia	47	73	15	67	25	70
Norway	53	71	33	62	38	67

Source: MTUS World 5.51, own calculation.

In all the countries, men's and women's relative time commitment to paid work as a proportion of their total work load is very inequitable – women have a much lower proportion of their total labour time remunerated than men do. However, the extent to which motherhood is on average associated with a deepening of the division of labour between paid and unpaid work by sex varies cross-nationally. Of childless women, Italians have lowest proportion of paid to unpaid work (28%), Norwegian women the highest (53%), with Australia (at 47%) not far behind. But with a youngest child under five, it is Australian women who have the lowest ratio of paid to unpaid work: 15%. This implies that Australian women have a more pronounced lifestyle change upon motherhood than women in the three other countries. Norwegian mothers have the highest proportion of paid to unpaid work of all the mothers in the sample (33%), though it is substantially lower than that of their childless compatriots. Motherhood is also associated with a very low proportion of paid work time in Italy (16%), but the difference from childless women is not as marked as in the other countries.

For men, the picture on work-family time allocation is different than it is for women. Childless men's average unpaid to paid work ratios are fairly similar cross nationally, suggesting that women's lives are more affected by work-family regime than men's. Also, while all fa-

thers spend more time in unpaid work than childless men, the variation is less than for women. Norwegian men make the most time adjustment, Italian men the least, and Australian and German men fall in the middle.

4.2 Multivariate analysis

To investigate whether these patterns can be attributed to nationality and parenthood independently of other factors, this paper conducts multiple regression analysis, as described in the method section above. Recall that four increasingly specified models were run. The results tables are set out in Table 8, Appendix A.

Model 1 shows that there is slight variation cross-nationally in both total work and in unpaid work. Australian men in the reference category average 9.16 hours a day total work of which 1.59 hours is unpaid work (shown as the constant terms). Being Norwegian and Italian is associate with less total work and unpaid work, and being German with slightly more. The effects of gender markedly outweigh those of nationality. Cross nationally, being female predicts 40 minutes extra total work and over three hours extra unpaid work a day (see Table 8).

However, Model 2 shows that having one variable for sex obscures important cross national variation. There are significant differences between being a woman in each of the countries. The cross national finding in Model 1 that women do more total work than men seems to reflect the behaviour of Italian women only. When dummy variables combining sex and nationality are entered, Norwegian, Australian and German women are predicted to do less total work, but Italian women are predicted to do more. In contrast, German men are predicted to do more total work, and Norwegian and Italian men are predicted to do less, than men in the reference category. This means that within Italy, there is a large difference between male and female total workloads, which is not found in the other countries in the sample. The workload equivalence by sex is only for total work, not unpaid work. In all the countries, women do more unpaid work than men, although the discrepancy is least marked in Norway (see Table 8).

Model 3, which introduces variables for age of youngest child, confirms that cross nationally there is a high time demand associated with parenthood. Having a youngest child under five predicts 45 minutes more total work, and an hour and a quarter more unpaid work. The model also confirms that the time demand of children diminishes as they mature, with the presence of children between 5 and 11 associated with an increased total workload of about 12 minutes total work, and about 20 minutes unpaid work (see Table 8). However, these variables average the impact of children across gender and nationality. Model 4 interacts nationality, gender and the age of the youngest child, and is therefore able to show the effect of parenthood in each country for each sex, and for each age group of children (see Table 8). Of the sample studied it is Australian women who experience the most increase in both total and unpaid workload, when they have a child under five. Interestingly, the workload impacts of parenthood are less pronounced upon Italian women than upon either Austra-lian or German women. For Norwegian women, the effect of motherhood upon total work is actually neutral.

Norwegian men, in contrast, are predicted to increase their total workload by an hour and ten minutes in association with having a child under five. Of this, nearly an hour is unpaid work. This is the biggest effect upon male unpaid workload in the sample. The least effect is upon Italian men, with that upon Australian and German men falling between. So in the country in which birth rates are highest, men do most unpaid work, in the country in which birth rates are lowest they do least. This suggests that gender equity in the domestic division of labour is associated with higher fertility. However, this conclusion cannot be confidently drawn, as being German is associated with comparatively high male unpaid work when there are children, and German birth rates are nearly as low as Italian.

When other factors are controlled, for parents with a youngest child aged between five and eleven years, only Australian men and women have a total workload that is significantly different to those in the reference group (childless Australian men in the base category). In no other country (all else equal) does the workload penalty persist beyond the pre-school period. Further, in none of the countries including Australia, is unpaid work different for fathers with a youngest child aged five to eleven than for childless men. In contrast, having a youngest child aged between five and eleven predicts a higher unpaid workload for all mothers, with the effects strongest in Australia.

5 Discussion and conclusion

This study aimed to investigate whether time use study can contribute to knowledge on fertility decline, by comparing the impact of children on adult time in four countries with different social, cultural and policy environments, and seeing if time allocation differences corresponded to variation in birth rate.

The results were mixed. There were substantial differences in the workload of parents and non-parents in all four countries, but the pattern of difference did not correspond to birth rate ranking. So the study did not find support for the idea that birth rates will be higher where the time commitment of parents (both in total workload and in unpaid workload) is most similar to that of non-parents, and in this regard could offer little insight into policy effects. In contrast, there was some indication that the ability of women to balance their time between home and market is implicated in fertility rates. However, intriguingly, birth rate ranking corresponded more closely to the work-family balance of childless people than of parents. This does support the idea that female workforce participation is associated with higher fertility, but suggests that it may be most relevant at the point before women have children. The study also found support for the idea that birth rates are higher where male and female time allocation to paid and unpaid work is most equitable, again suggesting policy environment could influence fertility. But once more, birth rates corresponded more closely to cross national variation in childless households than in households with children. It was the countries in which the pre-child division of labour was least marked that had the highest birth rates. So the find-

ings in this study give some support to the fertility theories that suggest domestic gender equity and female work-force participation are important to maintaining higher birth rates, but imply that it is the "before baby" picture that matters. This raises interesting questions about the effect of gender equity upon parity progression, that is, whether people will have a first child, and then, having had one child, people go on to have a second, or a third. Parity progression is very important in fertility decline, as it may make the crucial difference between an adequate birth rate and a baby bust (Kippen, 2001; Kohler et al., 2002; McDonald, 2004a). There is arguably one threshold to have any children and another threshold to have each extra one.

The results of this study could imply that fewer women take the decision to go from no children to one child in situations of extreme domestic unfairness (as in Italy and Germany) because they are already overburdened. Where domestic labour and workforce participation amongst the childless is more equitable (as in Norway and Australia), women may be more willing to have a first child. Then the decision about whether to have subsequent children may rest on whether motherhood adds considerably to women's domestic workload and reduces female workforce participation. If their domestic responsibilities post-motherhood mean they are heavily burdened with domestic labour and/or cannot balance work and home commitments, women may not go on to have a second child, or from two, to any subsequent children. Conversely, in countries where motherhood does not bring such penalties, women may be more willing to have more children. In Australia, childlessness is not historically high compared to levels found at the beginning of the century (de Vaus, 2002). However, family size is falling dramatically, and increasingly, Australian women stop at one child (Kippen, 2001). In Norway, second children are reportedly more common (OECD, 2003). The difference may be attributable to the more extreme consequences of motherhood upon domestic gender equity and workforce participation in Australia than in Norway. This suggests that where childless couples have a relatively equitable division of labour and childless women relatively high workforce participation rates, women will start a family, but that if the consequences of having that child is extreme deepening of the division of labour, and great difficulty combining work and home commitments, they may refrain from subsequent births. If so, policies intended to encourage a higher birth rate should not only be addressed to the parental situation, but to pre-parental conditions, and should include both policies that encourage male participation in unpaid work (before and after fatherhood) and policies that encourage female participation in paid work (before and after motherhood).

This small study of the interaction between social policy, time allocation and birth rates does suggest that investigating time use patterns in cross-national perspective could assist understanding of contemporary fertility decline. More specifically, it lends support to the view that domestic equity and work family compatibility are implicated in fertility outcomes. However, the findings are far from conclusive, and as discussed above, the study is subject to a number of limitations. Further research into more countries with more detailed policy comparison and improved data would test and build on these preliminary results.

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Appendix

Table 5
Economic indicators by country

	National income per capita	Relative poverty	Income inequality	Child poverty
	GDP per capita in $US dollars	Poverty rate: Proportion of the population below 50% median income poverty threshold	Income inequality: Evolution of the gini coefficient	Share of children 17 years and under living in households with equivalised disposable income less than 50% of median income, percentages
Year	2003	2000	2000	2000
OECD-average	25,587	10.2	30.8	12.1
Germany	26,400	9.8	27.7	12.8
Australia	29,300	11.2	30.5	11.6
Italy	26,200	12.9	34.7	15.7
Norway	36,100	6.3	26.1	3.6

Source: OECD 2005, own calculation.

Table 6
Economic indicators by country

	Age dependency ratio		Fertility rates		Women's employment rates		
	Age-dependency ratio: Population aged 65 and over as a percentage of population aged 15-64		Total fertility rate for countries		Women's employment rates by presence of children in 2000 as a percentage of persons aged 25-54		
Year	2000	2050	1990	2002	2000	2000	2000
					No children	One child	Two or more children
OECD average	21	47	1.86	1.60	74	71	62
Germany	24	49	1.45	1.31	77	60	56
Australia	18	40	1.91	1.75	69	55	43
Italy	27	65	1.33	1.26	53	52	42
Norway	24	44	1.93	1.75	83	83	78

Source: OECD 2002a; OECD 2005, own calculation.

Table 7
Mean daily hours spent in total work and unpaid work by sex age of youngest child and country

Mean daily hours spent in …		…total work (paid and unpaid)		… unpaid work	
Country		Men	Women	Men	Women
Norway	No children	7.69	7.90	2.26	3.71
	0-4	9.20	8.55	3.49	6.57
	5-12	8.52	8.07	2.78	5.04
Italy	No children	5.13	7.09	1.11	5.14
	0-4	6.32	8.82	1.79	7.45
	5-12	5.89	8.21	1.42	6.65
Australia	No children	8.30	8.02	2.24	4.24
	0-4	9.43	9.30	3.10	7.91
	5-12	9.05	8.44	2.71	6.33
Germany	No children	8.84	8.45	2.32	4.83
	0-4	9.82	9.61	3.19	7.52
	5-12	7.31	8.55	2.05	6.15

Source: OECD 2002a; OECD 2005, own calculation.

Table 8
Cross-national regression models (predictor variables)

	Model 1		Model 2		Model 3		Model 4	
	Total Work	Unpaid Work	Total Work	Unpaid Work	Total Work	Unpaid Work	Total Work	Unpaid Work
Constant	9.16	1.59	9.70	1.90	9.64	1.78	9.63	2.12
Country Effects								
Norway	-0.36 ***	-0.32 ***						
	(0.08)	(0.07)						
Germany	0.16 **	0.12 *						
	(0.06)	(0.05)						
Italy	-0.33 ***	-0.42 ***						
	(0.06)	(0.05)						
Sex								
Female	0.65 ***	3.08 ***						
	(0.04)	(0.04)						
Sex and country								
Female								
Australian			-0.36 ***	2.51 ***	-0.34 ***	2.56 ***	-0.48 ***	1.66 ***
			(0.08)	(0.07)	(0.08)	(0.07)	(0.12)	(0.10)
German			-0.22 **	2.59 ***	-0.32 ***	2.46 ***	-0.37 **	1.80 ***
			(0.08)	(0.07)	(0.08)	(0.07)	(0.11)	(0.10)
Norwegian			-0.71 ***	1.76 ***	-0.76 ***	1.70 ***	-0.41 *	1.08 ***
			(0.11)	(0.09)	(0.11)	(0.09)	(0.16)	(0.10)

Table 8 (cont.)

	Model 1		Model 2		Model 3		Model 4	
	Total Work	Unpaid Work	Total Work	Unpaid Work	Total Work	Unpaid Work	Total Work	Unpaid Work
Italian			0.46 ***	2.84 ***	0.47 ***	2.87 ***	0.52 ***	2.65 ***
			(0.08)	(0.07)	(0.08)	(0.07)	(0.12)	(0.10)
Male								
German			0.23 **	0.13	0.13	-0.04	0.12	-0.04
			(0.08)	(0.07)	(0.08)	(0.07)	(0.12)	(0.14)
Norwegian			-0.26 *	0.19 *	-0.29 **	0.14	-0.46 *	0.03
			(0.11)	(0.09)	(0.11)	(0.09)	(0.17)	(0.10)
Italian			-1.67 ***	-1.23 ***	-1.67 ***	-1.24 ***	-1.52 ***	-1.08 ***
			(0.08)	(0.07)	(0.08)	(0.07)	(0.12)	(0.10)
Age of youngest child								
< 5					0.73 ***	1.24 ***	0.66 **	0.61 ***
					(0.07)	(0.06)		(0.12)
5-11					0.20 **	0.38 ***	0.49 ***	-0.02
					(0.07)	(0.06)	(0.17)	(0.14)
Female and youngest child under 5								
Australian							1.07 ***	2.67 ***
							(0.14)	(0.12)
Italian							0.71 ***	1.25 ***
							(0.12)	(0.10)
Norwegian							0.28	2.11 ***
							(0.20)	(0.16)

Table 8 (cont.)

	Model 1		Model 2		Model 3		Model 4	
	Total Work	Unpaid Work	Total Work	Unpaid Work	Total Work	Unpaid Work	Total Work	Unpaid Work
German							0.87 ***	2.18 ***
							(0.11)	(0.10)
Male and youngest child under 5								
Australian							0.66 ***	0.62 ***
							(0.15)	(0.12)
Italian							0.51 ***	0.39 ***
							(0.12)	(0.10)
Norwegian							1.17 ***	0.09 ***
							(0.20)	(0.17)
German							0.79 ***	0.72 ***
							(0.12)	(0.10)
Female and youngest child 5 to 11								
Australian							0.52 **	1.45 ***
							(0.17)	(0.14)
Italian							0.16	0.41 ***
							(0.10)	(0.09)
Norwegian							-0.41	0.64 **
							(0.22)	(0.19)
Male and youngest child 5 to 11								
Australian							0.50 **	-0.02
							(0.17)	

Table 8 (cont.)

	Model 1		Model 2		Model 3		Model 4	
	Total Work	Unpaid Work	Total Work	Unpaid Work	Total Work	Unpaid Work	Total Work	Unpaid Work
Italian							0.08	-0.11
							(0.11)	(0.09)
Norwegian							0.31	0.04
							(0.26)	(0.21)
Age								
25 to 34	0.11 *	0.16 ***	0.08	0.14 ***	-0.09 ***	-0.14 ***	-0.10 *	-0.23 ***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.04)	(0.05)	(0.04)
45 to 54	0.02	0.15 **	-0.02	0.13 **	0.10	0.34 ***	0.10	0.33 ***
	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)	(0.05)	(0.06)	(0.05)
Education								
Above secondary	0.11	0.03	0.05	0.00	0.01	-0.07	0.00	-0.09 *
	(0.06)	(0.05)	(0.06)	(0.05)	(0.06)	(0.05)	(0.06)	(0.05)
No of children	0.34 ***	0.51 ***	0.34 ***	0.51 ***	0.19	0.25 ***	0.18 ***	0.23 ***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)
Day of week								
Saturday	-2.21 ***	0.73 ***	-2.22 ***	0.72 ***	-2.21 ***	0.73 ***	-2.22 ***	0.73 ***
	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)	(0.04)
Sunday	-4.91 ***	-0.34 ***	-4.91 ***	-0.35 ***	-4.91 ***	-0.34 ***	-4.91 ***	-0.34 ***
	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)	(0.04)
Work Status								
Part time		0.76 ***		1.15 ***		1.12 ***		0.95 ***
		(0.06)		(0.06)		(0.06)		(0.06)

Table 8 (cont.)

	Model 1		Model 2		Model 3		Model 4	
	Total Work	Unpaid Work	Total Work	Unpaid Work	Total Work	Unpaid Work	Total Work	Unpaid Work
Not employed		2.34 ***		2.20 ***	***	2.17 ***		2.06 ***
		(0.04)		(0.04)		(0.04)		(0.04)
Income								
Lowest quartile	-0.72 ***	-0.20 **	-0.75 ***	-0.18 *	-0.75	-0.16 *	-0.73 ***	-0.14
	(0.09)	(0.07)	(0.09)	(0.07)	(0.09)	(0.07)	(0.09)	(0.07)
Highest quartile	0.14 *	-0.23 ***	0.18 **	-0.23 ***	0.22 ***	-0.16 ***	0.23 ***	-0.13 **
	(0.06)	(0.05)	(0.06)	(0.05)	(0.06)	(0.05)	(0.06)	(0.05)
Spouse's Work								
Part time	0.26 ***	0.30 ***	0.07	0.06	-0.01	-0.08	-0.05	-0.03
	(0.07)	(0.06)	(0.07)	(0.06)	(0.07)	(0.06)	(0.07)	(0.06)
Not in labour force	-0.71 ***	-0.45 ***	-0.47 ***	-0.28 ***	-0.52 ***	-0.37 ***	-0.54 ***	-0.31 ***
	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)	(0.04)
R square	.342	.446	.370	.478	.373	.489	.374	.364

Source: MTUS World 5.1,own calculation.
Note: * P-value<0.05 ** P-value<0.01 ***P-value<0.001, N=29767.

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Multiway data analysis for comparing time use in different countries - Application to time-budgets at different stages of life in six European countries

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Abstract

Important time-budget methodological issues are concerned with analysing time use tables, obtainable from time-budget diaries to face the multipurpose nature, the size and the complexity of time-budget data. After a brief introduction to the main time use analysis the paper focuses on the cross-sectional analysis using the explorative multidimensional data analysis. The paper deals with the multiway methods suitable for comparing statistical studies (i.e. countries) when each of them has many variables (i.e. activities) observed on many cases (i.e. categories of population). This article examines an example of application to cross-national differences in time use in six European countries at different stages of life. The results are exemplary of the applicational steps and statistical aspects of the methods proposed rather than definitive findings.

JEL-Codes: C49, C89, J16, J19

Keywords: Cross-national, cross-sectional, explorative multidimensional data analysis, multiway analysis, statis method, multiple factor analysis method

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1 Introduction

1.1 The international growing relevance of time use data

Since the mid-1920 – early in URSS, USA, UK and Poland and then in many other countries[1] – Time-Budget Studies (TBS) and Time Use Surveys (TUS) were used for analyzing peoples' behaviour, patterns of social life associated with the temporal distribution, the allocation and management of human activities.

Actually many countries collect time-budget data which are more and more relevant mainly to monitor similarities, differences or changements in the way of life of populations or social groups, documenting patterns of time use of total sample or subgroups, studying practical problems in order to face the problems related to urban environment (daily rhythm of urban traffic, opening and closing hours of public services, shops, entertainement etc., peak hours and duration of the activities connected with the electric power, water consumption, internet daily use and so on); and the problems related to health (i.e. studying the rhythm of daily activities as to sleeping, eating etc. related to special problems i.e. insomnia, obesity, cardiovascular illness and so on).

In this context countries are also fastly developing international websites (Multinational Time-Use Studies (MTUS), the International Association for Time Use Research (IATUR), Harmonised European Time Use Studies (HETUS), and more general international websites as to EUROSTAT and the National Statistical Institutes websites) that are essential for accessing original time use study data and information.

Therefore the experimentation and harmonization of suitable methodologies to analyzing complex data in view to exploring, comparing and synthesizing large volume of time use data are becoming more and more useful.

1.2 The object of the paper

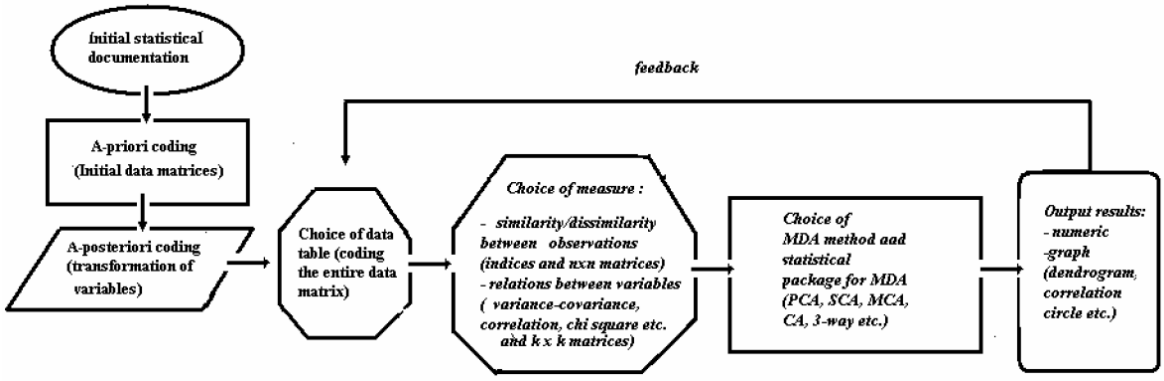
The paper proposes, in addition to the many other possible simple and multivariate statistical methods of analysis, the use of the explorative multidimensional data analysis (MDA) for the analysis of time use tables (matrices) when each of them is dealing with many cases: individuals (microdata) or categories of individuals or social groups (macrodata) and many variables (quantitative/ qualitative) simultaneously considered. MDA includes many multivariate techniques which can be classified into two main groups: classification analysis (cluster analysis)

[1] Further details on the history of Time Use Studies and on-line Survey Documentation can be found in the web site: http://www.iser.essex.ac.uk/misoc/timeuse/information/technical compiled by Fisher, Kimberly, Institute for Social and Economic Research, University of Essex.

and factorial analysis[2], each-one is a particular different way to analyse and synthesize the initial data set. Among the several factorial analysis techniques the paper considers the multiway analysis for multiple quantitative tables (see par. 4).

From a methodological and applicational point of view besides the specific MDA technique which will be carried out it is useful to see multidimensional data analysis as a system composed of various steps equally important and interdependent. At each step it is necessary to make choices and to carry out operations having statistical and computational aspects not always governed by fixed rules or single criteria. In other words we can list seven main steps (Figure 1) which make up an MDA and special emphasis is given to the preliminary four steps often considered the 'hotspot' of the entire process (Fraire, 1995)[3].

Figure 1
The seven phases of Multidimensional Data Analysis (MDA)



Source: own elaboration.

Very synthetically, the above phases (in brackets the paragraphs corresponding to the stepsreferring to the application) in Figure 1 are defined as follows:

- The first step is related to the initial statistical documentation and it is concerning the definition of the object and the scope of the study, the survey plan and the actual data collection i.e. the questionnaires filled out, data downloaded from internet web sites, data bases etc. (par. 2);
- The second step concerns the 'a priori' coding i.e. the transposition of all raw data collected in the form of the initial data matrix or matrices (par. 3.1);

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2 Among the factorial analysis there are several methods: Principal Component Analysis (PCA), Canonic Correlation Analysis (CCA), Simple and Multiple Correspondence Analysis, Multidimensional Scaling, Multiway analysis including many different techniques (see par. 4). Many of them were developed in the first half of the century from conceptual and methodological point of view but seldom utilized. Nowadays the great and generalized capacity to process large volume of data and to carry out complicated calculation rapidly by the hardware and software available have created the conditions for further diffusion of their applications.

3 We shall not dwell here upon this argument which can be deepened in Fraire (1995, p.5-51).

- The third step concerns the 'a posteriori coding' as transformation of variables with different aims (i.e. dividing a variable into classes, transforming a variable into ranks, standardizations etc.). This phase includes the first descriptive univariate and bivariate statistics generally carried out on the 'columns' (variables) of the initial data matrix (par. 3.2);
- The fourth step concerns the 'a posteriori coding' of the whole data matrix concerning the choice of the data table generally different from the initial data matrix (i.e. generalized contingency table, complete disjunctive table etc. or table obtained as feedback from preceding multivariate analysis carried out on the initial data matrix i.e. factor scores matrix). In the multiway analysis considered in the paper this step concerns the choice of one of the possible research situations (par. 4.2) as starting point data table and the tables obtained as feedbacks of the three aspects characterizing the multiway analysis (par. 4.3, 4.4, 4.5);
- The fifth step concerns the choice of the measure of relation between cases (distances, similarities etc.) or between variables (correlation coefficients, variances and covariances etc.) according to the data table obtained in the fourth step (par. 4.3, 4.4, 4.5);
- The sixth step is related to the choice of the method and software of MDA (CA, PCA, MFA etc.) (see par. 4.1);
- The seventh step is devoted to results (i.e. eigenvalues, factor loadings etc.) and graphic (i.e. factorial planes, dendrograms etc.) (par. 4.3, 4.4, 4.5, 5).

As to time use methodological point of view it is important distinguish two different but complementary aspects which can characterize time use data analyses:

1. Cross-sectional time use analysis: based on average duration for each activity (referred to all persons or only to those who have performed the activity with the percentage of population engaged in the daily activities). These tables are fitting for analysing time allocation, time management, typical time-budgets, time use structures of various categories of population, social groups etc.;
2. Longitudinal time-use analysis (temporal sequences of daily events): based on percentages of the population or social groups engaged in single or all daily activities at selected time-points during the day. These tables are fitting for analysing as the daily rhythm (distribution shape) of a specific daily activity, or the global sequence patterns of daily life. In the last case we analyse simultaneously the all daily activities performed at selected timepoints during the day by the population or by the social groups considered.

In the paper we focus only on cross-sectional time use analysis and in particular on the multiway data analysis which is suitable for comparing statistical studies (i.e. referring to different countries at the same time) when each of them has many variables (i.e. activities) observed on many cases (i.e. population at different stages of life)[4].

[4] Statistical aspects and applications concerning Cluster Analysis and Principal Component Analysis can be seen in Fraire M.(2004), I Bilanci del Tempo e le indagini sull'uso del tempo. Time-Budget Studies(TBS)

The application considered concerns cross-national comparison in time use crossing employment status and different stages of life by gender in 6 European countries in 2003.

2 Source of data, sample size, cases and analysis variables

2.1 Source of data, sample size and the countries considered

The data used for the application is a sub-file extracted from Eurostat, 'Time-use at different stages of life in 13 European countries in 2003', downloaded from Eurostat web site (http://europa.eu.int). The Eurostat data referred to 13 countries time use surveys but only six followed very closely the harmonized guidelines issued by Eurostat. This means that they are comparable between countries concerning the slight differences in age group covered. In the application we consider for simplicity only six countries: Belgium (BE), Estonia (EE), Finland (FI), Norway (NO), Slovenia (SI), United Kingdom (UK).

It is to remark that the data analysis considered could be applied to much more countries as well. In Table 1 we report the sample size and survey characteristics of the six European countries.

Table 1
Sample size and survey characteristics of 6 European countries

Country - Source	Fieldwork period	Population covered: age	Sample size: respondents
Belgium (BE) National Institute of Statistics and Free University Brussels	December 1998 - February 2000	12-95	8392
Estonia (EE) Statistical Office of Estonia	April 1999- March 2000	10 -	5728
Finland (FI) Statistic Finland	March 1999- February 2000	10-	5332
Norway (NO) Statistics Norway	February 2000- February 2001	10-79	3211
Slovenia (SI) Statistical Office of the Republic of Slovenia	Aprila 2000- March 2001	10-	6190
United Kingdom (UK) Office for National Statistics	June 2000- September 2001	8-	10366

Source: Eurostat, 'Time-use at different stages of life in 13 European countries in 2003' from Eurostat web site (http://europa.eu.int), own calculation.

and Time-Use Surveys, Ed. CISU, 2004, Roma in particular Part III concerning Paths of Time Use Multidimensional Data Analysis.

2.2 Defining the cases

The cases considered in the application concern 14 categories of population obtained crossing by sex: the employment status and the 'compositional' variables represented here by lifecycle variables obtained crossing (non exhaustively) age class/ civil status/ presence of child living with parents according to youngest age.

The N=14 cases are detailed as follows (in brackets are reported the labels of the cases):

1. Women (W);
2. EmployedWomen (EmplW);
3. Women less than 25 years old, Not having Child<18 years old living with parents (W<25NCh<18);
4. Women of any age living in Couple and having the youngest Child of 0-6 years old living with parents (WCACh0-6);
5. Women of any age living in Couple and having youngest Child of 7-17 years old living with parents (WCACh7-17);
6. Women 45-64 years old living in Couple Not having children <18 years old living with parents (W4564CN<18);
7. Women more than 65 years old living in Couple, Not having children<18 years old living with parents (W>65CN<18).

The same categories have been obtained for Men:

8. Men (M);
9. Employed Men (EmplM);
10. Men less than 25 years old, Not having Child<18 years old living with parents (M<25NCh<18);
11. Men of any age living in Couple and having youngest Child of 0-6 years old living with parents (MCACh0-6);
12. Men of any age living in Couple and having youngest Child of 7-17 years old living with parents (MCACh7-17);
13. Men 45-64 years old living in couple Not having Children <18 years old living with parents (M4564CN<18);
14. Men more than 65 years old living in Couple, not having children<18 years old living with parents (W>65CN<18).

2.3 Defining the variables

The variables considered in the application concern the activities collapsed in 12 primary activity groups exhaustive of all daily activities. In Table 2 is reported the classification of the activities.

The classification of the activities derives from the Eurostat more analytical classification (12 activities groups instead of 8) employed in the above mentioned study and it is suitable for the purpose of the present application concerning the explorative description and comparative analysis of time-budgets of different categories of individuals in the six countries considered with respect to the main time use areas characterizing the daily activities.

Finally the type of day considered is the average day of the week over the whole year.

Table 2
Classification of primary activities

Primary activity groups (labels)	Primary activities
1. Sleep (Sleep)	Sleep
2. Eats (Eats)	Meals and personal care
3. Work (Work)	Gainful work
4. Study (Stud)	Study
5. Housework & Family care (H&Fa)	Household work and family care
6. Volunteer work (FreV)	Volunteers work and informal help to other households
7. Socializing (Soci)	Socializing (participatory activities, social life and entertainment and culture)
8. Leisure Time (Leis)	Sports and outdoor activities, hobbies and games, unspecified leisure time and resting
9. TV (Tv)	TV and video
10. Other media (OMed)	Other mass media (radio, music, reading)
11. Travel (Trav)	Travel including travel for work
12. Other unspecified (OUns)	Other, unspecified and filling in TUS diary

Source: Own definitions.

3 The initial data matrix

3.1 The initial data matrix of the application

Considering the cases (N=14) and the variables (Xj (j=1, 2, …, k=12)) the activities above defined in Table 2 are arranged together with the N=14 cases in a matrix forma (initial data matrix) as start point for the application (Figure 2).

The matrix has the following statistical characteristic:

1. The matrix is composed of 6 basic tables (six two-indices matrix: cases × variables foreach country) put one upon the other;
2. The rows are the time-budgets of the categories of population considered and therefore the row-sum is equal to 1440 minutes. The raw is the time use profile (description) of the categories considered;
3. Comparisons among rows (also transforming data in % of the 24 hours=100) give the differences in the time-budgets of the 14 categories of population;
4. The columns represent the distributions of each activity group among the N=14 categories of population;
5. Each column gives the consistency (amount of time spent) and the dispersion of the activity among the 14 categories considered;
6. The data considered in the matrix are the average duration in minutes of the primary activity groups computed dividing the total duration of time devoted to that activity group to the whole category of population considered (including persons who has not performed the activity).

The use of means instead of individual duration means that the correlations are not perturbed by large numbers of zeros in the data.

Referring to the average duration of activity to the whole population or only to those who have performed the activity has the following main meanings:

1. Average durations referred to the whole population is suitable to focusing the analysis on time-budget in other words it allows us to analyse the incidence of average duration of each activity on the 1440 minutes= 24 hours= 100.
2. Average durations referred only to those who have performed the activity is suitable to focusing the analysis on time use structure. In other words it allows us to analyse the typical duration of each activity.

In the application average durations referred to the whole population have been considered.

3.2 Descriptive statistics for the first analysis of data

Univariate descriptive statistics such as arithmetic mean, range, min-max, standard deviation, coefficient of variation, % doers etc. give an important frame of the time-use matrices. These statistics are necessary also in view to further ‘a posteriori’ data matrix codings (i.e. transformation of the original data in deviations from the mean, standardization, dividing into classes, change of scale, ranging etc.). Bivariate statistics such as correlations and partial correlations, scatter diagram show the relationship (shape and intensity) between primary activities and represent an important first analysis of data. However for the sake of brevity we shall not

dwell on these statistics and in Table 3 we report only the means, standard deviations and coefficient of variation of the 12 activity groups for each country.

Figure 2
The initial data matrix of the application (synthetic example)

Cases	Sleep	EatPers	Work	Study	HFamCare	VolontWork	Socializ	Leisure	TV	OthMedia	Travel	OthUnsp
						BELGIUM						
Women	521	162	88	41	238	8	65	68	132	34	76	7
EmplWomen	495	156	232	4	226	6	61	43	94	25	92	6
W<25NCh<18	548	154	27	231	83	7	77	76	108	36	86	7
WCACh0-6	502	145	157	4	319	8	59	37	92	18	93	6
WCACh7-17	499	160	133	4	298	10	63	45	109	30	85	4
W4564CN<18	512	167	71	2	297	12	55	66	148	33	71	6
W>65CN<18	536	171	0	0	282	9	63	97	193	40	42	7
Men	507	157	158	45	143	9	59	78	144	44	91	5
EmplMen	481	154	300	4	135	9	54	47	115	32	103	6
M<25NCh<18	548	140	44	202	54	7	69	117	124	40	89	6
MCACh0-6	481	151	287	4	173	8	50	43	110	25	102	6
MCACh7-17	482	154	277	4	147	12	53	52	124	32	98	5
M4564CN<18	503	163	150	3	181	10	54	66	164	51	89	6
M>65CN<18	534	178	2	3	194	16	60	112	204	63	67	7
						ESTONIA						
Women	530	129	120	27	267	13	51	54	135	49	60	5
EmplWomen	503	126	249	5	241	10	45	31	113	41	71	5
...	...	...	...	...	...	...	...	...	...	...	...	...
M>65CN<18	558	148	44	0	207	13	37	105	179	95	49	5
						FINLAND						
Women	522	126	124	36	212	14	68	72	128	60	66	12
EmplWomen	502	122	247	13	201	11	60	52	100	47	76	9
...	...	...	...	...	...	...	...	...	...	...	...	...
M>65CN<18	534	152	21	1	175	21	50	123	193	97	48	25
						NORWAY						
Women	500	121	140	38	196	9	135	73	105	47	70	6
EmplWomen	488	111	219	19	199	7	132	57	87	38	77	6
...	...	...	...	...	...	...	...	...	...	...	...	...
M>65CN<18	494	163	41	2	184	15	95	100	180	102	58	6
						SLOVENIA						
Women	520	127	133	44	265	6	68	72	110	31	61	3
EmplWomen	484	118	279	7	250	4	60	52	88	22	74	2
...	...	...	...	...	...	...	...	...	...	...	...	...
M>65CN<18	535	163	48	0	197	12	61	142	165	76	39	2
						UNITED KINGDOM						
Women	523	136	116	40	221	12	73	57	136	33	81	12
EmplWomen	505	126	237	12	207	10	67	41	110	23	93	9
...	...	...	...	...	...	...	...	...	...	...	...	...
M>65CN<18	515	170	19	2	214	16	62	83	203	79	63	14

Source: sub-file extracted from the EUROSTAT 'Time-use at different stages of life in 13 European countries in 2003' Data File, Eurostat, downloaded from Eurostat web site: http://europa.eu.int
Note: the meaning of labels is reported in par. 2.2. Own calculations.

From univariate statistics it is to remark that among the mean durations of the activities: Sleep, Eats and personal care, Work, Housework and Family care, TV have overall average durations higher than Study, Volunteers activities, Socializing Leisure, Other Media, Travel; for this reason the coefficient of variation fit well and better than the standard deviation for measure the dispersion of each activity among the cases considered. Because the categories of population considered in the application are obtained crossing employment status and different lifecycles by gender: particularly high result the coefficients of variation for the activities Work, Study, Household work and Family care in all six countries.

Table 3
12 primary activity groups in 6 European countries in a weekday in 2003. Univariate statistics: mean (in minutes and in percent of 1440= 100), standard deviation (in minutes), coefficient of variation CV (in percent).

Activity / Country	Sleep	Eats and personal care	Work	Study	Household & family care	Volunteer works	Socializing	Leisure	TV	Other media	Travel	O. Unspecified
Belgium												
mean	516	158	137	39	197	9	60	67	132	35	84	6
%	36	11	9	3	14	1	4	5	9	2	6	0
std	22	9	101	73	79	3	6	25	33	11	15	1
CV%	4.3	5.7	73.7	187	40.1	33.3	10.0	37.3	25.0	31.4	17.8	17.0
Estonia												
mean	529	131	159	26	216	12	46	61	143	47	65	5
%	41	9	10	2	14	1	3	4	9	2	5	0
std	27	7	94	48	96	4	15	28	22	17	11	1
CV%	5.1	5.3	59.1	181	44.4	25.0	32.6	44.3	14.7	34.0	15.4	20.0
Finland												
mean	521	122	170	32	179	13	58	81	130	54	67	13
%	36	8	12	2	12	1	4	6	9	4	5	1
std	25	12	107	52	80	5	11	33	26	18	12	5
CV%	4.8	9.8	62.9	163	44.7	38.4	19.0	40.7	20.0	33.3	17.9	38.4
Norway												
mean	499	116	172	32	178	9	120	74	115	45	72	8
%	35	8	12	2	12	1	8	5	8	3	5	1
std	25	20	93	49	67	3	15	25	24	22	12	3
CV%	5.0	17.2	54.0	153	37.6	33.3	12.5	33.7	20.8	48.8	16.6	25.0
Slovenia												
mean	518	127	180	34	215	7	65	80	118	29	65	2
%	37	9	13	2	16	0	4	5	8	2	4	0
std	26	12	103	61	97	3	11	26	23	15	15	7
CV%	5.0	9.4	57.2	179	45.1	42.8	16.9	32.5	19.4	51.7	23.0	35.0
UK												
mean	515	129	172	34	184	10	62	3	141	31	83	10
%	36	9	12	2	13	1	4	4	10	2	6	1
std	31	20	107	58	88	5	8	23	26	17	12	1
CV%	5.7	15.5	62.2	171	47.8	50.0	12.9	36.5	18.4	54.8	14.4	10.0

Source: own elaborations.

Among the 'a posteriori coding' of the initial data matrix (the third phase of MDA par. 1.2) because of the great differences of the means and dispersions of the 12 activities considered the data have been transformed in standard deviations (mean= 0 and std= 1).

In view to compare the time-budgets of the six European countries more easily the 12 activities have been classified in the following five daily activity areas:

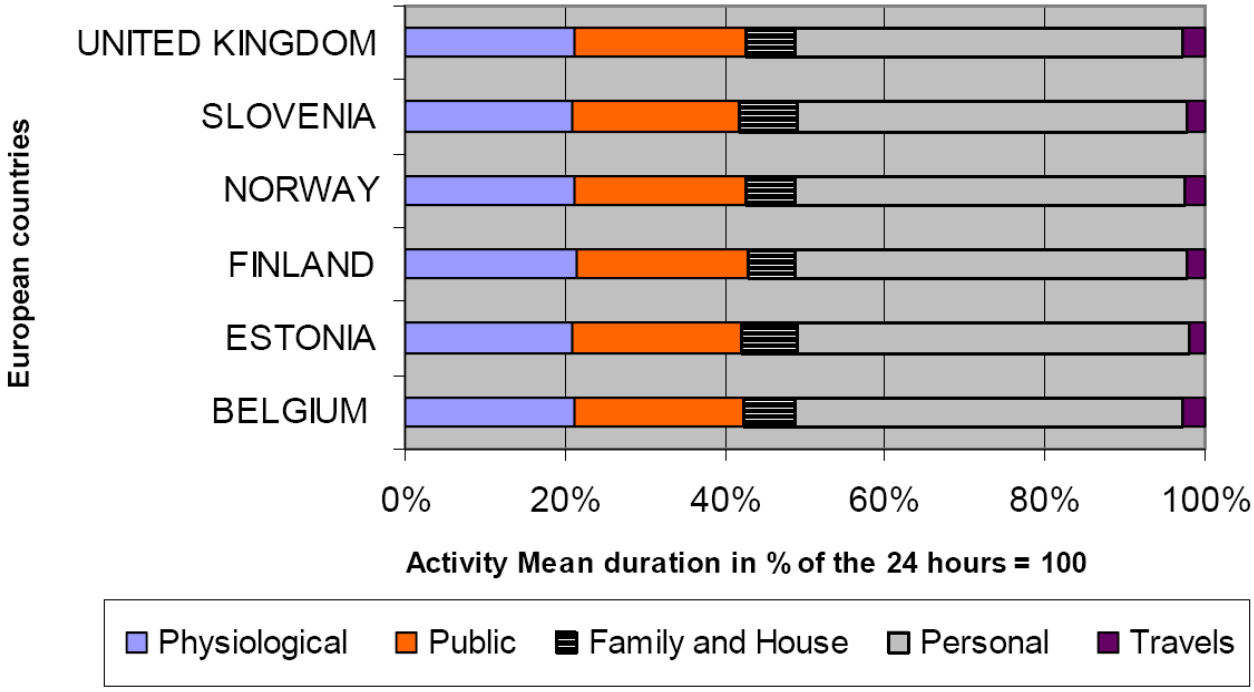
Table 4
Codes and Activities

Codes and Activity groups	Activity areas	Codes
1. Sleep	Physiological area	1-2
2. Eats and personal care	Physiological area	1-2
3. Work	Public area	3-4
4. Study	Public area	3-4
5. Housework and family care	Family area	5
6. Volunteers	Personal area	6-10, 12
7. Socializing	Personal area	6-10, 12
8. Leisure	Personal area	6-10, 12
9. Television	Personal area	6-10, 12
10. Other mass-media	Personal area	6-10, 12
11. Travel	Travels or Mobility area	11
12. Other unspecified activities	Personal area	6-10, 12

Source: own definitions.

In Figure 3 the six time-budgets are reported.

Figure 3
Time-budgets of six European countries at different stages of life and five areas of daily activities in a weekday in 2003



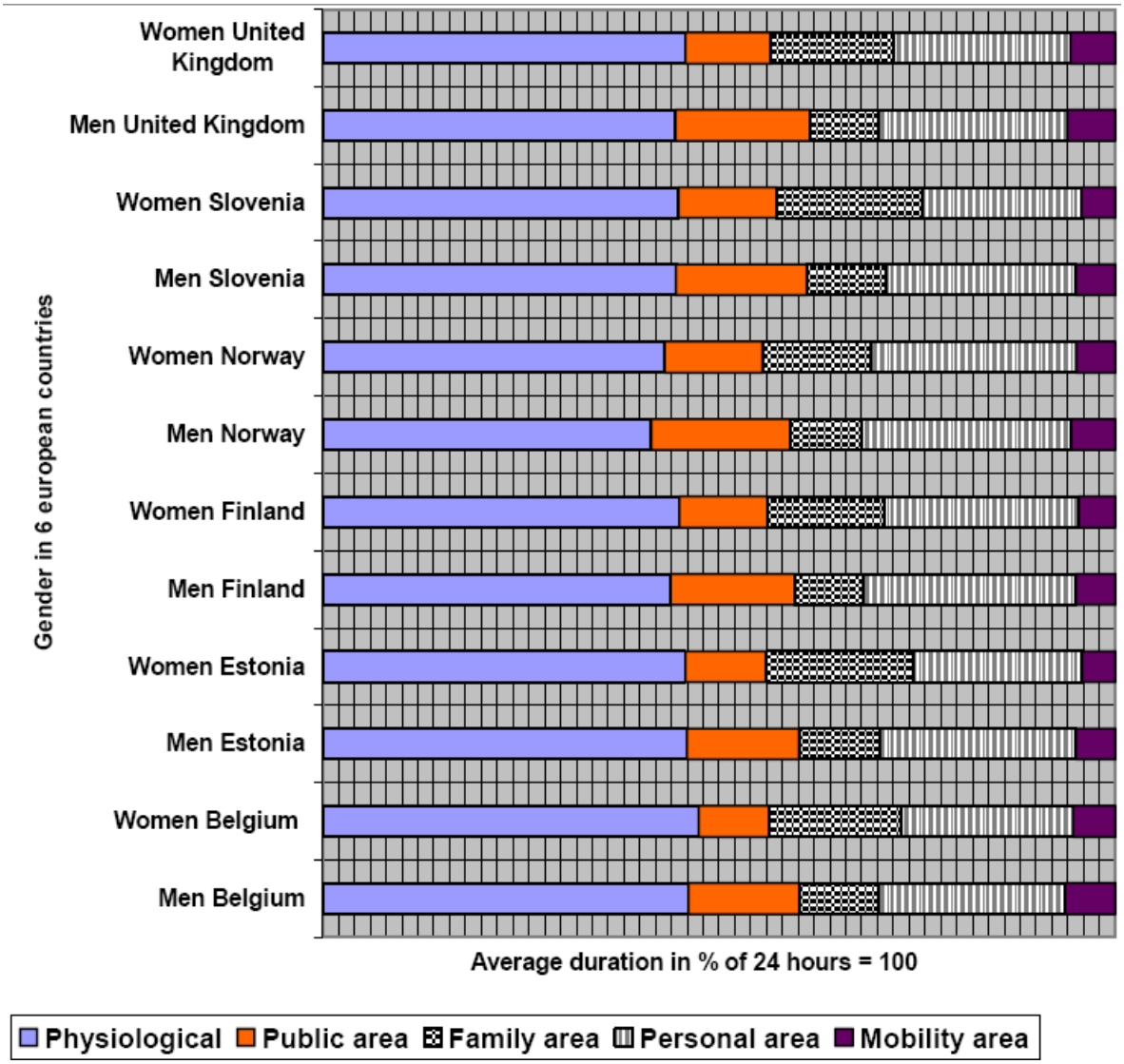
Source: EUROSTAT 'Time-use at different stages of life in 13 European countries in 2003, own elaborations.

It is possible to remark that the 6 countries notwithstanding their geographical and cultural differences have similar patterns of spending their time use (similar % of the 24 hours devoted to the 12 activity groups considered) in the average day of the week over the whole year.

Considering the time-budgets of the five activity areas: all countries devote almost 42-45% of the 24 hours to physiological activities, 14% to family and house activities, 20% to public activities and 20% to personal activities.

Comparing the time-budgets of men and women in the 6 countries (Figure 4) it is possible to remark that there are large differences in the gender division of gainful work and domestic work: in all countries men devote more time to gainful work/study than to domestic work. Men have overall more free time than women.

Figure 4
Gender differences in time use of six European countries in 2003 (weekdays)



Source: EUROSTAT 'Time-use at different stages of life in 13 European countries in 2003, own elaborations.

Multivariate Principal Component Analysis (PCA) and Cluster Analysis (CA) have been applied for the first explorative analysis of each of the six tables separately considered. The main results[5] (not reported for simplicity) are concordant (even if separately for each country) with the results of the multiway analysis allowing to compare simultaneously the timebudgets of the 14 categories of population in the 6 countries and exposed in the following paragraphs.

4 Multiway data analysis

4.1 The three-way matrix for multiway analysis

The multiway data analysis concerns the analysis of multiple tables. As above mentioned the multiway analysis is especially interesting when we are looking for trends in situations found in different countries at the same time or in a given country in varying moments of time. By the multiway matrix analysis it is possible to explore, compare and synthesize several multiple tables overall and simultaneously.

Many techniques for multiway data analysis are available in connection with the type of multiples tables to be analysed (Procrustean analysis, Tucker, 1958); Metrical and non metrical multi dimensional scaling (PARAFAC, Harshman, 1970), INDSCAL (Carrol and Chang, 1970); Multiple Factorial Analysis (Escofier and Pages, 1983); ACT-méthode STATIS e ACT-méthode STATIS-DUALE (Escoufier, 1980 and 1985); Generalised Canonical Analysis (Horst, 1961).

The paper deals with the three-way data analysis referred to quantitative matrices and in particular with the ACT-Statis-Duale Method and the Multiple Factor Analysis carried out employing the softwares ACT-Statis and WinSPAD-Analyse Factorielle Multiple[6].

Usually three-way (or multi-way) data matrices have data classified according to three (or more) criteria or ways or dimensions. The same table (i.e. the basic table cases × variables which is a two-indices matrix) built up over several years or places or situations. In general this third criteria or way is called 'occasion'. Simplifying in Figure 5 is reported an example of the time use three-way data of the application proposed.

The initial three-way data matrix of the application $_{O=6}X_{N=14;\ K=12}$ has the following characteristics:

O= occasions= 6 European countries,

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5 For example: in the PCA each country have a very similar two-dimensional time-budget structure underlying the time-budgets of the 14 categories of populations; in CA four clusters of individual can be identified in each country.

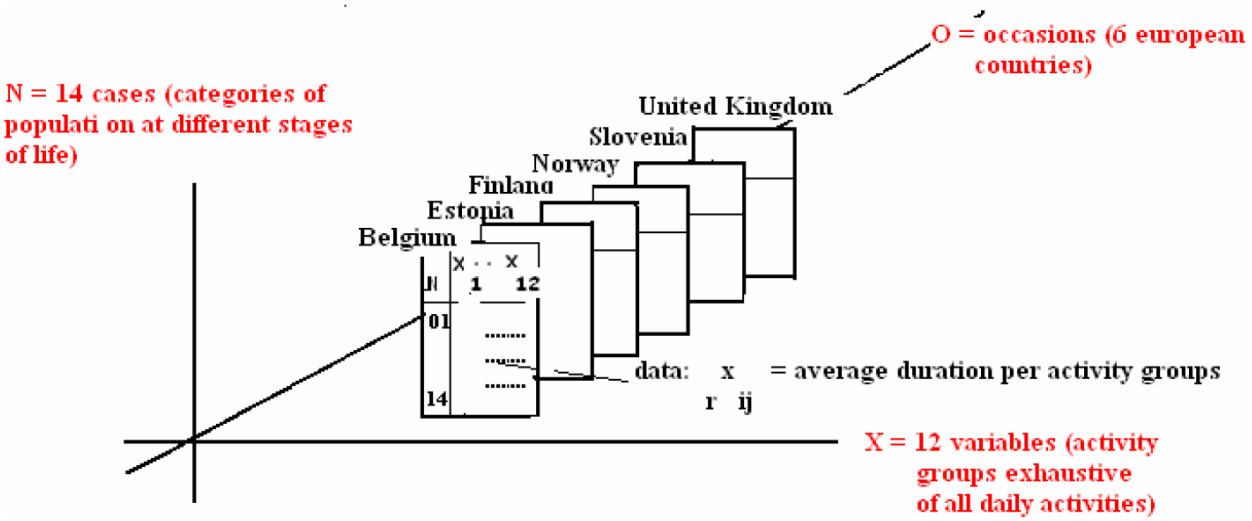
6 The acronym ACT means Analyses Conjointes des Tableaux and STATIS means 'Structuration des Tableaux A Trois Indices de la Statistique'. The two software mentioned are of the CISIA, Centre International de Statististques et d'Informatique Appliquée, France.

N= statistical units or cases= 14 categories of population;

K= variables= 12 primary activities

$_rX_{ij}$ (r=1, …, 6; i= 1, …, 14; j= 1, …, 12) are the data represented by the average duration (in minutes) computed on all persons of the category of population considered.

Figure 5
Time use three-indices data matrix of the application



Source: own elaboration.

In the multiway data analysis from a computational point of view the 'a priori coding' (the 2nd phase of AMD, see par. 1.2) of the initial data concerns the setting up of the initial data file (Figure 2).

4.2 'A-posteriori' codings of the initial data matrix

It is important to remark that the initial data matrices can have various a-posteriori codings according to three different research situations:

1. Three-indices matrix of dimension N, (K×O) in which in the various Occasions (i.e. years or places) the individuals N are the same and the variables are different;
2. Three-indices matrix of dimension (N×O), K in which in the various Occasions the individuals N are different and the variables are the same;
3. Three-indices matrix of dimension (N×K), O in which in the various Occasions the individuals N and the variables K are the same.

In this paper we will present an application in which the second situation (different cases and same variables across the different occasions O) is the a-posteriori coding that has been chosen for the application.

In particular the time-use three-way matrix $_{O=6}X_{N=14;\ K=12}$ considered in the application has been above defined. The 3-way data analysis and in particular the Act-Statis Method is developed into three different steps:

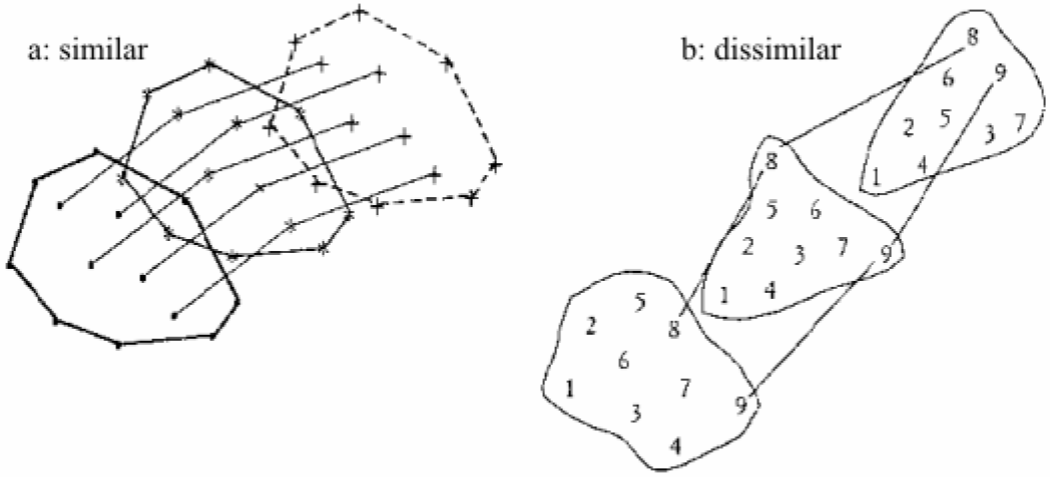
1. Inter-structure analysis;
2. Intra-structure (or compromise) analysis;
3. Trajectories analysis.

In the following paragraphs the three steps are detailed applied to the example.

4.3 The inter-structure analysis: the overall similarity and dissimilarity of the time use in the six countries

The inter-structure analysis want to do an overall comparison of the six statistical studies to recognize the studies which are near (they give similar representation of individuals) and those which are not (Escoufier, 1987). In the application it is possible to identify the overall distances among matrices in view to examine if each of the 14 categories of population has homologous (correspondent points) similar (near) or dissimilar across the 6 countries. In other words it means that if the categories of population (cases) develop thorough the occasions (six countries) in the same way or in different way they can be respectively represented (Bolasco, 1999) like in Figure 6.

Figure 6
Shapes of scatter diagrams in concomitance with no changes (similar) or changes (dissimilar) in the corresponding points of the basic tables



Source: own elaboration.

The distances of the correlation coefficients[7] reported in Table 5 (0=dissimilar matrices, 1=similar matrices) remark that the 6 tables concerning the time-budgets of the 14 categories

[7] The similarity or dissimilarity among the six time use table can be measured by between similarity/ dissimilarity measures (euclidean distances etc.) or by the distances between variances-covariances (V) or correla-

of populations in the 6 countries are very similar: the coefficients are all near 1. It means that countries with coefficients near to 1 have similar homologous points. In other words the same category of population across the 6 countries does not present structural changes in the time-budgets (% of 24 hours devoted to the 12 activities considered).

In particular the data of table 5 indicate that:

- the most similar time use tables are between the pairs of countries:
  - Finland/ Belgium (coefficient 0,906),
  - United Kingdom/ Finland (coefficient 0,906),
  - Norway/ Finland (coefficient 0,902);
- the most dissimilar:
  - Estonia/ Norway (coefficient 0,782),
  - Estonia/ United Kingdom (coefficient 0,734).

It is useful to represent the plot of the six matrices. In Figure 7 is reported the overall and simultaneous representation of the 6 time use tables on the first factorial plane explaining 93.15% of the total variance. The plot allows to examine the reciprocal position of the six countries and their position with respect to the mean (compromise) matrix (V in the plot) (see par. 4.4).

Table 5
Distances matrix of correlation coefficients
(range: 0= max. distance (dissimilarity), 1= max. similarity between pairs of tables)

	Belgium	Estonia	Finland	Norway	Slovenia	UK
Belgium	1.000					
Estonia	0.806	1.000				
Finland	0.906	0.818	1.000			
Norway	0.863	0.782	0.902	1.000		
Slovenia	0.900	0.864	0.860	0.894	1.000	
UK	0.899	0.734	0.906	0.893	0.809	1.000

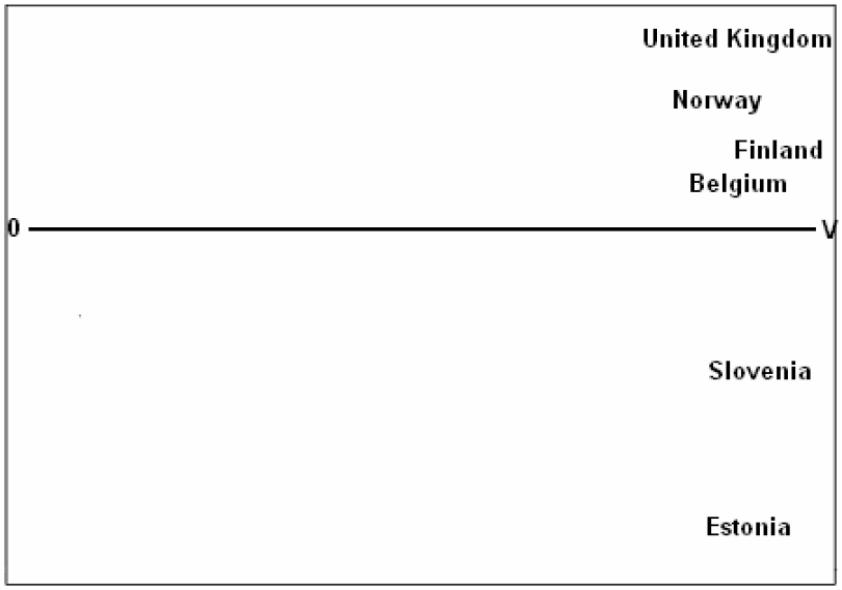
Source : own elaboration on sub-file extracted from the EUROSTAT 'Time-use at different stages of life in 13 European countries in 2003' Data File. 3-way analysis: ACT-méthode STATIS-DUALE -inter-structure analysis

In Figure 7 it is possible to verify the countries similar and dissimilar and their deviation from the mean represented by the compromise matrix V : countries similar are Finland and Belgium, United Kingdom and Norway and on the opposite side of the factorial plane under the mean, Estonia and Slovenia. Further examining the reciprocal position of the six countries we

tion coefficients (R) according to the 'a posteriori codings' chosen for the three-indices matrix. In the application the coding of second type (see par.4.2) requests distances between correlation coefficients (RV).

note that Norway, Finland and Belgium are very near (similar), more distant from them the United Kingdom, all four countries over the mean (V). Estonia and Slovenia are not very similar but under the mean.

Figure 7
Simultaneous representation of the 6 time use tables on the plot of the first factorial plane (explaining 93.15 % of the total variance)



Source: own elaboration on sub-file extracted from the EUROSTAT.
Three-way analysis: ACT-méthode STATIS-DUALE – inter-structure analysis.
Notes: V is the mean (compromise) matrix and V=0 because data is standardized (mean 0 and standard deviation 1)

4.4 The intra-structure analysis: the compromise individuals and variables

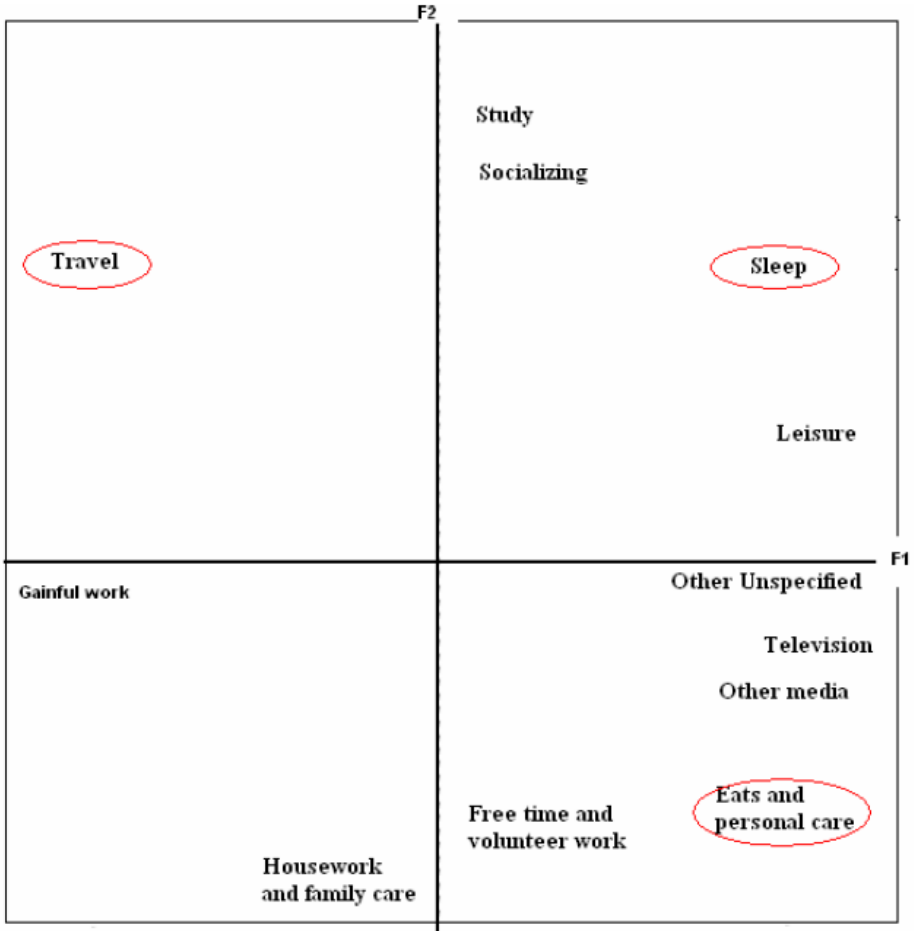
The compromise or intra-structure analysis has the goal to summarize the six studies. In particular it analyse the individuals (i.e. 14 categories of population) and variables (i.e. 12 activity groups) in view to identify the mean (or compromise)-individuals (mean-category of population: i.e. men, women in the application) and the mean (or compromise) variables (meanactivities: i.e. mean-time-budget) across the six occasions (countries).

The mean matrix (compromise matrix) represents the synthesis of all matrices and is calculated in different way according to the a posteriori data coding[8]. In the intra-structure analysis the compromise matrix is diagonalized and it is possible to represent on the principal compromise planes (in this application explaining the 69.75% of the total variance) the meanindividuals points and the mean-variables points referred to all the six occasions. In the present application the meaning of mean-individuals-points is enough clear and correspond to the men and women of the six countries. Similarly for the mean-variable points they correspond to the mean time-budget across the 6 countries.

[8] In the application (different cases and same variables) the compromise matrix is obtained by the scalar product of the correlation matrices and their weighted arithmetic mean.

In the multiway analysis, act-statis-duale method, the intra-structure (compromise) analysis when the 'a posteriori coding' is that one concerning different cases and same variables it is possible to represent on the compromise factorial plane the mean-variable points which are reported in the Figure 8.

Figure 8
The underlying dimensions of the six European countries time-budgets.
Mean-variable points on the first factorial compromise plan
(explaining 69.75% of total variance).



Source: own elaboration on sub-file extracted from the EUROSTAT. Three-way analysis: ACT-méthode STATIS-DUALE – intra-structure analysis.

From Figure 8 it is possible to identify the mean-structure underlying the time budgets of the six countries. Two underlying dimensions (factors) characterize the time-budgets structures:

- the first compromise axis characterized by the activities of gainful work opposed to leisure-watching TV-other media;
- the second compromise axis characterised from the housework and family care-volunteerswork opposed to study and socializing.

Three activities groups are correlated with both axes and could be defined interstructural activity groups: sleep, eats and personal care, travel.

But it is now time to return back for the last analytical description of the time-budgets individuals, 14 categories of population at different stages of life in the six European countries by the last phase of the multiway analysis.

4.5 The trajectories analysis: comparing analytically activities and individuals across the countries

The aim of the trajectories analysis is to have a detailed exploration of differences between the studies comparing the 12 activities of the 14 categories of population across the 6 countries in view to identify the role of each variable in the time use differences, always referring to an average day of the week. It is possible to represent the trajectories in many different ways. In the application because the cases are different and the data are macro data (average durations of categories of population) the analysis of the trajectories obtained by the statisduale method do not add new important information with respect to the analysis above mentioned. On the contrary it is possible to obtain a more analytical description of the variables and individuals by the Multiple Factor Analysis (MFA)[9]. In Figure 9 we report the plot of the 84 individual-points[10] across the six countries on the first factorial plane (explaining the 72.39 % of the total variance).[11]

From the Figure 9 it is possible to identify, excluding the cluster of individual points near the origin of the axis corresponding to the mean-individual points in the six countries (corresponding to total men and total women in each country), four clusters of individual-points each-one including the categories of population at different stages of life similar with respect to their time-budget in a weekday:

- Cluster 1: Men and Women Employed, Men and Women living in Couple with Child 0-6 and 7-17 years old living with parents, for all the six countries. From Figure 9 it is possible to see and compare with the other clusters the size (number of points), the shape and the dispersion of the individual points of the cluster;
- Cluster 2: Men and Women 45-64 years old living in couple without children living with parents in all countries;
- Cluster 3: Men and Women more than 65 years old living in couple not having children less than 18 years living with parents in all countries;
- Cluster 4: Men and Women less than 25 years old Not having children less than 18 years old living with them in all countries.

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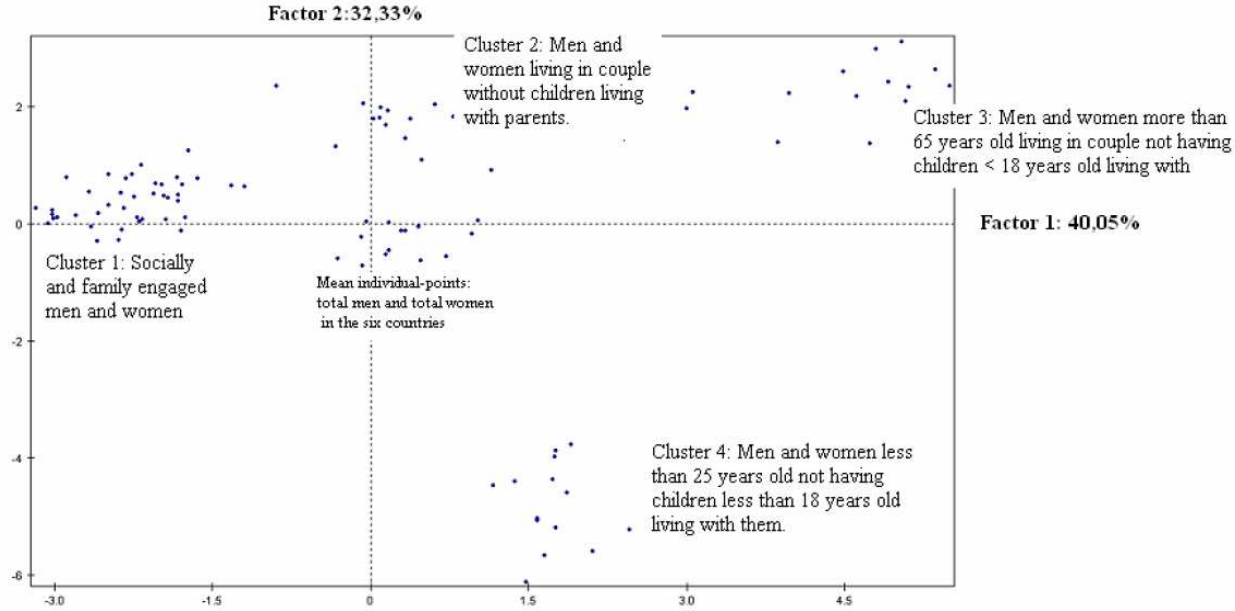
9 Among the multiway analysis the Multiple Factor Analysis is suitable to analyse different groups of individuals on which are observed the same or different quantitative or qualitative variables. MFA is based on repeated applications and synthesis of Principal Component Analysis (for quantitative variables) or Multiple Correspondence Analysis (for qualitative variables).

10 84= 14 categories of populations at different stages of life × 6 European countries.

11 It is to remark that the plot of the variable-point (circle of correlation) on the first factorial plane obtained with the Multiple Factor Analysis is the same obtained in the compromise Statis-Duale analysis reported in Figure 8.

It is important to remark that cluster 1 and cluster 3 are correlated with the first axis characterized in the compromise analysis (see par. 4.4) by the gainful work opposite to leisure and mass media and that cluster 2 and cluster 4 are correlated with the second compromise axis characterized by the housework and family care-volunteers work opposed to study and socializing.

Figure 9
Plot of the 84 categories of population at different stages of life across the six countries on the first factorial plane (explaining the 72.39 % of the total variance)
The size (number of points), shape and dispersion of the four clusters



Source: own elaborations on sub-file extracted from the EUROSTAT Multiple Factor Analysis method

5 Concluding remarks

In the above application the multiway data analysis has shown to fit well for exploring and comparing many time use tables simultaneously. At this purpose the application considered on cross-national comparisons in time-use at different stages of life in six European countries has given important results and could be applied to much more countries, cases and variables as well.

The inter-structure analysis has revealed a general similarity in the homologous points (time-budget of the same category of population across the six countries). Belgium and Finland resulted very similar United Kingdom-Finland and Norway-Finland too, Estonia results very dissimilar with respect to all other countries but particularly United Kingdom and Norway and similar to Slovenia. All the countries except Estonia and Lithuania are located over the mean line.

The intra-structure analysis has revealed two main dimensions underlying the time-budget structure of the 14 categories of population across the six countries: the first factor related to the activities of gainful work opposed to leisure-watching TV-other media; the second factor related to the activities of the housework and family care, volunteers work opposed to study and socializing. Interstructural activities resulted Travel, Sleep and Eats and Personal care.

Finally the trajectories analysis has identify four clusters of population with respect to their time use across all countries: cluster 1) Men and Women Employed, Men and Women living in Couple with Child 0-6 and 7-17 years old living with parents; cluster 2) Men and Women 45-64 years old living in couple without children living with parents; cluster 3) Men and Women more than 65 years old living in couple not having children less than 18 years living with parents; cluster 4) Men and Women less than 25 years old Not having children less than 18 years old living with them. The correlations of the four clusters of individuals with the two underlying factors (see par. 4.5) characterising the time-budget structure in the six countries allow us to identify four ways of life, patterns of spending the time use across the six European countries in a weekday: a) Cluster 1: Socially and Family engaged men and women; b) Cluster 2: Men and women living in couple without children; c) Cluster 3: Old (>65 years old) living in couple d) Cluster 4: Young men and women (<25 years old). It is possible to compute the typical time-budget characterizing the pattern of time use of each cluster by the average time-budget of the cluster cases.

Finally notwithstanding their geographical and cultural differences the six European countries reveal the same large differences in the gender division of gainful work and domestic work and gender differences in the free time available.

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On measuring heterogeneity in the use of time

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Abstract

This paper discusses methods that permit evaluating the degree of heterogeneity in the use of time. In particular, it is argue that scalar measures of multivariate scatter constitute a general means to assess the degree of within-group time-use heterogeneity. The techniques are then illustrated by inquiring into the heterogeneity in the allocation of time of retired and employed older adults.

JEL-Codes: J22, J26

Keywords: Time-use heterogeneity, multivariate scatter, retirement

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1 Introduction

The purpose of this paper is to discuss methods that permit evaluating the degree of heterogeneity in the allocation of time. While most empirical time-use studies compute measures of central tendency from a set of time-use data, there are situations in which the computation of some statistic summarising the pattern of variability in the use of time could be specially relevant. Consider for instance the case where the degree of convergence in patterns of time use of a group of individuals is to be assessed. By measuring the degree of time-use heterogeneity in two moments of time we could infer the extent of time-use convergence underwent by the group[1].

The next section discusses three techniques that permit evaluating the degree of time-use heterogeneity in different situations. While two of them are appropriate to measure the degree of between-group time-use heterogeneity, scalar measures of multivariate scatter are advocated as a general method to evaluate the degree of within-group time-use heterogeneity. For the sake of example, some of these measures are then utilised to assess the degree of heterogeneity in patterns of time use of retired and employed individuals of similar characteristics. Section 3 describes the data utilised and presents the results. A final section summarises the main conclusions.

2 Heterogeneity in the use of time

This section starts reviewing two methods – already utilised in the time-use literature – that evaluate, either graphically or numerically, the distance between multivariate vectors containing average times devoted to several activities by two groups of individuals. While particularly convenient to the study of between-group time-use heterogeneity, these methods are not suited to assess the degree of time-use heterogeneity within a group of individuals. Scalar measures of multivariate scatter – in particular, the effective variance proposed in Peña and Rodríguez (2003) – are then advocated as a general means to evaluate the degree of withingroup heterogeneity in the use of time.

Gershuny (2000) utilises a graphical device to study the existence of convergence in the allocation of time. Average proportions of waking time devoted to paid work, unpaid work, and leisure by individuals classified into two groups are depicted in the 2-dimensional simplex $S^2 \equiv \{s \in R_+^3 : s_i \geq 0; s_1 + s_2 + s_3 = 1\}$ where s_i represents the average proportion of waking time de-

[1] Several authors (including Dow and Juster (1985), Csikszentmihalyi and Larson (1987), Kahneman et al. (2004)) have proposed data-gathering methodologies in which the collection of time-budget information is complemented with measures of the satisfaction people derive from their activities. The assessment of timeuse convergence could thus provide the possibility to assess convergence in well-being.

voted to some of the three activities. In order to know whether the between-group allocation of time has become more convergent, the distance between the vectors of means for the two groups – an indicator of the degree of between-group time-use heterogeneity – is visually evaluated for the 1960s and the 1990s. Although useful in some situations, this kind of visual displays suffer from the impossibility to be extended to the analysis of time-use data with more than four components. A more general method to assess between-group time-use heterogeneity is provided by calculating dissimilarity indexes[2]. Gauthier and Smeeding (2000), for instance, calculate one such index by numerically evaluating the distance – using the absolute value norm – between multivariate vectors containing average percentages of daily time devoted to several activities by two populations of individuals. Dissimilarity indexes, however, are designed to compare only two groups of individuals[3], and a reference dimension – given, e.g., by time, gender, or geography – is required in the data in order to gauge the size of the dissimilarity.

Neither the ternary diagram utilised in Gershuny (2000) nor the dissimilarity indexes take advantage of the individual-level time-use information in measuring heterogeneity. As a consequence, for instance, they cannot indicate which of the comparing groups has patterns of time use more heterogeneous. Scalar measures of multivariate scatter can fill this gap. The underlying idea is that, instead of evaluating the distance between the centres of gravity of two swarms of points as in the previous two methods, it is the overall shape of the swarms what these measures examine. Three scalar measures of multivariate scatter are the generalised variance (proposed in Wilks (1932)), the total variation (see, for instance, Seber (1984, Ch. 5)), and the effective variance (proposed in Peña and Rodríguez (2003)). Let $x \in R_+^p$ be a p-dimensional random variable with information on the amount of time devoted to p activities on a given day and Σ its associated covariance matrix. The total variation is then given by $tr(\Sigma)$, the generalised variance by $|\Sigma|$, and the effective variance by $|\Sigma|^{1/p}$. As discussed in Peña and Rodríguez (2003), not all three measures satisfy a series of desirable properties for a useful scalar measure of dispersion. For example, a change in scale in x induces a proportional change in scatter only when measured with the generalised and effective variances[4]. On the other hand, the effective variance can be utilised to compare the scatter of random variables of different dimensions – i.e., groups in which the day is split into a different number of activities – while the other two measures cannot. It is because of these relative advantages that we advocate the use of the effective variance as a descriptive measure of within-group heterogeneity in the use of time.

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2 Stewart (forthcoming) compares alternative dissimilarity indexes and makes a useful recommendation for research.

3 With more than two groups we could calculate, say, the average distance of the group vectors with respect to the vector containing the average of the groups, which resembles the notion of dispersion discussed next.

4 A proportional change in scatter implies that relative dispersions are not affected by the units of measurement.

Before computing the effective variance from a sample of time-use data, however, a difficulty to time-use data analysis created by the constant-sum constraint on the components of x must be firstly removed[5]. Assume, without lost of generality, that time is measured in hours:

(1) $$x_1 + ... + x_p = 1 .$$

Therefore,

(2) $$\operatorname{cov}\left(x_i, x_1 + ... + x_p\right) = 0 \quad (i = 1, ..., p),$$

implying that the entries in each row of Σ must add up to zero. As a consequence, the matrix Σ is singular, for one of its eigenvalues is zero:

(3) $$\sum \mathbf{1} = \mathbf{0} = 0\mathbf{1},$$

where **1** is the p ×1 vector with each element 1. Hence, the effective variance calculated from a sample of time-use data will always be zero[6].

We propose to delete one component of x before computing the effective variance from a sample of time-use data[7]. An example could illustrate this approach. Consider a swarm of points in R^3 representing time-use vectors of order three. Because of the constraint in (1), the points are located on a plane, and the determinant of Σ, a measure of the volume that the swarm of points occupies in the space, is zero. Yet, the swarm does occupy an area on the plane. To evaluate this area, one component of the vector is dropped, and the determinant of the 2×2 covariance matrix obtained by deleting the row and column of Σ that intersected on the variance of the deleted component is computed. This determinant is invariant to the component being deleted since, as shown in Appendix A, all principal minors of Σ are equal. In this example, the effective variance could be interpreted as the length of the side of the square whose area is equal to the area occupied by the swarm of points[8]. An analogous approach is usually employed in the estimation of Engel curves, where one equation is dropped because all of its parameters can be inferred from knowledge of those in the other equations (see, e.g., Deaton (1986)).

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5 See Aitchison (1986) for a much broader discussion. Aitchison's monograph was brought to my attention by Clarke Wilson, to whom I am deeply grateful.

6 As discussed in Aitchison (1986, Ch. 3), the bottom line of this constraint difficulty is that standard statistical methods designed for unconstrained Euclidean spaces may become inappropriate when applied to some constrained region of R^p . As a consequence, the additional constraints placed on the covariance structure by the restrictions in (2) render also difficult the interpretation of the results obtained with the total variation and the generalised variance.

7 Aitchison (1986) proposes two alternative transformations of the data to avoid the constraint difficulty. Yet, they both involve taken logarithms of x and, given the fair number of zeros in time-use vectors, cannot be directly applied to time-use data. Several techniques (surveyed, e.g., in Martín-Fernández et al. (2003)) have been developed that replace zero components before applying some of the Aitchison's transformations. These techniques, however, seem more appropriate when zeros are the consequence of some rounding-off than when they indicate the complete absence of an activity. Also, they seem more suited for inference than for description.

8 See Peña and Rodríguez (2003, p. 363).

Thus, to obtain the sample counterpart of the effective variance, let $x_1, x_2, ..., x_N$ denote a random sample of size N from a p-dimensional distribution with finite mean $\bar{x}$ and covariance matrix Σ. The sample of vectors with one component, say the ith, deleted is denoted as $x_1^{(-i)}, x_2^{(-i)}, ..., x_N^{(-i)}$. The multivariate analogue of the univariate unbiased estimate of variance calculated on the sample of transformed data is[9]

$$\hat{\Sigma}^{(-i)} = \frac{1}{N-1}\sum_{t=1}^{N}\left(x_t^{(-i)} - \bar{x}^{(-i)}\right)\left(x_t^{(-i)} - \bar{x}^{(-i)}\right)', \tag{4}$$

where $\hat{\Sigma}^{(-i)}$ denotes the principal submatrix obtained by deleting the i-th row and i-th column from the sample covariance matrix, $\hat{\Sigma}$. The sample effective variance can then be computed as $\left|\hat{\Sigma}^{(-i)}\right|^{1/(p-1)}$. Its asymptotic distribution has been derived in Peña and Rodríguez (2003): Under sampling from a normal population, the sample effective variance is asymptotically normally distributed with estimated asymptotic variance given by

$$\frac{\left(\left|\hat{\Sigma}^{(-i)}\right|^{1/(p-1)}\right)^2 2/(p-1)}{N-1}. \tag{5}$$

3 Do patterns of time use become more heterogeneous after retirement from the labour market?

Gruber and Wise (1999) present evidence from eleven industrialised countries showing that retirement from the labour market is accompanied by changes in individuals' circumstances such as changes in income or health status. In the light of Becker (1965), these changes could significantly alter individuals' patterns of time use. Furthermore, even if individuals react in the same way to them, their magnitude and, consequently, the size of the response they induce can be different. By changing individuals' distribution of time among activities and perhaps the very variety of activities consumed, retirement could alter the degree of heterogeneity in the allocation of time. We illustrate the previous methods by inquiring into the degree of timeuse heterogeneity of retired and employed German older adults[10].

[9] See Seber (1984, p.8).

[10] We do not claim we are isolating the causal effect of retirement on the degree of time-use heterogeneity. At the very least, the data – a single cross-section – preclude to compare the same individual under different circumstances. Yet, the descriptive evidence reported in this paper could motivate more sophisticated future work.

3.1 Data

The German Time Use Survey 2001/2002 has recently collected nationally-representative time-use information for the non-institutionalised population of individuals 10 years old and older. 11,962 individuals were personally interviewed between April 2001 and March 2002, each of whom filled out three time diaries[11]. Individuals who declared to be either employed or retired to a question assessing their labour market status were selected for the present study[12]. Besides, to partially adjust for demographic differences between samples, only men in the age range 60-64 are considered. As reported for instance in Blöndal and Scarpetta (1998), the average age of transition to inactivity of older German workers is contained in this age interval. Individuals' uses of time are then classified into a system of comprehensive, mutually exclusive time-use categories. Daily time is initially split into the 10 first-level activity categories in Commission of the European Communities (2000, Annex VI). Table 1 provides the centres of gravity of the swarms of points whose degree of heterogeneity is next evaluated[13].

Table 1
Time use on an average day by men aged 60-64 (hours)

	Employed	Retired
Personal care	10.31 (.12)	11.61 (.07)
Employment	4.50 (.22)	0.03 (.01)
Study	0.02 (.01)	0.05 (.02)
Household and family care	2.02 (.14)	3.54 (.09)
Volunteer work and meetings	0.53 (.09)	0.60 (.06)
Social life and entertainment	1.46 (.10)	1.62 (.07)
Sports and outdoor activities	0.48 (.05)	0.69 (.05)
Hobbies and games	0.35 (.04)	0.50 (.04)
Mass media	2.67 (.11)	3.94 (.10)
Travel and unspecified time use	1.66 (.08)	1.42 (.06)
Person-days	539	610

Source: Own calculations with data from the German Time Use Survey 2001/2002.
Notes: Weighted estimates. Standard errors are in parentheses.

[11] See Commission of the European Communities (2000) for more information regarding this survey.

[12] Labour market status is obtained from variable stat. An individual is considered as retired when s/he declares to be receiving a pension (Rentenbezieher/innen). Börsch-Supan and Schnabel (1999) provide institutional background about retirement in Germany.

[13] Since more than four activity categories are considered, the graphical method in Gershuny (2000) cannot be utilised.

3.2 Results

Based on the time-use categories listed in Table 1, Column (1) of Table 2 shows the value of an index of dissimilarity between employed and retired German older adults and the sample effective variance of each group. The index of dissimilarity is calculated as

$$(6) \qquad 100\times\left(\sum_{i=1}^{p}\frac{\hat{\bar{x}}_i^{emp}-\hat{\bar{x}}_i^{ret}}{24}\right)^2,$$

Where $\hat{\bar{x}}_i^{emp}$ (respectively, $\hat{\bar{x}}_i^{ret}$) denotes the sample mean of hours devoted to activity i on an average day by the group of employed (retired) older adults. In computing the sample covariance matrices, the observations have been weighted, so that the effective variance evaluates dispersion with respect to behaviour on an average day. Appendix B provides the STATA code utilised to calculate the sample effective variances.

Table 2
Heterogeneity in patterns of time use of men aged 60-64

	(1) First-level activity categories		(2) Second-level activity categories	
	Employed	Retired	Employed	Retired
I_d	39.3		40.3	
V_e	1.5386	1.1886	.2165	.1949
	(.0313)	(.0227)	(.0022)	(.0019)
Activities	10	10	37	34
Person-days	539	610	539	610

Source: Own calculations with data from the German Time Use Survey 2001/2002.
Notes: Weighted estimates. Standard errors (in parentheses) are computed using expression (5).
I_d is the dissimilarity index in expression (6). V_e stands for the effective variance.

The dissimilarity index between retired and employed German older adults suggests that 39.3% of the daily time would need to be reallocated in order to obtain identical patterns of time use in both groups. Although the dissimilarity index cannot indicate which group shows patterns of time use more heterogeneous, this issue can be assessed with the help of the effective variance. The sample effective variances reported in the first column of Table 2 suggest that retired German men in the age range 60-64 have patterns of time use less heterogeneous than those exhibited by employed German men in the same age range: The sample effective variance of retirees amounts to 1.19, while that for employed individuals is 1.54, being the difference statistically significant at the 95% of confidence level.

Can the level of activity aggregation selected influence these findings? Stewart (forthcoming) shows that some dissimilarity indexes are sensitive to the presence of short-duration activities.

Analogously, the degree of scatter observed in the data could be affected by the number of activity categories in which the day is split: At least because of the 24 hours constraint, if we devote time to some activities we have to curtail in others, implying that times devoted to some activities could be correlated. To examine this issue, the initial 10 time-use activity categories were further disaggregated into the 42 second-level activity categories in Commission of the European Communities (2000, Annex VI). Results are provided in Column (2) of Table 2[14]. Since the dissimilarity index in (6) belongs to a family of indexes robust to the presence of short-duration activities, its level remains quite stable. On the other hand, the amount of time-use dispersion observed in the data is clearly affected by the selected level of activity aggregation, and sample effective variances reported in Column (2) of Table 2 are lower than those in Column (1). Notably, however, the relative finding remains the same: Results continue suggesting that patterns of time use are less heterogeneous among retired German men than among employed German men of similar age, being the difference statistically significant at the 95% of confidence level.

4 Conclusions

This paper has advocated the scalar measure of multivariate scatter proposed in Peña and Rodríguez (2003) as a useful method to assess the degree of within-group time-use heterogeneity. Before computing the effective variance from a sample of time-use data, however, it is needed to firstly remove one component from the data vectors in order to overcome the difficulties created by the constant-sum constraint on the interpretation of the sample covariance structure. Secondly, since the level of activity aggregation selected by the researcher could affect the amount of dispersion observed in the data, comparisons among groups – or across time within the same group – are better done with the same classification of activities.

The lower degree of heterogeneity in the allocation of time found among German retirees cannot be claimed to be a consequence of labour market retirement: At least, the samples of employed and retired individuals are not made up of the same individuals observed under different circumstances. To better isolate the causal effect of retirement – or of any other event – on the degree of time-use heterogeneity, we would have to control for observed and, if possible, unobserved differences among sampled individuals. Statistical techniques suited to the special features of time-use data that permit accomplishing this task are to be investigated.

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[14] In both groups, to some of these 42 activity categories the sampled individuals devote no time. As a matter of fact, then, dispersion is evaluated with respect to the number of activity categories provided in the nextto-last row of Table 2.

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Appendix

Appendix A

Proof of the claim that the principal minors of Σ , the covariance matrix associated to a pdimensional random variable with information on the amount of time devoted to p activities on a given day, are all equal.

Σ is assumed to be a $p \times p$, symmetric, positive semi-definite matrix with $rank(\Sigma) = p - 1$ Let $\boldsymbol{\sigma}_i$ denote the i-th row of Σ and 1 the $p \times 1$ vector with all its elements 1. Since time-use data are subject to a constant-sum constraint, $\boldsymbol{\sigma}_i \mathbf{1} = 0, \; i = 1, ..., p$ The fact that all rows of $\Sigma$are orthogonal to **1** and the assumption that p–1 of them are linearly independent imply that p–1 rows of Σ form, jointly with **1**, a set of basic vectors in R^p. Let $\mathbf{a}_i \in R^p$ denote the column

vector containing the cofactors of the elements in the i-th row of Σ . Since Σ is singular, $\boldsymbol{\sigma}_i \mathbf{a}_i = 0,\ i = 1,..., p$ Besides, by the properties of determinants, $\boldsymbol{\sigma}_k \mathbf{a}_i = 0,\ \forall k \neq i$ Since $\mathbf{a}_i$ is orthogonal to every row of Σ , it must have the same direction as **1**, and, as a consequence, it may be written as $\mathbf{a}_i = \lambda_i \mathbf{1}$ being λ_i an scalar. By the symmetry of Σ , $a_{ij} = a_{ji}$, implying $\lambda_i = \lambda_j = \lambda$ Hence, any principal minor (m_{ii}) of Σ is given by $m_{ii} = a_{ii} = \lambda,\ i = 1,..., p$.

Appendix B

This appendix provides the STATA code utilised to compute the sample effective variances in Column (1) of Table 2 (those in Column (2) of Table 2 have been computed similarly). The code, intended to serve as a template for the user's own analysis, cannot be run as it stands since, at least, the user must add his/her own data set. The program assumes a data set named data.dta, extracted from the German Time Use Survey 2001/2002, containing observations (person-days) of men aged 60-64 that are either employed or retired (a total of 1,149 observations). Among others, this data set contains the variables stat (codifying the labour market status), h_pzv95n (an individual weight), and a set of variables with times (in hours) devoted to the 10 first-level activity categories in Table 1.

```
version 8.0
#delimit;
clear all;
use data.dta;

*Assessing dispersion. "Personal Care" is not included to overcome the con-
       straint difficulty;
*Computing the sample covariance matrices (Sigmahat);
matrix accum E = employment study householdcare volunteer sociallife sports
       hobbies media travel [pweight=h_pzv95n] if (stat>=1 & stat<=5), de-
       viations noconstant;
matrix Sigmahatemployed = E/(r(N)-1);
matrix list Sigmahatemployed;
matrix accum R = employment study householdcare volunteer sociallife sports
       hobbies media travel [pweight=h_pzv95n] if stat==12, deviations no-
       constant;
matrix Sigmahatretired = R/(r(N)-1);
matrix list Sigmahatretired;

*Computing the sample effective variances (EV);
scalar EVemployed = ((det(Sigmahatemployed))^(1/9));
scalar EVretired = ((det(Sigmahatretired))^(1/9));
scalar list EVemployed;
scalar list EVretired;
```

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news on time use research in the
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New developments in time technology – projects, data, computing and services

THE 2001 JAPANESE SURVEY ON TIME USE AND THE COMING 2006 SURVEY

Tetsuaki Sato
Statistics Bureau of Japan (SBJ)

The Statistics Bureau of Japan (SBJ) has conducted time use surveys every five years since 1976, collecting a sample of 200,000 people in each survey. The survey was conducted by asking people to choose activities out of 20 categories which they did over 15 minute intervals on two successive days.

In 2001, prompted by the Harmonized European Time Use Surveys (HETUS), the SBJ also began to carry out time use survey in diary form, in which diarists are asked to record their activities in their own words, to be analyzed by the researchers afterwards.

The SBJ published the results of the 2001 free diary form survey in 2002 (SBJ, 2002). The English translation is available both in paper form and on our website. However, categorization in this survey was based on Japanese understanding of life activities: for example, caring for pets or baking cakes is considered as "leisure" in Japan, not as "housework", and having breaks between tasks is counted as "rests".

To lessen such cultural gaps which may lead to misunderstanding of results, the SBJ recategorized the 2001 survey based on HETUS standards and published the results at the end of March 2006 (SBJ, 2006). The English translation may be available on our homepage by September 2006. It is notable that in Japan both working men and women have longer working/studying time than in European countries, and that working women's activities feature long hours of mealtime and personal care, while working men do very short hours of housework.

The SBJ also published a study of unpaid work (SBJ, 2006). This shows that the working couple's working time including unpaid work is two hours more than that of the couples in which the wife has no paid job. However, the former spend about 3.5 hours less time on unpaid work than the latter, apparently by seeking outside services to lessen unpaid work such as cooking or childcare. There are some interesting phenomena, such as an increase in the working time of wives as children grow older, due to an increase of expenses for education (Ohta, 2006).

In the coming 2006 Survey, the SBJ is planning to supply information on people's average schedulings of life-activities such as getting up, having breakfast and going to bed. It also plans to supply summary data comparing different groups of people, whether or not they have a partner or children in the same household.

The 2001 survey collected data on primary and secondary activities. The 2006 survey will add a cross table of both.

Website: http://www.stat.go.jp/english/data/shakai/index.htm. Email: tsatou5@stat.go.jp

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AMERICAN HERITAGE TIME USE SURVEY (AHTUS)

The Centre for Time Use Research (CTUR), presently based at the Institute for Social and Economic Research at the University of Essex in the UK, is pleased to announce the pre-release of the American Heritage Time Use Study (AHTUS). The AHTUS includes harmonised main activity, secondary activity, location, mode of transport, and who else was present variables at the episode level for national time use surveys collected in the USA in 1965-66, 1975-76, 1985, 1992-94, and 2003. This dataset is the first cross-time harmonised episode-level time use dataset available to users to download for free over the internet. The AHTUS features data enhancement, whereby information the diarist recorded at any point in the diary for an episode is recorded in all relevant diary columns. The activity “outdoor cleaning and maintenance”, for example, is used both to code the activity of household maintenance and cleaning and the location of outside; and mode of transport column entry “drive to work” is recorded as both main activity “commute” and mode of transport “car”. AHTUS weights 0-weight cases where the sex or age of the diarist or the day of the week when the diary was completed is missing as well as

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cases of low quality diaries (missing in excess of 90 minutes main activity time; or including fewer than 7 episodes; or missing two or more of four broad categories of activities which most people do daily: 1) some form of rest, sleep or time out; 2) eating or drinking; 3) some form of personal care; 4) travel). CTUR developed the AHTUS for the Yale University Program on Non-Market Accounts with funding from the Glaser Progress Foundation. The data and documentation are presently under review, but users can explore the near final documentation and download the test data from: http://www.timeuse.org/ahtus/.

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Book notes

by Kimberly Fisher

DESA (United Nations Department of Economic and Social Affairs)
Guide to producing statistics on time use measuring paid and unpaid work (2005)

Publisher: United Nations Department of Economic and Social Affairs, New York
Website: http://unstats.un.org/unsd
Languages Available: English

This publication presents an overview of different approaches in the design of timeuse surveys. The publication provides further impetus to the development of time-use statistics and assistance to countries interested in undertaking time-use surveys. It reviews methods and practices in collecting, processing and disseminating time-use statistics through compilation of country experiences. It is also aimed at facilitating the harmonization of methods and practices in collecting, processing and disseminating time-use statistics. In addition, the publication is meant to solicit comments and suggestions on the trial International Classification of Activities for Time-Use statistics (ICATUS) which will subsequently be revised.

Kramer, C. Zeit für Mobilität – Räumliche Disparitäten der individuellen Zeitverwendung für Mobilität in Deutschland (2005)

Publisher: Franz Steiner Verlag, Stuttgart
Website: http://www.gesis.org/ZUMA/neue%20Buecher/2005/kramer.htm
Languages Available: German

This book is about daily time use for mobility in a modern society and is discussing a „speedy standstill" where space is without further meaning. Theoretically based on classical „Time Geography" the question about social and spatial unequal distributed time for mobility is analyzed. Based on the two German Time Budget Studies 1991/92 and 2001/02 it is shown that there are still different mobility patterns between West and East Germany and that there is not yet a reduction of real mobility in favour for a new virtual spatial mobility.

time-use research

McGinnity, F., Russell H., Williams J. and S. Blackwell
Time-use in Ireland 2005: survey report (2005)

Publisher: Economic and Social Research Institute, Dublin
Website: http://www.esri.ie/advsearch.cfm?t=Find%20Publications&mId=2&detail=1&id=2293
Languages Available: English

This book summarises the methodology of the first national time diary study in Ireland. The report also presents basic findings of time use in Ireland on the topics of the distribution of paid and unpaid work and the differences in time use of: women and men; age groups; people with different employment statuses and people with different family and household structures. The report notes many similar trends observed in other European countries also appear in Ireland. The report concludes with discussion of future plans for time use research in Ireland.

Varjonen J. and Aalto K.
Household production and consumption in Finland 2001: household satellite accounts (2006)

Publisher: National Consumer Research Centre, Helsinki
Website:
http://www.kuluttajatutkimuskeskus.fi/files/4919/2006_household_satellite_account.pdf
Languages Available: English

This book builds from the Eurostat and SNA93 guidelines to develop satellite accounts for Finland to measure the value of unpaid household production. The report makes use of the 1999-2000 Time Use Survey, the 2000-2001 Household Budget Survey, Statistics Finland salary statistics, and 2001 National Accounts figures. The authors estimate that only 13% of the 62.8 billion Euros of gross value added by unpaid household production appears in the national accounts. Housing, followed by meals and snacks, account for the greatest portion of household production.

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