Time-Use Surveys and the Measurement of National Well-Being

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SUMMARY

- There are four options for registering or measuring time-use: **questionnaire** items, **opportunity sampling** or "beeper" studies, **direct observation** and **diary** studies. Each has advantages and disadvantages; time diary studies are the focus for this report. ***(pp 4, 5)***

- Diary studies go back to the start of the 20th century, with large-scale UK surveys from 1961-2001. Diaries are **continuous sequential logs of events**, each event being characterised by one or more descriptive fields (eg multiple simultaneous activities, location, co-presence and subjective responses). There is a Harmonised European Time-use Study, collected by most EU states. Canada, Australia, Japan, China and others collect diary studies; the US does so annually. ***(pp 5,6)***

- Time diaries provide both **activity sequence information** (who does what, when?) and **time budgets** (how much of each activity?). Both sorts of evidence potentially contribute to the understanding of well-being. ***(pp 6-12)***

- Diaries contribute to our understanding of **paid work** by revealing the daily and weekly patterns of economic activity (long, short, interrupted, continuous, anti- or pro-social hours) as well as providing more reliable estimates of total durations than do questionnaire items. ***(pp 13-15)***

- Diaries provide direct evidence of amounts of time spent in **unpaid work** to produce services for families or voluntary agencies, which can be used as a basis for estimating the value of non-monetized economic activities outside the GNP. Since 1961 the UK's non monetized economic activity has been growing faster than GNP; **half or more of the value of all (money + non-money) economic activity or "extended National Product" (eNP) now stems from outside "the economy".** ***(pp 13-20)***

- How we spend our leisure time has major consequences for health. Appropriate exercise, eating, work and sleep patterns all contribute to well-being. Diary data show us some new and surprising results. For example, **doctors and teachers are substantially under-represented among those taking the most physical exercise, over-represented among those taking the least**. ***(pp 21-25)***

- Paid work, unpaid work and leisure/consumption time together make up the whole of the day. Over recent history **men and women's time balances have become more similar**. In aggregate terms, the **shifting time-balance away from work (paid+unpaid) towards leisure, which started in the mid-19th century, seems to have halted or even been reversed**. ***(pp 26-29)***

- Some diary studies link activities with **subjective evaluations**. UK and US studies in which respondents score their enjoyment of each diary event ("instantaneous utility"), can be used to calculate National Time Value (NTV) accounts, which allow us to contrast historical trends in respondents' aggregate enjoyment of activities with trends in eNP. **NTV seems to have slightly declined over a period when eNP has grown threefold in both countries**. Applying the valuations to time-use trends in a group of 15 countries, shows increases in NTV only for women in Nordic countries. The UK NTV is placed below continental Europe and above the US, while Italy and Spain show big gender gaps, men with high NTV, women with low NTV. ***(pp 30-39)***

- **The same time budget tables can be used to produce both eNP and NTV**, as well as health-related behaviour and environmental impact accounts, and images of the work-leisure balance. **Time diaries thus provide a means for integrating various distinct, potentially opposing, views of economic output and aggregate well-being**. ***(pp 39-42).***

1 Introducing Time Diary Surveys

1.1 Time and well-being

Time is experienced and recalled as durations, or elapsed time, spent in various activities and with various sorts of feelings. ***Well-being*** is promoted by, amongst other things, money income, by emotional and sexual satisfaction, by an acceptable social and environmental context—and also by the use we make of our time. Intrinsically satisfying work activities inside and outside the money nexus, healthy and enjoyable consumption and leisure, and an appropriate balance between work and leisure activities contribute to it, as do the economic and cultural resources that provide the prospect of continuing these in the future.

Time-use, in what follows, describes the allocation of time among various circumstances and subjective states. It is a key social indicator, which finds particular applications in the assessment of individuals' material welfare and well-being. It provides the core measure of amounts of work in specific paid occupations ("normal/actual hours per week"), and for unpaid work in private households or in volunteer groups. Exactly *when* these activities take place, during the day, week and year, is also significant for understanding well-being. It provides measures of healthy—or unhealthy—behaviours: durations in purposive exercise, or in other activity such as walking a dog, or cycling to work that have significantly positive metabolic consequences, or of too extended static periods watching television or asleep, which may have negative consequences. It can provide measures of the extent, durations and purposes of access to leisure activities, or of information technology use.

The intensity of subjective or "affective" experiences (eg happiness, enjoyment, stress or pain) is registered by ordinal scales (such as "low/moderate/high" or "disliked strongly/indifferent/liked strongly"). Time-use provides the appropriate parallel metric for the *extent* of individuals' experiences of such states (eg "*how long* in moderate distress").

Since all human states and activities occupy time, an appropriately designed time-use survey instrument can provide a comprehensive account of rhythm and balance among all the conditions and circumstance of daily life. As such, time-use accounts provide the basis for the systematic integration of various measures of well-being.

1.2 Options for the measurement of time-use

There is a variety of ways of measuring time-use. Most familiar is the use of ***"stylised" time-use items within conventional questionnaires***. We may ask **"***How often* do you…(engage in various activities)?", "*Who usually* does the...(various routine items of domestic work)? or "*How much* time do you usually spend…(in various activities)? However the stylised questionnaire approach has a range of problems, including *recall* issues, unclarity about the *inclusiveness* of activity categories or descriptions, and uncertainties about the specified *reference period* (in particular, whether successfully recalled events actually occurred within it). Questionnaire items are also disproportionately prone to social *desirability effects* (as compared with methods mentioned below) in that they allow a merely passive admission of participation in positively-valued activities, rather than requiring active invention of episodes of participation in them.

A second is the "beeper study" or ***Experience-sampling method*** (ESM) approach in which respondents are prompted, at random instants through the day and week, by a signal (a "beep") from an electronic device, to describe their current activities and affective circumstances (Larson and Czikszentmihalyi 1983). This approach potentially provides highly accurate weighted sample estimates of the population's aggregate time-use, since we know that each moment of the day must be exactly equally represented in any analysis. The immediate response required by this approach means that recall problems are avoided. And indeed, it allows direct measures of affective responses (by contrast, the intensity of subjective response is particularly difficult to measure reliably through retrospective questionnaire methods). Reference period effects are entirely avoided because only current events are reported, and activity inclusiveness issues are at least partially avoided by the use of respondents' own words to record responses. And there are fewer desirability effects, since honesty is the *easiest* policy for respondents in this case (respondents would otherwise have to actively *invent* a false description of the current circumstances).

However, ESM generates problems of respondent burden, and particularly of intrusiveness into normal life. These studies are only acceptable with relatively widely spaced prompts (more than two or three per day become seriously problematical), and the resulting discontinuity of observation makes for insurmountable difficulties for estimating total elapsed time in activities for individuals. It also loses the potential for *comprehensive* coverage of an individual's time. This has the consequence that sequential contexts—what happened before or is expected after the current activity—that may have an influence on the current affective state, are altogether missing.

A third approach is ***continuous observation***. This has in the past been achieved by human observers (eg Robinson 1977, Harms 2004), but is both enormously expensive if undertaken on any considerable scale, and also very intrusive. Now however it is possible to undertake continuous observation unobtrusively through electronic tracking and monitoring. There are examples of GPS/GSM continuous real time geographical tracking for this purpose, and this approach may be paired with real time physiological monitoring and recording, which allows the direct estimation of the metabolic consequences of the various activities. But the resulting electronic records can for the most part only be interpreted with the addition of continuous descriptions of the purposes or intensions of activities, (answering questions such as: Why were you running? What were you doing there?), to be provided subsequently by the human subjects of the observations.

This means that they require supplementation by the fourth of the time-use measurement methodologies**:** ***time-use diaries***, maintained continuously throughout a specified period, usually of 24 hours, sometimes of two, five or seven days. There is now a substantial record of development and collection of representative national, annual, time-use diary samples, by both academic researchers and national statistical institutes.

1.3 History of time diary measurement

Time diary studies have a long history, originating from the activities of late 19th century Russian official "zemstvo" (county) researchers investigating the daily life of peasant families. In the second decade of the 20th century, Maud Pember-Reeves, researching on behalf of the Fabian Society in London, who may have been aware of the previous Russian work in this area, collected a small number of single week diaries of working class

housewives in London (Pember-Reeves 1913). Strumilin collected large diary samples in the USSR between 1921 and 1923 for economic planning purposes (Zuzanek 1980), and the United States Department of Agriculture (USDA) made a major collection of women's diaries (with farm, town and "college women's" samples) between 1925 and 1931, as part of its programme of agricultural extension work. The academic study of time-use took its origin in the USA with the Russian émigré sociologist Pitirim Sorokin, who had been a colleague of Strumilin's in Moscow in the early 1920s. His Time Budgets of Human Behaviour (Sorokin and Berger 1939) provided a first introduction to this field to many social scientists.

Public and private broadcasting organisations developed interests in diary studies from the 1930s. The BBC's pioneering Audience Research Department conducted "viewer/listener availability studies"—which involved the collection of detailed activity diaries—from 1937 onwards. The Columbia Broadcasting Corporation did similarly from the early 1950s, and the published reports from this source combined with those from the USDA contributed materials to the first academic studies of historical change in time-use derived from diary materials (Converse and Robinson 1975, Vanek 1974, 1978).

Before the advent of electronic computing, the production of even the simplest of tables of mean durations in an activity from a large diary sample might take many months. Cross national comparative work in this area, requiring multiple tables broken down by country, therefore started only with the first general diffusion of computers in the 1960s. In a major initiative funded by various UN agencies, a working group led by the Hungarian Alexander Szalai developed a standard time diary instrument that was adopted initially by 12 participating countries (Szalai 1972). This format was subsequently copied for surveys in a number of other countries—including Canada in 1971 (Harvey 1975), and for an age-restricted sample in Britain (Young and Willmott 1974).

Virtually all of the subsequent time diary data collection across the world (with the single exception noted below) has developed from the Szalai model. Andrew Harvey updated the original Szalai specifications (Harvey 1993), and his revisions in turn formed one of the starting points for the Eurostat Working Party which, during later part of the 1990s devised the Harmonised European Time-use Study (HETUS) Guidelines (Gershuny 1995, Eurostat 1999). The first tranche of 15 HETUS studies was collected between 1998 and 2003; a second tranche of national studies covering the period 2008-2013 is currently underway.

In 2003 the US Bureau of Labour Statistics started a continuous American Time-use Study (ATUS), with an instrument designed independently of the Szalai and HETUS lineage, re-interviewing a subsample of the eighth wave of the Current Population Survey sample (equivalent to the multi-wave Eurostat Labour Force Survey design). The ATUS designers' decision to collect only primary activity plus prompted "childcare responsibility" has subsequently proved to be problematical (eg for the understanding of computer use). The Canadian Bureau of Statistics, which used a single activity code in earlier surveys, has now reverted to something closer to the Szalai pattern.

In the UK we find a diary study forming part of the Social Survey of Merseyside in the mid-1930s (Jones et al 1934). Mass Observation collected more than 1000 single-day diaries (which have yet to be comprehensively analysed) from its observers between 1936 and 1939. Claus Moser collected a sample of time diaries from working-class London women in the late 1940s. His findings were published, tellingly, only in French (Moser 1949). The historical evolution of British time-use can be established from the still-surviving original diary

materials collected by BBC Audience Research in 1961 and 1974/5 (other Audience Research studies before and after these dates are less useful), and the large diary studies funded by the ESRC 1983-4 (Winter) and 1986 (Summer), together with the UK's only major official diary study, organised by ONS (2000/1) on the HETUS model, (though small samples of much simpler time diaries, only partially compatible with the HETUS and surviving "heritage" datasets, has also been collected by the ONS).

Diary records, providing a repeating stream of *activity sequence information*, are directly useable, and now increasingly widely used, for a range of analytic purposes directly related to well-being. But until the last decade or so, most major applications have started, not with the raw activity sequences, but with these transformed into aggregated "*time budget*" statistics. Time budgets are accounts of the overall disposition of time over a specified period, broken down into various time-use categories, analogous to money budgets. "*Time diary research*", throughout this report, refers to the broader field encompassing both sequential and aggregated time budget analysis.

1.4 Time diary measurement methods

The special diaries designed for time-use studies involve the continuous registration of an individual's sequence of activities throughout a defined observation period (hence producing exhaustive minute-by-minute accounts throughout the observation period). Within this general description is a wide range of possible specifications.

There are ***sampling issues*** concerning the nature of the universe that the sample is intended to represent. Does it cover the whole year (including holidays and special days such as Christmas), or some specified part year? Does the sample represent individuals in the population, or multiple members of the same household? Does it cover the whole age range (in which case there will have to be some proxy respondents for children below a given age, and some elderly)?

There is the issue of the ***length of the observation period.*** A single diary day is the emerging modern standard, though there are some examples of shorter diaries, and some contested arguments for substantially longer instruments, with successful examples of seven day diary studies in the UK and the Netherlands. The Eurostat HETUS standard calls for two days from each respondent, one weekday and one weekend. (The arguments for this are chiefly fieldwork cost efficiencies.)

There are issues of ***survey administration***. Originally paper- and more recently computer-based personal interviews were the norm, but the two-day HETUS design makes self-completion a necessity. The ATUS is conducted entirely through telephone interviews. And there are examples of internet panel samples.

The approach to survey administration itself depends in part on the answers to specific issues of ***instrument design***:

- Does the diary rely on *own words* or on *precoded* responses?
- Does the diary use *variable observation intervals* (based on the start and finish times of episodes of activity), or *fixed intervals* (which might be between from 2 and 30 minutes long)? The HETUS design uses 10 minute intervals.

- Does the diary have *single or multiple activity registration fields*? And are these *hierarchical or parallel?* The norm is to invite respondents to designate simultaneous activities as "primary" or "secondary". The ATUS however collects only primary activity plus episodes of child responsibility and eating—a design decision that is emerging as distinctly problematical
- Does the diary have *additional "objective" fields* registering location, co-presence and purpose?
- Does the diary have *additional "subjective" or "affect" fields* registering enjoyment, stress, rushed feelings etc?

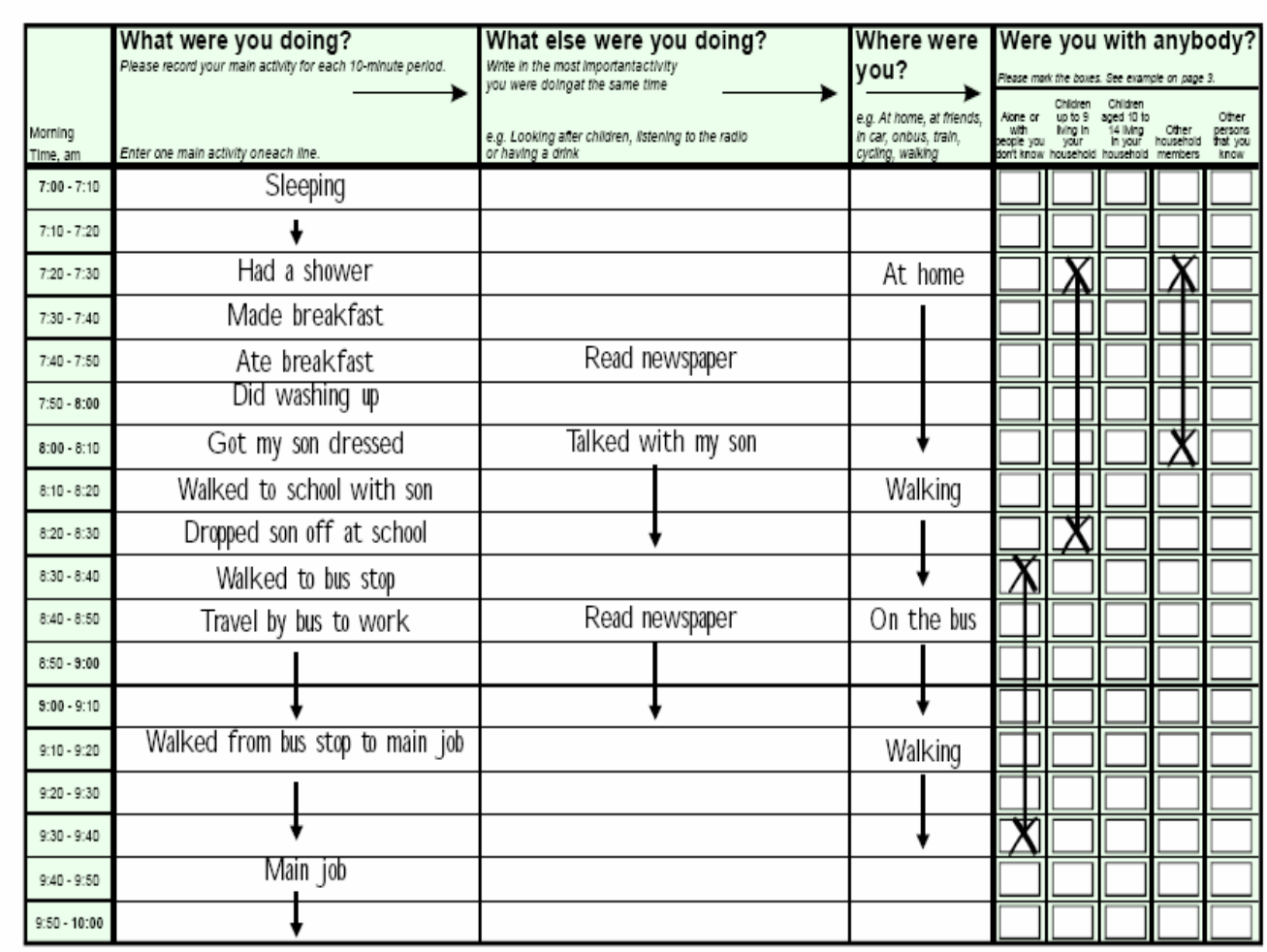
Time budgets, particularly those derived from single day diaries, have the problem of too many zeros. This is not in essence an issue of poor sampling or bad diary-keeping (though both of these may sometimes contribute to the problem). Zero time in a particular activity in a short diary either means that the respondent is *always* a non-participant, or just a non-participant *during the sampled period* (ie a conflation of inter- and intra-personal variation). For example, if everyone went to church, but only on a Sunday, a single-day time-use survey that randomly selected days of the week, would only get aparticipation rate in church of one in seven people. .As a result, studies can produce accurate estimates of mean times in activities for samples and subgroups, but potentially misleading pictures of the distribution of these activities across the sample/population.

However new measurement and estimation approaches can now be deployed to solve this problem. Nutrition diaries have been subject to the same excess zeros problem. Statisticians working with these have developed new techniques for combining stylised and diary measures in a single instrument, keeping the advantages of both methods and mutually compensating for their disadvantages, allowing in effect, long-term estimates of time-use to be derived from short-term diaries. Extensions of this approach, utilising the zero-sum/24 hours characteristics of time, further increases the effectiveness of the solution in the time diary case. A simple summary of this method is given in Appendix A.

1.5 A diary example: The Harmonised European Time-use Study (HETUS)

Survey design normally poses problems of balance between information quality and informant burden. The very wide range of available options for time diary design leads to some considerable variety in instruments. The HETUS design (following a detailed "input harmonisation" protocol developed by Eurostat 1999) collected by the ONS in 2000-1 had open own-words primary and secondary activity fields, with full activity location and co-presence information (Figure 1).

The ONS has also collected small samples of a "Light Diary" design, with 15 minute fixed intervals, 35 pre-coded activity categories, limited co-presence and no location field in 1995, 2000 and 2003.



Morning Time, am	What were you doing? Please record your main activity for each 10-minute period. Enter one main activity oneach line.	What else were you doing? Write in the most importantactivity you were doingat the same time e.g. Looking after children, listening to the radio or having a drink	Where were you? e.g. At home, at friends, in car, onbus, train, cycling, walking	Were you with anybody? Please mark the boxes. See example on page 3. Alone or with people you don't know	Children up to 9 living in your household	Children aged 10 to 14 living in your household	Other household members	Other persons that you know
7:00 - 7:10	Sleeping							
7:10 - 7:20	↓							
7:20 - 7:30	Had a shower		At home		X		X	
7:30 - 7:40	Made breakfast		↓					
7:40 - 7:50	Ate breakfast	Read newspaper						
7:50 - 8:00	Did washing up							
8:00 - 8:10	Got my son dressed	Talked with my son					X	
8:10 - 8:20	Walked to school with son	↓	Walking					
8:20 - 8:30	Dropped son off at school		↓		X			
8:30 - 8:40	Walked to bus stop		↓	X				
8:40 - 8:50	Travel by bus to work	Read newspaper	On the bus					
8:50 - 9:00	↓	↓	↓					
9:00 - 9:10	↓	↓	↓					
9:10 - 9:20	Walked from bus stop to main job		Walking					
9:20 - 9:30	↓		↓					
9:30 - 9:40	↓		↓	X				
9:40 - 9:50	Main job							
9:50 - 10:00	↓							

Figure 1: Part of the 2000/1 UK HETUS diary form

1.6 Time diary studies worldwide

The number of countries collecting time diary studies has been steadily growing over recent decades. At the most recent count (late 2010) 13 countries had committed to collect HETUS compliant studies for the 2009-12 round of data collection. The US now collects approximately 9000 diaries per year for the continuous American Time-use Survey. A number of Pacific rim (Japan, Korea), South Africa and newly industrialising countries (including Brazil, China and India) are now collecting diary studies. Table 1 lists countries with long records of nationally representative level diary studies (most these surveys are harmonized within the Multinational Time-use Study). A more complete list of studies, linked to survey descriptions and documentation, will be found at

http://www-2009.timeuse.org/information/studies/.

Most of the surveys listed in Table 1, with others, form part of the Multinational Time-use Study (MTUS); which produces *ex post* harmonised versions of these datasets to enable cross-national and historical comparisons of time-use patterns. The comparative examples in sections 2.4 and 2.5.4 below are drawn from this source. More information about access to these data is provided on the above website.

Table 1: Selected major national time-use studies by period

H = HETUS compliant

	1961-79	1970-75	1976-84	1985-89	1990-94	1995-99	2000-05	2006-12
Australia		/		/	/	/	/	/
Austria			/		/			H
Canada		/	/	/	/	/	/	/
Denmark	/			/			H	H
Finland			/	/		H		H
France	/	/		/		H		H
Germany	/				/		H	
Italy			/	/			H	H
Netherlands		/	/	/	/	/	H	H
Norway		/	/		/		H	H
Spain							H	H
Sweden					/		H	H
UK	/	/		/		/	H	
USA	/	/		/	/	/	/	/

1.7 A time budget example

Table 2 provides a set of simple time budget accounts for the UK (working age) population for 1961, 1983/4 and 2000/1 (we have no comparable evidence for 2011). The metrics are the minutes per day for the whole population (aged 20-60), which sum to the 1440 available minutes of the society's "great day". The larger bold time-use cells represent estimates that derive directly from the time-diary surveys, while the smaller italicised cells represent assignments of paid work time to the satisfaction of different sorts of human wants. A quite substantial part of the consumption wants of UK citizens is satisfied by the work of people outside the UK. And conversely, a not-inconsiderable part of work with the UK goes to satisfy the consumption wants of people living outside the UK. So these time budget estimates include a row and a column that represent respectively exported and imported work time[1].

Over this period, time devoted to sleep, perhaps unsurprisingly, remains unchanged. But there are substantial changes in virtually all the other broad categories. The total of time taken to satisfy basic wants for shelter, nutrition and domestic services has reduced from 619 to 556 minutes (43% of the day to 39%), and the time devoted to more luxurious wants for out of home entertainment (and also for shopping, to which we return in a moment) has substantially increased from 176 to 259 minutes (12% to 18% of the day). The amount of paid work embodied in retail activities has fallen from 14 to 8 minutes per day, reflecting increases in the efficiency of the retail sector of the economy (the spread of large-scale

[1] The italicised time-use estimates are produced by (1) assigning final output from the national accounts to the specific rows relating to categories of want, (2) working back through input-output tables to the originating industries (also using the same tables to allocate investment and international trade flows to those industries), and then (3) using survey evidence to distribute industrial employment across occupations. A more elaborate description of this national time accounting method can be downloaded from:
<www.sociology.ox.ac.uk/documents/working-papers/2008/2008-03.pdf>

supermarkets and associated activities). But this was accompanied by a very substantial growth in what might be sensibly considered as unpaid work associated with provision for this want (shopping and associated travel time), from 25 minutes per day in 1961, to 47 minutes in 1984 and 52 minutes in 2001: the growing efficiency in the Gross National Product-related economy thus imposing a substantial negative externality within the General Production Boundary.

Table 2: UK Time Budget Accounts (UK adults ages 20-60)								
	UK time (minutes/day)_____							
	leisure time	unpaid work	UK paid work time				**All UK time**	Non-UK time
			Consumer service professions	managers, scientists, etc	other service workers	manual workers		Foreign work imported
1961								
sleep, shelter, clothes	564	94	*1*	*10*	*20*	*43*	**732**	*14*
nutrition	94	65	*0*	*6*	*12*	*29*	**206**	*10*
other domestic	213	12	*1*	*2*	*5*	*12*	**245**	*4*
travel, shopping		25	*0*	*1*	*5*	*8*	**39**	*1*
out-of-home leisure	87		*0*	*1*	*8*	*4*	**100**	*2*
medical, educational	5		*12*	*2*	*10*	*8*	**37**	*2*
background services			*1*	*5*	*13*	*17*	**36**	*1*
exports			*0*	*5*	*11*	*30*	**45**	*6*
ALL	**963**	**196**	**15**	**32**	**83**	**150**	**1440**	**40**
1983/4								
sleep, shelter, clothes	550	83	*2*	*8*	*14*	*20*	**677**	*16*
nutrition	82	72	*0*	*3*	*5*	*8*	**169**	*6*
other domestic	268	20	*1*	*2*	*4*	*5*	**299**	*3*
travel, shopping		47	*0*	*1*	*3*	*4*	**55**	*2*
out-of-home leisure	121		*0*	*1*	*8*	*2*	**132**	*2*
medical, educational	11		*14*	*3*	*12*	*5*	**46**	*3*
background services			*1*	*5*	*11*	*7*	**23**	*1*
exports			*1*	*7*	*11*	*20*	**39**	*10*
ALL	**1033**	**222**	**19**	**29**	**68**	**70**	**1440**	**43**
2000/1								
sleep, shelter, clothes	558	88	*3*	*13*	*13*	*18*	**693**	*16*
nutrition	65	59	*0*	*5*	*4*	*7*	**141**	*6*
other domestic	244	24	*2*	*3*	*4*	*4*	**281**	*3*
travel, shopping		52	*0*	*2*	*3*	*3*	**60**	*2*
out-of-home leisure	136		*0*	*2*	*7*	*2*	**146**	*2*
medical, educational	8		*25*	*5*	*11*	*4*	**53**	*3*
background services			*2*	*8*	*10*	*6*	**25**	*1*
exports			*2*	*11*	*11*	*18*	**41**	*10*
ALL	**1011**	**224**	**34**	**47**	**62**	**62**	**1440**	**43**

Key

Figures in bold time-use represent estimates that derive directly from the time-diary surveys, Figures in italics represent assignments of paid work time to the satisfaction of different sorts of human wants.

Overall paid work time in the UK reduced substantially between 1961 and 1984, but somewhat increased from 1984 to 2001, still leaving a 27% net decline over the entire 40 year period. But most remarkable is the change in the occupational balance of paid work time: a more than doubling of the proportion of all UK paid work time contributed by consumer professionals and by engineers, scientists and other highly qualified workers, and a reduction of the proportion contributed by people in non-service manual occupations from more than half of all paid work in 1961 to less than one third of all work in 2001. A more detailed tabulation would show that, not only has there been an increase in the proportion of the workforce in the professional and technical occupations, but also their individual hours of work have increased proportionally relative to those in manual occupations (a phenomenon reproduced in all of the 11 other countries which have a similar long historical series of time-use surveys: Gershuny, 2011).

The ratio of paid to unpaid work has changed remarkably: 59% of all work in 1961, by 2001 paid work was just 48% of the total. Unpaid work remains strongly gendered, though it has become less so over the period: while (not shown in Table 1) women did more that four time as much unpaid work as men in 1961, women did less than twice as much as men in 2001, with the result that, despite the shift to unpaid work, a more detailed gendered breakdown of Table 1 would show the total of paid plus unpaid work of men and women as approximately the same, at around 480 minutes per day in 1961 and around 430 minutes per day in 2001. (And the fact that women still do more unpaid work and less paid, means that women still have less opportunity to accumulate paid-work-experience type human capital, and hence have lower expected wages, than otherwise similar men.)

These shifts of time—particularly when disaggregated by economic and socio-demographic characteristics—are potentially of major public policy interest, concerning as they do the changing balances between basic and luxury wants, between paid and unpaid work, and between work in general and leisure. Note in particular the zero-sum nature of change through the three panels of Table 1: unlike National Product, the National Time Budget is essentially about the *distribution of a fixed resource* across the different spheres of daily life.

2 Contributions to the measurement of national well-being

2.1 Measuring work inside the System of National Accounts (SNA)

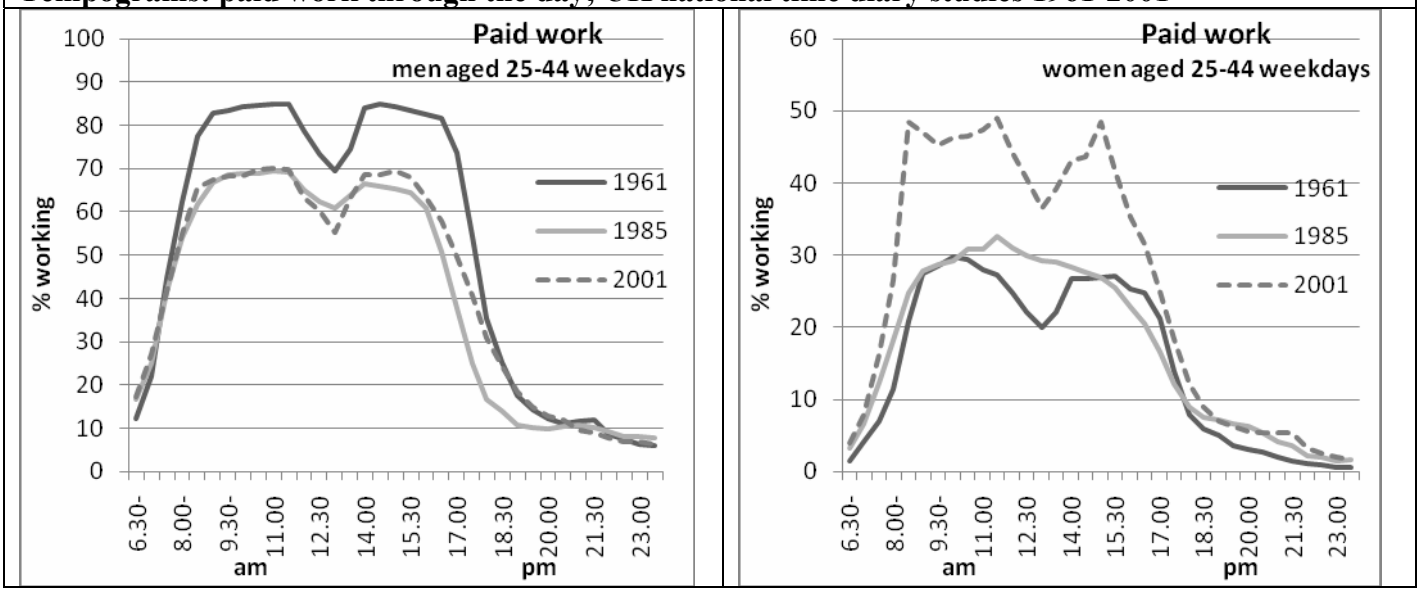
Measures of amounts of paid work undertaken within the System of National Accounts Production Boundary (SNAPB) are conventionally collected in a Labour Force Survey through a battery of stylised "how long?" questions which converges progressively from non-specific long term "usual" to the very specific "actual hours worked last week". Issues of reliability and systematic bias resulting from this approach, which might be corrected using diaries to calibrate paid work-time estimates, are discussed in section 3.3 below. The discussion here relates to the contribution of diary approaches to aspects of well-being related to paid work.

The stylised measures have shortcomings associated with the measurement of work-leisure balance. Actual or usual duration questionnaire items are entirely unrevealing of work rhythms. They do not tell us *when* during the day and the week paid work is undertaken (and therefore lack evidence of atypical or antisocial hours). They do not tell us the *duration of work spells* (and so lack evidence of work stress). They tell us nothing of whether spouses or

other household members are *simultaneously working* or taking leisure (hence they miss evidence of unsoc*iable* hours). Yet arguably the most important impact of paid work changes on well-being relate to exactly these issues of daily and weekly work rhythms

Figure 2 provides the very simplest sort of day-graph or "tempogram" showing change, over the last 50 years, in the proportions of men and of women engaged in paid work throughout the day. It shows the M-shaped structure of the working day, with few people working before 6.30am or after 8pm, and with a clear effect of the lunch break, in the middle of the day, from about 11.30 to 2pm. There are two clear stages of change. Men's participation in paid work throughout the day reduced substantially from 1961 to 1985. Women's daily work pattern by contrast increased substantially between 1985 and 2001. In both cases we see only a minor spread of work into the early evening. In neither case do we see evidence of the emergence of a" 24-hour society": work remains mostly a daytime activity. Equivalent diagrams show the extent of the disappearance of Saturday morning paid work (50% of men were working at 11am on Saturdays in 1961, 22% did so in 2001), and a continuing low level of paid work throughout Sunday.

Figure 2:
Tempograms: paid work through the day; UK national time diary studies 1961-2001



Using nationally representative samples of daily sequences we can identify the various different daily patterns, with short long, broken, evening and night work (Kan and Lesnard 2010). We can identify the precise distributions of work starting and stopping times and the lengths of work breaks. We can examine household activity patterns (eg what husbands are doing during the day and night while their wives are at work; Voorpostel et al 2010).

The HETUS-pattern studies also collect 7-day work schedules alongside the day diaries[2]. These allow us to look at the number of respondents' days that contain any paid work, at the times of starting and stopping work through the week, and hence the regularity or otherwise of the working hours across the week's work days, at shift patterns, at the extent of

[2] Early UK research on weekly work schedule instruments funded by the Department of Employment , Marsh 1991) and some current research on the HETUS weekly instrument (Glorieux 2011) suggests that they somewhat overestimate work time, but to a lesser extent than do the stylised instruments – and they do in addition permit sequence-analytic and other similar research on weekly paid work rhythms.

compensation for weekend workdays by non-work weekdays, and much else that is simply invisible through the lens of the Labour Force Survey. Sequence analysis using Optimal Matching approaches adapted from microbiology can be used to identify *historical change in the distribution of weekly work patterns* across the population (Glorieux 2011) as well as national differences in these patterns (Kan and Lesnard 2011).

The diary-plus-work-week instrument is much more expensive *per interview* than the stylised questions in the Labour Force Survey. But the LFS, a continuous and very large-scale exercise, produces evidence that is *less reliable* on actual work durations, *less specific* on actual hours of work, and *less well-integrated*—insofar as diary studies collect information on both work rhythms and work durations *in a single instrument*. So the re-allocation of a small proportion of the LFS budget to a time diary study—even just once per decade—would pay substantial informational dividends.

The sequential diary evidence on paid work can illuminate and provide explanations for some of the interpersonal *variation* in well being (ie connections between work patterns and work-satisfaction or feelings of happiness in general). *It may therefore be itself appropriate as the basis of a proxy indicator of well-being.*

2.2 Economic activity *outside* the System of National Accounts Production Boundary (SNAPB)

A great deal of work takes place outside what we normally think of as the economy. We are accustomed to view the general history of economic development as a continuous process of transfer of economic activity from the non-monetised "informal" sector (hunting and gathering, subsistence farming etc) into the "formal" money economy. But the sequence of time budgets in Table 2 tells a different story. Paid work does, just as we would expect, decline substantially over this period, from 280 minutes of the society's great day, to 205 minutes in 2001 (we have, to repeat, no comparable evidence for 2011). Over this same period unpaid work *increased absolutely* from 196 to 224 minutes. What was in the middle of the last century a 6 to 4 advantage of the formal over the informal sector, becomes, at the turn of this century, a *52% majority of all work time lying outside the money economy.*

This perhaps unfamiliar fact reflects an important technological change in the nature of the service economy. Once, those with income to spare above their needs for immediate subsistence bought services, largely from "final service industries" (transport, entertainment, cleaning services etc) in the form of trips on buses and trains, visits to restaurants, cinemas and theatres, laundries and domestic servants and so on. Over the third quarter of the 20th century and subsequently, consumption (as evidenced by trends in consumer expenditure: Gershuny, 1977) switched progressively to purchase of consumer goods (cars, televisions, washing machines and so on) that were used, in private households to provide equivalent services *quasi-autonomously*. Quasi-autonomous final production of services is in large part dependent on the money economy for the purchase and maintenance of productive equipment and for the infrastructure and materials necessary to use it. But the "*really final"* services that are genuinely and ultimately consumed—those materials and sensations that are literally *incorporated*, insofar as they cross the boundaries of the self, the lips and the eyes and the eardrums, from the outside to the inside—showed a substantial switch during these decades, to include many more final production processes outside the money nexus.

There is nothing that we can consider inevitable in this switching process (as emphasised by Esping Andersen 1999); we see multiple movements of *really final* service production both away from and towards the money nexus. And we can certainly speculate that new material circumstances (eg major resource depletion or environmental change events) might well reverse it in a more conclusive way. But this technological change in "*modes of provision for wants*" was certainly a very important social force underlying the economic expansion of the "trente glorieuse" years of the last century. And—a theme to which we return later in this report—we might foresee a somewhat similar future evolution allied to the world-wide web (Gershuny 1983).

These shifts in consumption and money expenditure are entirely clear and visible within official statistical sources without much investment in unfamiliar concepts. But the attribution of specific activities outside the money economy to the category "work" does merit careful consideration. This classification of activities is based on a concept which underlies the entire system of national accounts, the "third person criterion": "work" is considered to be any activity which could be delegated to some third party without loss of the final utility that derives from it.

It is a very strong criterion indeed. It asserts that work is purely a means, to some end that lies strictly outside the sphere of work. This proposition flies in the face of much of what we understand of both work and leisure. Indeed, the unsatisfactory nature of this means/ends dichotomy is what underlies much of the discussions of utility, enjoyment and happiness to which we turn in due course. Yet this criterion is the bedrock of the National Accounts.

It does provide us with a reasonably clear means of identification of unpaid work. Any activity that *could be* delegated, according to the third person criterion, *but is not*, is defined as informal or unpaid work. But a degree of unclarity remains, related to the genuinely dual natures, both means *and* end, of both work *and* leisure. Some may enjoy watching cricket, for example, but I myself could pay a third party to accompany my wife to a cricket match without any loss of final utility whatsoever. Some might claim to be willing to continue to do their own jobs even if not paid for doing them, while many derive at least some direct enjoyment (ie "final utility") from their paid employment. Michael Young and Peter Willmott (1974) collected a time diary sample whose instrument included an additional column in which respondents classified the current activity as one of work, leisure, neither or both. As compared to the third person criterion assignment of current activities in this dataset, 35% of all "work" time was not so classified by the respondents themselves, while 28% of all "leisure" was classified as not pure leisure.

We cope with such problems of principle by asserting subsidiary accounting *conventions*. All unpaid activities such as:

housework, cooking, cleaning, household maintenance, gardening and pet care,
all child- and adult-care,
any driving where this is a means to the provision of some other service,
any shopping that involves purchase of commodities (but not "window shopping"),

whether undertaken for members of an individual's own private household, or as voluntary activity for a member of some other household, and irrespective of whether it is undertaken under the auspices of some volunteering organisation or through some other less formal connection—are simply *designated*, for National Accounts extension purposes, as unpaid work.

If a society's consumption patterns—those sequences of paid and unpaid work and leisure activities referred to above as "modes of provision for wants"—remained unchanged over historical time, then we would have no need to consider unpaid work for National Accounting purposes. If we could assume that throughout the recent past, a given total of production in "the economy" gave rise to a given amount of consumption activity outside it, then we could conclude that each proportional increase in national product gives rise—distributional issues and the Easterlin paradox (Easterlin 1974) apart—to an equivalent increase in economic activity-related well-being.

But modes of provision *do* change. And when they change, so also does the relationship between money-denominated production and final satisfaction. The value-added from retail services, for example, may grow over time. But if the population must spend more time driving to and from and walking and queuing in the shops, then the growth in money-denominated national product ought to be set against the growth of "externalised" costs in the form of increased shopping time. If we ignore these costs we have an incomplete understanding of the welfare consequences of the historical change in modes of provision. Wherever we have a change in modes of provision, we have a similar potential mismatch between change within the SNAPB and change in welfare. Simply: the conventional GNP measure takes a too-narrow view of work to correctly represent historical change in the contribution of economic activity to well-being. This is a sufficient reason for seeking well-founded *extensions to national accounts* based on unpaid work.

There is also a second, related, reason for measuring and valuing unpaid work, concerning issues of gender and fairness. Despite substantial change over the last half century, women still do very much more unpaid work, and substantially less paid work, than men. This gender difference cannot in itself be construed as unfair. Private households are free to divide their work as they choose without sanction. But where the result of this choice is differentiation between members of married or cohabiting couples in the amount of paid employment, there is a directly consequential difference between the partners' respective rates of accumulation of human capital. This amounts, in effect, to a *transfer of earnings capacity or "capability"* over time, from the partner specialising in unpaid work to the partner specialising in paid.

A transfer of this sort is unproblematical as long as money earnings are shared and the couple stays together. But if, as may well be the case for nearly half of those currently forming partnerships, the couple splits, the outcome is often that the male partner departs with his enhanced human capital, leaving the female partner with her diminished human capital (and, conventionally, the baby, which prevents her from reviving her earnings capability, at least in the short term). This outcome is potentially (ie in the absence of appropriate compensation) inequitable; at present in the UK divorce generally leaves men significantly better off than women (Jenkins 2004). Proper evidence of the joint distributions of paid and unpaid work within households in particular—and more generally, evidence of men's and women's differing contribution of both paid and unpaid work to economic well-being—is therefore a necessity for the formulation of appropriate public policy.

2.2.1 Measuring non-money economic activity

The two methods for extending GNP to include the extra-SNAPB component involve placing money values respectively on unpurchased final service *output* and on unpurchased final service *consumption*. The *output* approach (eg Hawrylshn 1974, Gronau and Hamermesh

2006) has two sub-categories. There is a *shadow wage* approach, based strongly on rational choice assumptions: it is clear, at least to some theorists, that if the brain surgeon chooses to cook rather than to operate, the subjective value of her marginal time in the kitchen must be greater than that in the operating theatre, so her time spent baking cakes is to be valued (at a minimum) by her own marginal wage. Doubters might however argue that the surgeon's productivity in this case is probably considerably less than that of a trained and competent pastry-chef. So the second subcategory, in which unpaid work time is valued (at a maximum) by some *market wage for equivalent tasks*, is normally preferred.

The *consumption* approach takes the converse element of time, ignoring work, counting instead all consumption events of the various sorts (using time-use diaries or similar evidence) and valuing those events by the market prices of equivalent services (thus, a meal for an individual in a relatively poor household is valued as equivalent to that in a cheap restaurant, a trip in a private car as a taxi-ride and so on: Holloway et al 2002). In both of these approaches, time-diary surveys provide the crucial evidence of the extent and distribution of extra-SNAPB economic activity.

Of course the central evident fact about production outside the SNAPB is that it *does not have market values* and so we cannot argue that any particular method of valuation is in any essential sense correct; the point of these methods is however to provide some parallel estimation of externalities alongside the GNP.

2.2.1.1 Extended *national output or product*

We can produce an approximate version of national product straightforwardly by multiplying the paid work totals by estimates of productivity levels. For the purposes of this discussion we can use constant wage levels (from 2000) and a standard historical hourly productivity index for the economy as a whole, with 1961 as 100. In Table 3 we multiply the occupational work time from the bottom rows of the three segments of Table 2 by the appropriate wage rates and productivity indices, and we arrive at an approximately three-fold (2.95) real per capita growth over the period. (Note that Table 2 is based on the working-age population (20-60); the proportion of children in the general population has declined substantially over this 40-year period, while the proportion of older people has substantially increased, so the working-age base for this calculation will produce indices approximately similar to per capita real growth indices for the general population.)

Table 3: UK national product and extended national product estimates (based on ages 20-60)								
	% contribution to extended national product					National Product, 1961 = 100	Extended National Product, 1961 = 100	Extended NP as % of NP
	unpaid work time	consumer service professional work time	managers, scientists, etc work time	other service workers' time	manual workers' time			
1961	39	5	11	17	28	100	100	164
1983/4	50	7	11	16	15	162	199	201
2000/1	46	12	17	13	12	295	334	185

And in a similar spirit of simplicity we can produce an Extended National Product estimate by adding a valuation of the output of the unpaid work in Table 2. The occupational wage approach is (for reasons previously explained) preferred to the use of the unpaid producer's own shadow wage. This approach could be implemented in a complex way, looking for an equivalent paid occupation to correspond to every task separately identified by the time-diary surveys. But both for the principled reason that unpaid workers' hourly productivity may be expected to be generally lower than workers with specific training in particular occupations, and for the severely practical reason that detailed occupational information is not available for the first of the surveys used here, we adopt the much simpler "housekeeper wage" approach, taking the same low wage rate (£6.00 per hour in 2000 prices) to represent the value of all the various unpaid work activities.

We have already seen that the ratio of unpaid to paid work has risen substantially over this period. So despite the low imputed wages in the informal sector, it is not surprising that extended National Product has risen faster than conventional NP (by a factor of 3.34, as opposed to 2.95, over the period). And accordingly the ratio of eNP to NP has risen from 1.64 to 1.85 over the period (and indeed reached 2.01 in 1984). This implies that the real UK output of final service commodities as a whole was growing faster than we would realise on the basis of the traditional economic indicators. And arguably more important than this is the distributional point that would emerge with a gendered disaggregation of Table 1: women's work is relatively concentrated in the unpaid sector, so the conventional National Product calculation substantially understates women's contribution to growth in the economy as a whole.

2.2.1.2 Measuring care and volunteering activities

Estimating the extent of care activities (for children, adults and pets) and of volunteering outside individuals' own households are two areas of research into extra-SNAPB work time in which time diaries are of particular importance.

Estimating time devoted to **care activities** presents a particularly problematic conceptual issue. The column 1 of Table 4 gives the "primary activity" minutes per day (calculated from answers to the "What were you doing?" column in Figure 1) devoted to various activities by mothers of young children in UK 2000/1). The total minutes devoted to all activities sum, as

they must, to exactly the 1440 minutes in the day. But the time diary gives us other additional information about the context of the primary activity. We can for example use other diary fields to see if other child-related experiences accompany it. Columns 3 and 4 of Table 4 count, respectively, the minutes during the day that childcare was mentioned by the diarists as a secondary activity ("Were you doing anything else?" in Figure 1), and whether a child was co-present ("Who were you with?"). Very different amounts of time that might be counted as childcare emerge depending on whether we take just primary childcare time alone (160 minutes), primary plus secondary childcare time (145+104=249 minutes), or consider that for some at least of additional 370 minutes of child co-presence the mother is at least responsible for avoiding harm to the child (giving a possible maximum of about 600 minutes). It is possible to add a column to the diary instrument to denote responsibility for the care of someone who cannot be left alone at this time. (However, using *all* of this "responsibility time" in a calculation of extensions to national product, risks an inappropriate increase in the estimated value of unpaid work.) We cannot say which time estimate is right, since different measures will be appropriate for different purposes. But clearly no single stylised "How much childcare did you do?" questionnaire item will suffice for this purpose.

Table 4: Women with children (0-4) UK 2000/1: primary childcare, secondary childcare and child co-presence

	Total	..of which_____		
minutes per day		primary activity *only*	secondary child care	other child co-presence
	1	2	**3**	4
paid work	**122**	121	**0**	1
unpaid work	**237**	56	**44**	138
Child care	**160**	**145**	**15**	**0**
personal care	**606**	533	**14**	59
out-home leisure	**93**	32	**8**	53
TV and radio	**111**	37	**12**	62
chats etc	**43**	17	**4**	22
other home leisure	**68**	26	**7**	36
Total	**1440**	**966**	**104**	**370**

The stylised alternatives to diary instruments present particular difficulties for estimating the extent of **voluntary work**. This category raises problems of respondents' varying views of what "volunteering" consists of, and the perceived social desirability of the activity which may lead to exaggeration, perhaps encouraging respondents to stretch the specified reference period. It is also suspected that *informally organised* support for other households (as opposed to contributions to a formally organised volunteering institution) may be systematically under-registered by questionnaire items on volunteering. We find very low estimates of voluntary work in light diary designs even where (as in the UK 2005 study) its importance is highlighted—perhaps because informal volunteering is disguised as other routine or caring activities in this instrument. By contrast the HETUS diary design allows us to track informal volunteering by combining the diary's multiple activity fields with its more detailed location and co-presence records. (Fisher 2010 provides an extended discussion of UK diary evidence on this subject.) Diaries can also be used longitudinally to look at sequential patterns of activity associated with caring. Bittman et al (2004) use them to establish a "time signature" of daily caring activities enabling the estimation of the true size

of the population engaged in informal adult care (many of whom do not identify themselves as such).

2.2.1.3 Extended *national consumption*

The fundamental national accounting identity that applies both to SNA and extended national product calculations asserts that:

value of output = value of consumption.

That is to say, matching every unpaid service *production* event, is an exactly equivalently-valued service *consumption* event. Formal procedures for making empirical estimates of extended GNP via the production route have a long history (going back at least to Hawrylyshn 1974). The alternative approach to national accounts extension involving estimations of extended consumption is much less well developed; the ONS has taken a leading international role in this innovation, producing a set of experimental extended national consumption accounts for 2000 (Holloway *et al* 2002).

The consumption approach, as conceptualised by Holloway and her colleagues, involves four steps:

(1) *Count all instances* of unpurchased household service consumption states and events, including meals, leisure events, trips, sleep states. "States" in this sense include background services enjoyed in parallel to other events or activities (in the same way that the police and armed services provide for the consumption of a state of "security"). So for example the wearing of clean clothes constitutes a sort of background service consumption and should be included among the consumption states (valued at the cost of laundering the item commercially divided by the number of times worn between washes). Holloway et al, working before the 2000/1 UK TUS became available, used a variety of market research surveys as the basis for these event and state counts. Large-scale time-diary surveys provide an exhaustive source for such counts, and may be used either alone or in conjunction with other materials.

(2) Develop some form of *quality indication* for each event. Holloway *et al* adopted a rather *a priori* approach assuming, for example, households with highly capitalised kitchens and highly educated members, produce as a consequence high quality meals. But there is a direct empirical method, a specialised time and consumption diary, of the sort pioneered by Ironmonger (2007) in Australia, which, in effect, adds a "Using what?" column to an otherwise standard diary and "Wearing what?" information for clothing states, "Equipment and materials used?" for cooking events, " travel mode?" for all trips, and so on.

(3) Estimate *shadow prices* for each category of event or state:

- Meals – based on costs of different sorts of restaurant meals likely to be purchased by people with various levels of household income
- Clothing – based on amortised capital (purchase) and maintenance (cleaning) costs
- Leisure events – based on cinema prices for tv, club entrance fees for parties etc
- Trips – based on equivalent taxi-trip costs

- Sleep events – based on costs of various sorts of hotel corresponding to differing levels of housing quality

(4) The value of final services consumed directly as purchased (eg restaurant meals) are counted at their purchase price. In the case of final services produced outside the SNAPB (eg a home produced meal) subtract the costs of intermediate materials and services (food ingredients, electricity, paid household cleaning etc), and amortised costs of privately owned capital equipment (domestic white goods and dining room furniture) from the shadow price to estimate the extra-GNP value-added.

The ONS experimental accounts reported substantial agreement between the results of the production and consumption routes for estimation for some classes of extra-SNAPB services and substantial divergences of estimates for others. The divergent outcomes of the accounting experiments discussed in this report appear to be, for the most part, of the sort that may be reconciled through further development of the methods used in one or both of the estimation routes.

2.3 Activity outside the General Production Boundary (GPB)

2.3.1 Time spent in infrequent activities.

Despite their problems, "stylised estimate" questions are indispensible when dealing with relatively infrequent activities such as purposive exercise. But the issues of overestimation associated with perceptions of certain activities as desirable are substantial, and these are in effect doubled in the case of health-related behaviour. For these activities, respondents are likely, not just to seek to mislead others, but also to wish to mislead *themselves*, by upwardly adjusting perceptions of their own participation in what are generally understood to be healthy behaviours, and downwardly adjusting unhealthy ones. In this area, the open-coded (HETUS-type) diary design in which respondents construct their own unprompted accounts of their daily activity sequences, will have, in addition to the general recall, inclusiveness and reference period issues mentioned previously, extra advantages over stylised questionnaire methods.

Appendix A describes a statistical technique which uses randomly sampled time diaries as a means of calibrating answers to stylised questions, and uses the combined recalibrated questionnaire and diary materials to produce long-term estimates of daily time-use. Table 4 compares the daily mean time devoted to various infrequently occurring leisure activities (in column 1) to the mean time spent per day in each activity by those who engage in the activity on the diary day (column 2). Just under over minute per day, on average across the adult population in 2000/1, was devoted to cycling, but the 2.2% of our sample (column 3) who actually did use a bicycle on the diary day spent just about an hour doing so. Using the techniques described in Appendix A (which combine the information about last month's participation in various activities—including cycling—with the diary data) we calculate that 63% of our sample (column 5) ever use a bike, and long term mean daily time for those "long term participants" was 2 minutes per day averaged across these participants[3].

[3] Of course if we add in the 6220 zeros for the people who did not use a bicycle at all (or more precisely those who have a vanishingly small probability of doing so on a random diary day), we get back to the 1.3 minutes per

A "snapshot" of randomly sampled single days should give the just the same estimate of the overall allocation of time to various activities in the society as a whole as would a sample of weeks—or indeed population estimates calculated from "experience samples". Similarly, the population means of time in the various activities are identical whether calculated from the original diary evidence or from the adjusted long term estimates. However, the long-term estimates are particularly useful insofar as they allow us to consider the *distributions* of activities that influence the population's well-being.

Table 5 Infrequent leisure activities: diary day and long-term daily time-use estimates (UK adults 2000/1, N=16,988).

	day mean		participants on diary day		long term participants	
	1		2	3	4	5
	mins		mins	%	mins	%
cinema	0.9		135.7	0.7	1.5	56.5
go to watch sport	1.4		127.2	1.1	2	66.1
theatre, music, libraries etc	2.0		95.0	2.1	2	95.8
pop concerts, theme parks etc	1.5		96.0	1.6	1.5	97.1
eat, drink at pub, restaurant	7.7		68.5	11.2	7.7	99.9
All out-of-home leisure mins per day	**13.5**					
swimming	0.8		57.4	1.5	0.9	89.2
bicycling, travel by bike	1.3		59.9	2.2	2.0	63.4
keep fit, other training	2.6		75.9	3.5	2.6	99.3
gymnastics and jogging	0.8		39.0	2.0	0.9	81.5
low metabolic sport: bowls, golf, fish	2.6		147.6	1.8	2.7	97.7
high metabolic sport: skiing, tennis etc	2.3		171.5	1.3	3.4	65.5
taking walk, hike >2 miles	2.7		107.4	2.5	2.7	98.7
football, cricket, hockey etc	0.9		102.1	0.9	2.2	39.4
all exercise minutes per day	**14.0**					

2.3.2 Health-related behaviours: exercise

Perhaps the activity most generally associated with physical well-being is purposive exercise (as distinct from physical exertion as an incidental consequence of other activity—though of course activities such as dog-walking may have multiple motivations). This is, viewed through the lens of the single day diary, surprisingly rare. Table 5 tells us that only 3.5% of the population engage in any sort of "keep fit" activity on the randomly chosen day, and 2.5% go for a walk in excess of 2 miles (this excludes walks taken for non-recreational purposes; adding non-recreational walks totalling more than 20 minutes per day would more than double this percentage). Putting all these eight exercise categories together, we still arrive at

day for the adult population as a whole. The products of the minutes and the participation rates in Table 5 (ie column 2 * column 3, and column 4 * column 5) will similarly take us back to the daily means in column 1).

fewer than 20% of the adult population taking purposive exercise on any given day. If all we had to go on was the diary alone, we could not tell whether, at one extreme, 20% of the population take exercise every day while the rest take none, or at the other, 100% of the population exercise just once every 5 days.

Fortunately the statistical procedures for estimating long term activity patterns from diary data allow us to estimate some more useful population distributions. The long term estimates show virtually everyone in the sample participating to some degree in some sort of purposive exercise—only those who are predicted to engage in an activity less than once in three years (ie with a daily participation probability <.001) are treated as non-participants. Table 6 shows how the estimated overall-long term time spent in the total of all eight sorts of exercise is distributed across various occupation groups. Each column shows the distribution of members of the various occupational groups across the population deciles. The equivalent table constructed from the raw diary data would have shown the first seven rows as completely empty (ie 0%) because of the more than 80% non-participation in purposive exercise on any randomly chosen day.

Table 6. Time spent in active sports and exercise (decile percentages): long term estimates

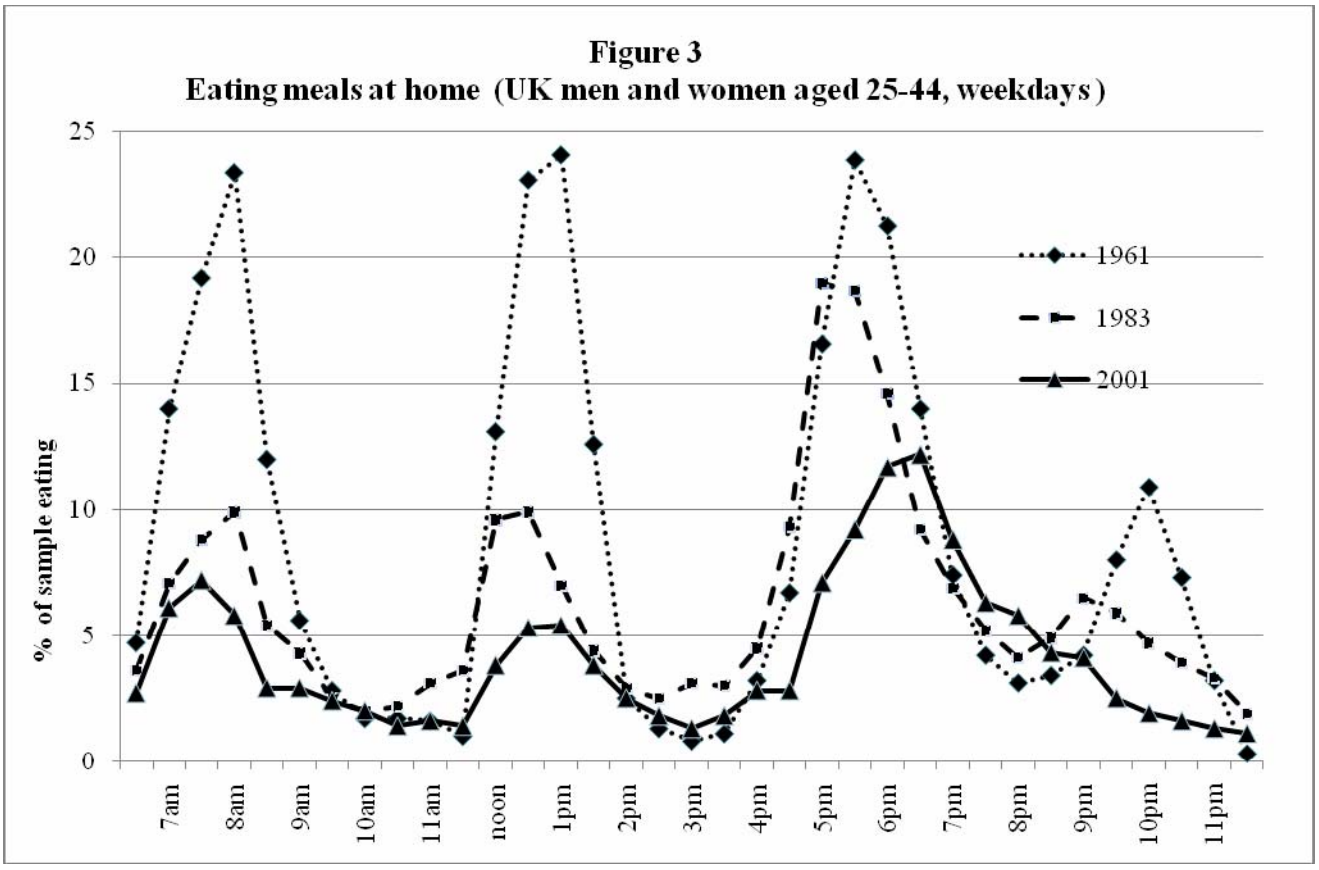
	managers	medical & educational professions	other professions	clerical	assembly, security, sales	farming, fishery & forestry	no occupation	N
bottom decile	13.5	12.9	6.6	12.0	9.7	3.3	4.0	1698
2	9.7	11.6	6.5	12.0	11.0	3.3	7.8	1700
3	8.4	12.0	7.2	11.5	10.6	1.6	11.2	1697
4	9.3	10.4	8.4	11.1	9.9	4.9	11.8	1699
5	8.1	10.5	8.0	11.3	10.1	5.4	13.4	1698
6	8.4	9.4	9.5	9.3	10.7	6.0	13.4	1700
7	9.2	8.9	10.6	9.0	10.7	8.2	11.3	1700
8	11.0	10.6	12.4	8.4	8.8	20.7	10.4	1699
9	11.7	8.3	13.3	9.0	9.3	17.9	7.0	1698
top decile	10.7	5.3	17.6	6.3	9.1	28.8	9.6	1699
column %	100	100	100	100	100	100	100	
N	2972	1151	2218	3123	5710	183	1631	16988

The combined diary-plus-questionnaire long-term estimates show some quite surprising features. Consider, for example the widely held expectations that those with higher levels of human and cultural capital will show higher than average levels of time in purposive exercise. This expectation appears to be borne out, to some degree, for managers and quite strongly for other professional workers. But members of medical and educational professions are over-represented in the bottom deciles, and under-represented in the top deciles. (The explanation may be found in this group's long hours of work, and limited leisure time, as shown by Appendix Table A4.) People in less well-resourced occupations generally conform well to the expected lower levels of exercise time. But those in the (small) primary (farming etc) occupations show a remarkable concentration at the top end of the distribution (perhaps because their geographical location provides fewer alternative recreations, or perhaps they come to enjoy strenuous exercise more as a side-effect of the physical demands

of their paid work). And the "no occupation" group, principally the retired or students, are under-represented at the lower end and somewhat over-represented in the middle parts of the distribution.

Exercise is potentially a central aspect of well-being. These striking results, which use the day diary, crucially, to correct the mis-estimations that arise from stylised questionnaire approaches to measurement of exercise, were invisible prior to the development of this combined estimation approach. Now we have the ability to use diaries to make estimates of exercise over given time frames (week/month/year). This will in turn allow us to make the crucial connection between different types of exercise and their metabolic consequence. An essential element in this process is already under way: Tudor-Locke et al (2009) has established comprehensive links from the Compendium of Physical Activities to the ATUS activity categories. It is a relatively small step to translate this into the HETUS activity categories.

2.3.3 Health-related behaviours: eating



Questionnaire items concerning food consumption are also unreliable, reflecting the usual problems of recall and distortions resulting from respondents' impressions of desirability. By contrast, full-scale HETUS-type time diary materials provide plausible evidence of the incidence of each eating episode. They allow us to count meals, whether in private homes or pubs or restaurants, establish their durations, discover their relationship to snacking (visible in the diaries where eating appears as a secondary activity alongside some other primary activity), and how they align with the eating patterns of other members of the household.

Do we, for example, eat proper meals, or continuously snack and browse? Eating patterns have changed dramatically over the period covered by UK time diary surveys. In 1961 we see (in Figure 3) a fair degree of national synchrony. There are three peaks, at 8am, 1pm and 6pm, representing with a fourth smaller "late supper" peak at 10pm. Nearly 25% of the population were eating meals at home at exactly the same point in the day, and a substantial majority of the population eating three discrete meals per day. By the time of the last major survey in 2001, the breakfast, lunch and dinner peaks were still just about visible, but (at 7%, 5% and 12% respectively), not nearly so pronounced as they were 40 years previously[4].

Obesity might be conceptualised as the negative outcome of a race between eating and exercise. Time diaries, treated in the manner outlined in section 2.3.1 and Appendix A, provide evidence of time spent in these two activity categories by the same individuals.

2.3.4 Health-related behaviours: sleep

Time diaries (with specific respondent instruction on sleep recording) provide the only national scale evidence on sleep patterns. No other source could, for example, show the sleep disturbance consequences of changing clocks for Summer and Winter Time in the US, or the long term historical constancy in sleep time totals (Robinson and Michaelson 2010) .

Sleep disturbance (considered as either fewer than seven or greater than eight hours of sleep) is associated with increased risks of mortality or morbidity in a majority of studies that investigate this (Simpson et al 2009). Short sleep is associated with elevated body mass index and self-related poor health. Both shorter and longer sleep is associated with hypertension and diabetes.

The clinical studies on which this summary is based rely on observational or questionnaire measures of sleep time, but not apparently on any sort of diary instrument. Basner et al (2008) observe that these results are difficult to interpret because of the complex nature of the causal relation between sleep and medical outcomes. There may be some third factor associated with both the sleep and the medical outcome. Or there may be a strong temporal *correlate* of sleep that is the effective cause. Basner and colleagues use the American Time-use Study (ATUS) diary materials to investigate the latter possibility on the basis that "short and long habitual sleep times are necessarily paired with greater or lesser waking activity". They find work time, television and socializing emerge as the strongest correlates of sleep. Of these, a long established non-medical time budget research literature points to work time as the most substantial. Yet, to Basner and colleagues' great surprise ("astonishing" is their description of this omission) work *time* is not used as a control variable in the clinical studies.

This omission will perhaps be less astonishing to readers of this report, given (1) the difficulty of establishing an individual's overall time budget without deploying an unavoidably cumbersome diary, and (2) the difficulty of disentangling intra- from inter-personal of a variability from a single day diary. The ATUS diary used in the Basner et al research covered a single day, and none of the waves of the ATUS contain any substantial battery of questions on longer-term participation in any activities other than paid work; it may

[4] Some care is needed in diary design to ensure full registration of food consumption: respondents should be reminded to use secondary activity columns to record both meals and "browsing", and additional questionnaire items may also be helpful.

therefore be helpful to repeat this analysis with the UK HETUS data, using the methods outlines in Appendix A.

Conversely, the Whitehall Study findings (eg Chandola et al 2006) discuss the interactions of stressful work circumstances, intermediate social status and the various physiological risk factors identified as the "metabolic syndrome" (abdominal obesity, high blood pressure, high density lipoprotene cholesterol, high fasting glucose) in the risk of heart disease. The Chandola et al article refers to a "dose-response" model, in which the effects of work stress are seen to accumulate in an additive manner over subsequent waves of the study. But is work stress really the *effective* causal factor, or some correlate such as interrupted sleep—or indeed some occupation-and-status-related exercise deficit along the lines of the doctors' and teachers' underperformance of exercise as shown in Table 5? It seems that a diary approach, which might allow a sequential observation of work, sleep, eating and leisure episodes through a day, using an instrument with some extra affect fields (perhaps for enjoyment, worry and time pressure) collected for the cohort respondents might help to disentangle some of the unresolved causal mechanisms.

2.3.5 Other leisure activities

Leisure participation, as we shall see demonstrated empirically in a later section, contributes substantially to well being. Time-use diaries, with co-presence fields that are directly associated with specific pastimes and locations, are particularly well adapted as for the measurement of patterns of sociability. Recent articles have focussed on spousal co-presence (Voorpostel et al 2010, Sullivan 1996), but the diary material will allow a much wider range of application, both for studying co-presence and cooperation among people of different ages within the household, and also among friends and others outside it. Time devoted to cultural activities (Table 7), for example, shows some of the same sorts of surprises as did time devoted to exercise (Similar tabulations for a full range of leisure activities are provided in Appendix A).

Table 7. Time spent at cinema, theatre concerts etc (decile percentages): long term estimates

	managers	medical & educational professions	other professions	clerical	assembly, security, sales	farming, fishery & forestry	no occupation	N
bottom decile	4	25	12	6	12	61	2	1699
2	5	15	10	9	14	22	2	1699
3	8	15	9	8	14	8	4	1698
4	8	11	9	9	14	4	4	1698
5	11	9	8	10	12	2	7	1700
6	11	7	9	10	10	1	10	1698
7	12	5	9	11	9	1	14	1699
8	13	5	10	11	7	1	16	1699
9	14	5	11	13	5		21	1697
top decile	13	5	14	13	4		21	1699
column %	100	100	100	100	100	100	100	
	2972	1151	2218	3123	5710	183	1631	16988

We see the expected over-representation of many of the better-educated in the top deciles of cultural participation, and the proportional under-representation of the manual workers. And again we see an extraordinary under-representation of medical and educational occupations in cultural activities—presumably reflecting their long hours of work. The farmers, fishing and forestry workers are pretty much absent from the top few deciles of time devoted to cultural activities, just as they were over-represented in the top physical exercise deciles. The converse of the same locational explanation (ie the relative absence of theatres and so on in the countryside) presumably applies here. And those with no occupation are clearly taking advantage of their relative lack of time pressure by high levels of participation in these cultural activities.

2.4 The work-leisure balance

Time diary accounts are exhaustive. A well designed and executed time diary study covers the whole spectrum of human activity in a representative fashion. Ultimately this exhaustiveness is the basis for the most general contribution that diary studies make to the measurement of well-being. Only time diaries can reveal the work-leisure- or work-life-balance, for the society as a whole, for subgroups, or for individuals. We are accustomed to consider time-budgets broken down by standard socio-demographic categories. Using the long term estimation methods discussed here, we may also do so for time allocation groups—contrasting perhaps those poor in leisure time with others, or "culture vultures" with "sports fiends" and "couch potatoes", or whatever.

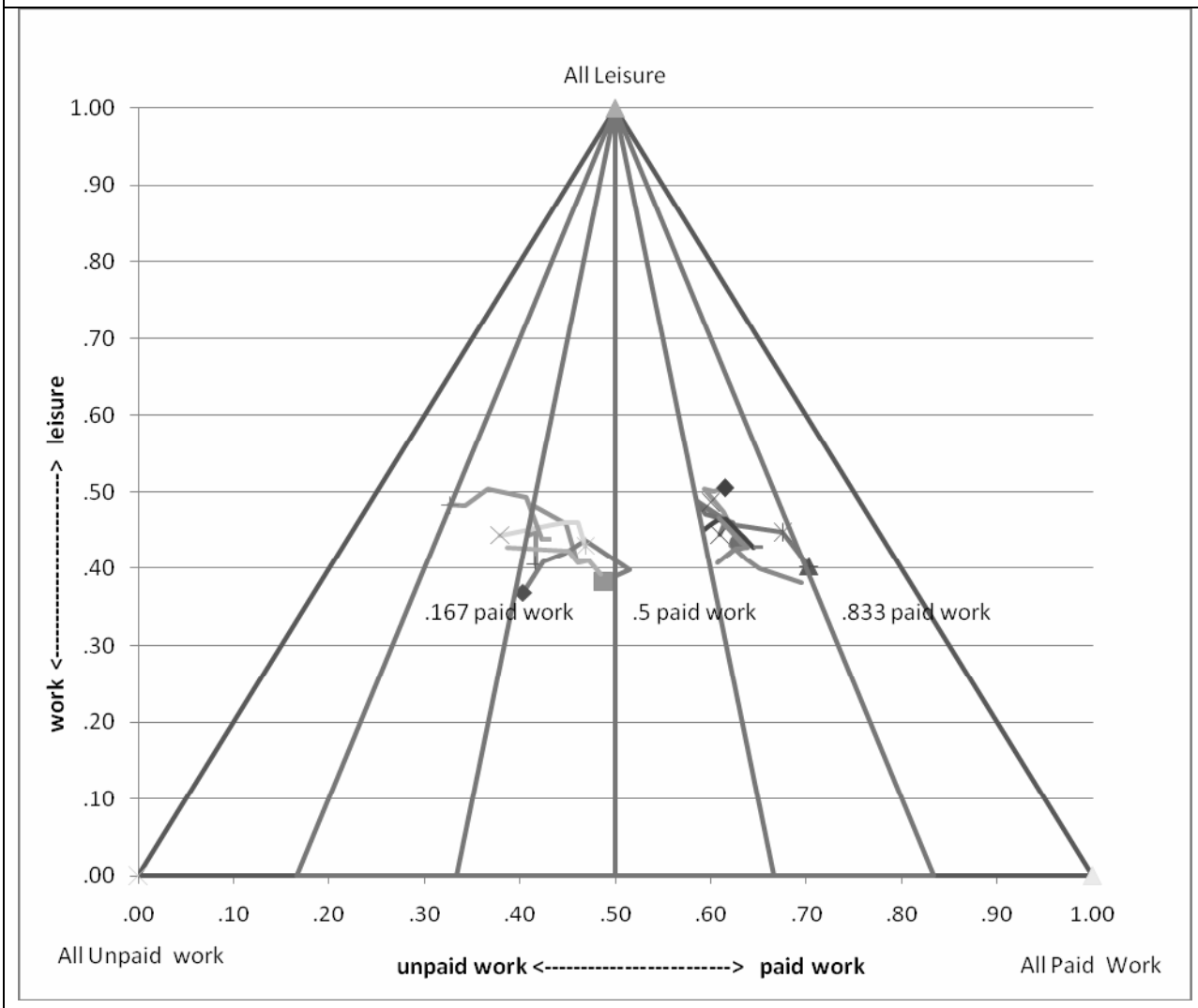
Figure 4 provides altogether the most general picture of the work/life balance, in the form of the *triangle of daily activities*. The two lower vertices of the life balance triangle represent respectively 24 hours devoted entirely to unpaid and to paid work, and the upper vertex represents 24 hours spent entirely without work. The vertical dimension represents the work leisure balance (the proportion of the day devoted to non-work activities), and the horizontal, the proportion of paid work (intra-SNAPB activities) to the total of work (ie activities within the General Production Boundary). Figure 4 plots 40 years of change in the work/life balance, separately for the two sexes. in five countries, taken from a total of 20 surveys from five countries. Figure 4, showing the entire triangle, reveals two groups of plots, lying mostly between the 40% and 50% leisure levels; on the left, with a higher proportion of unpaid work, are the women, and on the right are the men, with more paid work.

The two panels of Figure 5 show the central portions of the triangle, with separate plots for the men's and women's regions so as to make the individual countries' trajectories separately identifiable. Some clear common patterns emerge. We can see, for each sex and country, a movement inwards away from the sides of the triangle towards the .5 line of balance between paid and unpaid work, with the women's plots moving generally to the right, reflecting an increasing proportion of paid work, while the men's plots show a general leftwards movement, meaning an increasing proportion of unpaid. The women's plots show an inverted-U pattern, whose left side represents a period of growing leisure proportion from the 1960s through to the 1980s, which was reversed in the subsequent decades.

The US, UK and Norwegian curves are flatter, but with the same initial increase of the share of leisure in the day followed by a partial reversal—which still leaves the leisure share higher

at the end of the period than at the beginning. Only the Netherlands and Canada depart from this pattern, shifting from an initially relatively high leisure proportion (as compared with other countries in the third quarter of the 20th century) to a more average level of .42 to .43. The similarities across the national trajectories are striking, and as yet not at all well understood. But the balances of daily events that they (and analogous plots calculated at the individual rather than the group level) represent are clearly important. These sorts of pictures of the work/leisure balance show directly the central day-to-day experiences of all members of societies. They are invisible and unknowable without time diary survey materials

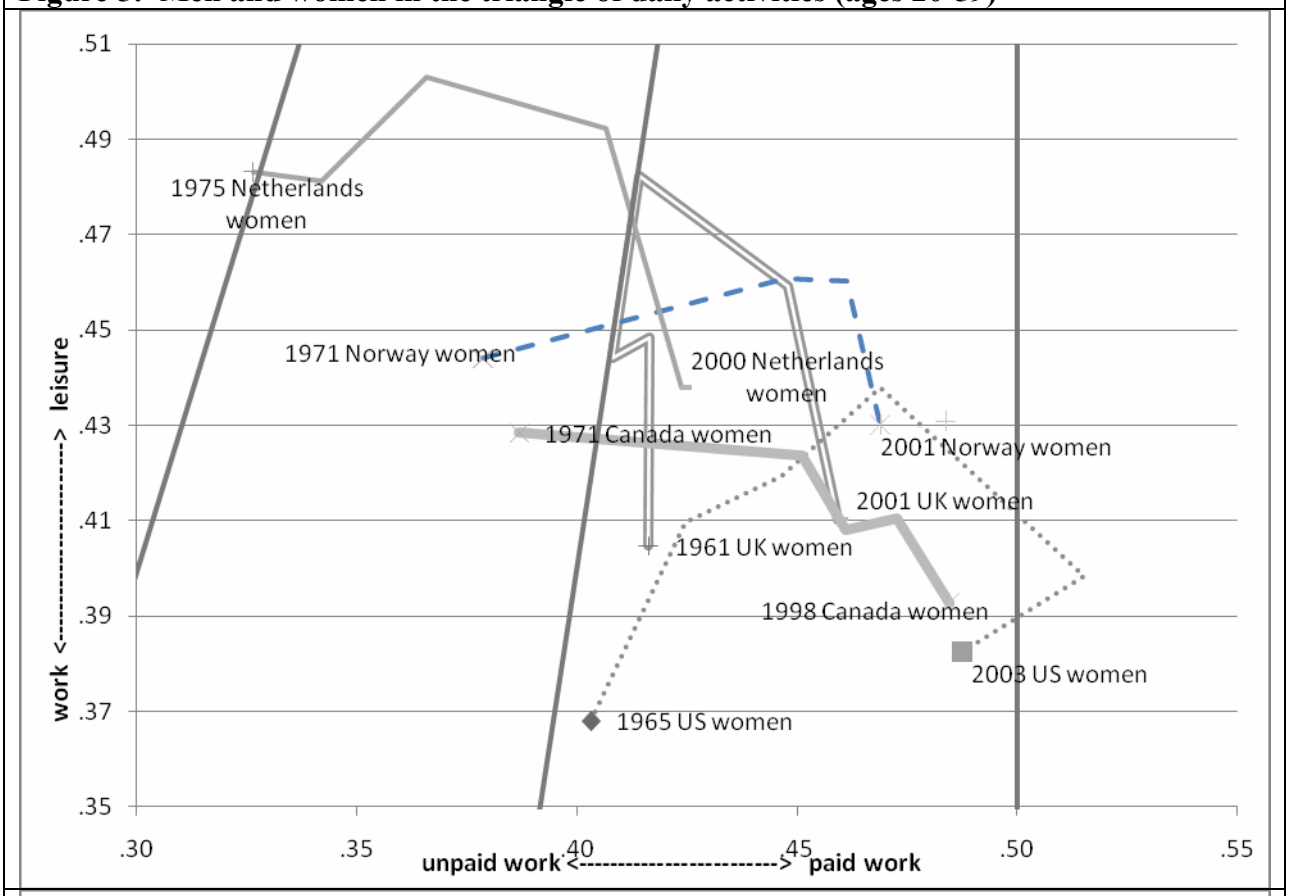
Figure 4: The life-balance triangle of daily activities in 5 countries (ages 20-59)

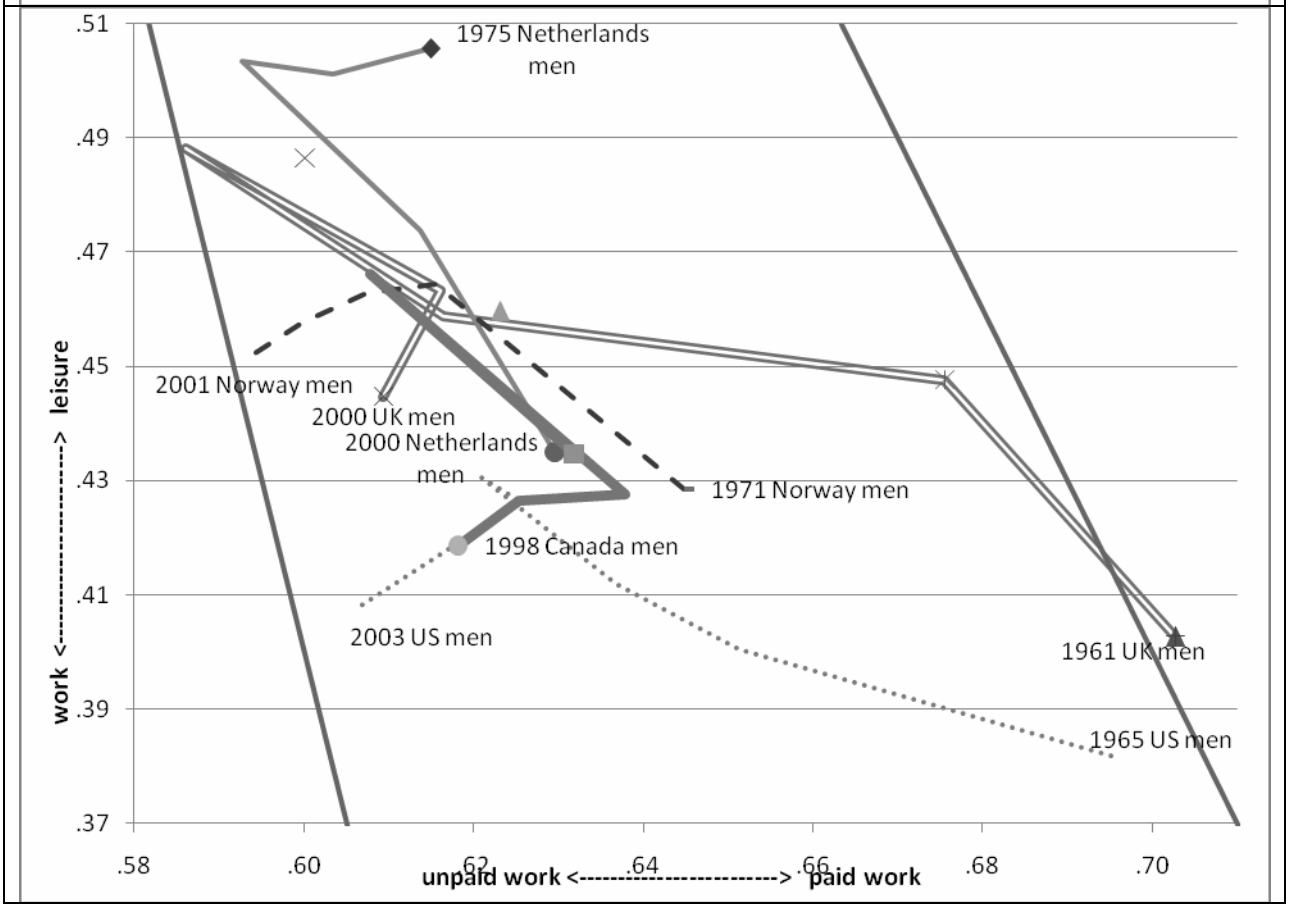


Of course these particular trajectory plots do depend ultimately on the definitions of unpaid work discussed in Section 2.2. The assignments of time among the three components of the day illustrated here are certainly subject to question. For example: much of the proportional increase in men's unpaid work since the 1980s, as well as the partial bending-back of the women's unpaid/paid balance in the later period, is to be explained by a growth in child care by both men and women—which has a strong affective content in addition to the instrumental

characteristic that, following the Third Person Criterion, places it among the work categories. Plainly, to understand the consequences of the changing balances of activity for individual and national well-being, we need some direct measures of the subjective, experiential quality of the various activities.

Figure 5: Men and women in the triangle of daily activities (ages 20-59)





2.5 The quality of experience: affect, happiness, utility

2.5.1 Non-diary approaches to measuring happiness

Briefly holding aside the question of exactly how to measure this most intangible of phenomena, sociologists (eg Durkheim 1899) and economists (eg Easterlin 1974), have for long been aware (together with the author of the biblical Book of Proverbs) that it bears a complicated relationship to monetary measures. The wealth of nations does not equate to their happiness.

A helpful distinction[5] is made between, on one hand, "global evaluative judgements", and on the other, "feelings of pleasure and displeasure summated over time". Both clearly *contribute to* well-being, clearly neither could be considered to *constitute* happiness on its own. The second of these is a central concern for this report, and is discussed in the following sections.

The academic study of global evaluative happiness judgements using empirical methods has advanced remarkably over the last two decades. There is a sequence of most helpful collected texts on the convergent sub-disciplines of "hedonic psychology" and the "economics of happiness" (Kahneman, Diener & Schwartz 1999, Krueger 2009, Diener, Helliwell & Kahneman 2010.) A popular book by Richard Layard (2005) brought the "new science of happiness" (with a rather broader scope including for example approaches from neuroscience) to a wider public. The Stiglitz report (Stiglitz, Sen & Fitoussi 2008), commissioned by the President of France, produced a raft of recommendations, though it stopped short of proposing an integrated framework.

Evidence of evaluative judgements are collected through various social survey questions and question batteries including the "Satisfaction With Life Scale" (Diener 1984), and the "Cantril Ladder of Living", collected by the Gallup organisation. The longstanding European contribution to this literature (dating from the 1960s: van Praag 1968, Veenhoven 1989), "domain satisfaction" measures, (separate questions asking for judgements of "happiness" with various dimensions of life experience, including jobs, finance, health, leisure, social life, marriage) is discussed at length in Van Praag & Ferrer-i-Carbonel (2004). Domain satisfaction measures, available amongst many other sources, in an eight year household panel for more than a dozen EU states (the European Community Household Panel Survey 1994-2003), might well feature more prominently in the international literature. The British Household Panel Study together and its Understanding Society successor, has collected these measures since 1995, and the German Socioeconomic Panel has done so since before 1990.

These judgement measures are intentionally distanced reflections on immediate conditions and experiences. As such they may be appropriate to be used as a means of evaluating, or calibrating, the consequences of the more immediate measures of enjoyment discussed in the following sections. They should be collected for the same respondents and considered in parallel with the time-delimited measures.

[5] Suggested by Diener, Kahneman, Tov and Arora in their contribution to Diener et al (2010)

2.5.2 Diary approaches: "objective happiness"

Kahneman (1999) defines "instant utility": "...borrowing the term 'utility' from Bentham 1789/1948)" as the *instantaneous enjoyment* of an activity. "Instant utility is best understood as the strength of the disposition to continue or to interrupt the current experience." He identifies the category of "subjective happiness", which corresponds to a *considered judgement* about well-being, of the sort described in the previous section, made at some degree of distance from the period which it describes. And he contrasts this with "objective happiness" category, considered as "…being derived from a record of instant utility over the relevant period". "Objective happiness" measures may be quite straightforwardly derived from time diary materials (Kahneman 2004).

The conceptual origin of the "objective happiness" approach may be traced back to some thinking associated with the US national time diary survey collected by the Institute for Social Research at the University of Michigan in 1975 (Juster and Stafford 1985). In the questionnaire that accompanied the initial diary placement, respondents were asked to provide enjoyment ratings, on a 0-10 positive scale, for each of a set of broad activity categories that corresponded precisely to the categories of the national time budget calculated from the time diaries. Juster and colleagues produced a hybrid measure of what they termed "***process benefits***", by multiplying each respondent's minutes spent in each of the time budget categories by their questionnaire-based enjoyment rating, summing these products and dividing the total by 1440 (minutes in a day). They proposed that the aggregate mean of the process benefits and the per capita national product should be viewed as "joint products" of the aggregate national activity pattern revealed by the national time budget—since the same activities, constituting national output and national consumption, produce both measures. Clearly, over historical time, *national product might increase but process benefits simultaneously decline*, perhaps as a result of an increase of work time relative to leisure, if leisure were rated more enjoyable than work.

This hybrid measure does not correspond exactly to Kahneman's notion of "objective happiness", however, because of the temporal and conceptual gap between the events measured in the diary and the ratings in the questionnaire. The instantaneous utility of a moment spent in a particular sort of activity may differ from other moments that individual devotes to that sort of activity or to something similar at other parts of the day week or year. And besides, how can we be certain that the activity categories rated in the questionnaire responses correspond exactly to the activities described in the respondents' diaries?

John Robinson, one of the Michigan academics involved in the 1975 survey, recognised this problem, and designed a diary instrument for the 1985 US national time-use study, corresponding approximately to the HETUS example in Figure 1, but with an additional field in which respondents could rate their enjoyment of each activity concurrently with their description of it, on a 0 to 10 positive scale[6]. Virtually simultaneously, a large scale time-use study in the UK (collected by Unilever Research: Erlich 1987) used a similar diary instrument, but with a 5 to 1 negative scale (see also Michelson 2010).

Figure 6 compares the mid-1980s UK and US mean activity ratings from these two diary studies. (The scores from the negative rating scale in the UK study are subtracted from 5.5

[6] Empirical evidence of the weak correlation between the diary and the questionnaire activity ratings only emerged much later (eg Krueger et al 2009).

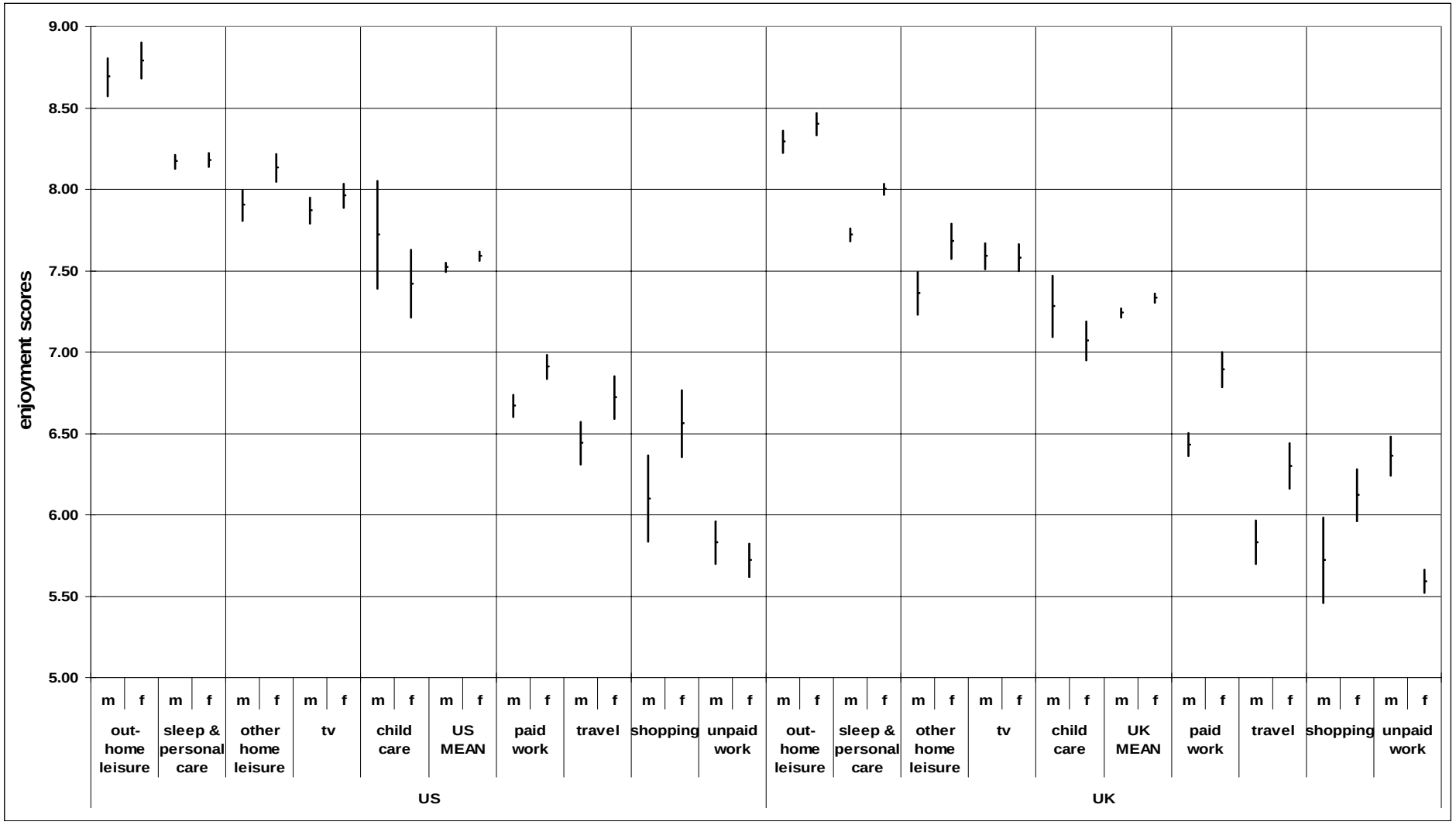
and then doubled so as to make them more intuitively comparable with US results.) The various activity categories in the figure have been ordered according to their mean ratings in the US study. The left half of the figure shows, separately for men and for women, the US mean activity ratings and their 95% confidence intervals, while the right half shows the equivalent UK ratings, listed in the same order.

We see immediately that the relative ratings of the various activities within the two countries is really very similar (particularly when we remember that the negative to positive transformation of the UK results is rather arbitrary—subtracting the original Erlich scores from a constant 6 or 6.25 would make the absolute levels of the UK scores correspond more closely to the US ones). We see that in general the men's and women's scores for each activity are rather similar: significant differences emerging in the same direction for both countries in the cases of paid work, travel, shopping (women enjoying the activity more than men in each case). A real UK/US difference in the male/female contrast emerges only in the "sleep and personal care" category—which may result from the methodological difference that the UK study collected more detailed information about personal care (reflecting Unilever's commercial interests in personal hygiene and care products). And it is clear from the confidence intervals, that within each country the mean ratings of the different activities are unequivocally both large and strongly statistically significant.

These ratings are ordinal. And they average-out interpersonal variation in the means and ranges of scores that result from the respondents own interpretations of the enjoyments scales. But, interpreted as if they were cardinal measures as in Figure 6, they make good plausible sense (out-of-home leisure being highest-rated, housework rated lowest and so on). And formal statistical tests suggest that the numbers emerging from the enjoyment fields of the diaries work *as if* they had attributes similar to cardinal scales (ie regular and approximately equal distances between successive integer measures[7]).

[7] As demonstrated by the regular intervals between successive cut-off values for categorical enjoyment levels in Ordinal Logistic regression models estimated for the same data used in the Ordinary Least Squares regression models described in the next section.

Figure 6: Men's and women's mean activity enjoyment scores and 95% confidence intervals
Duration-weighted event data, US 1985 and UK
1986

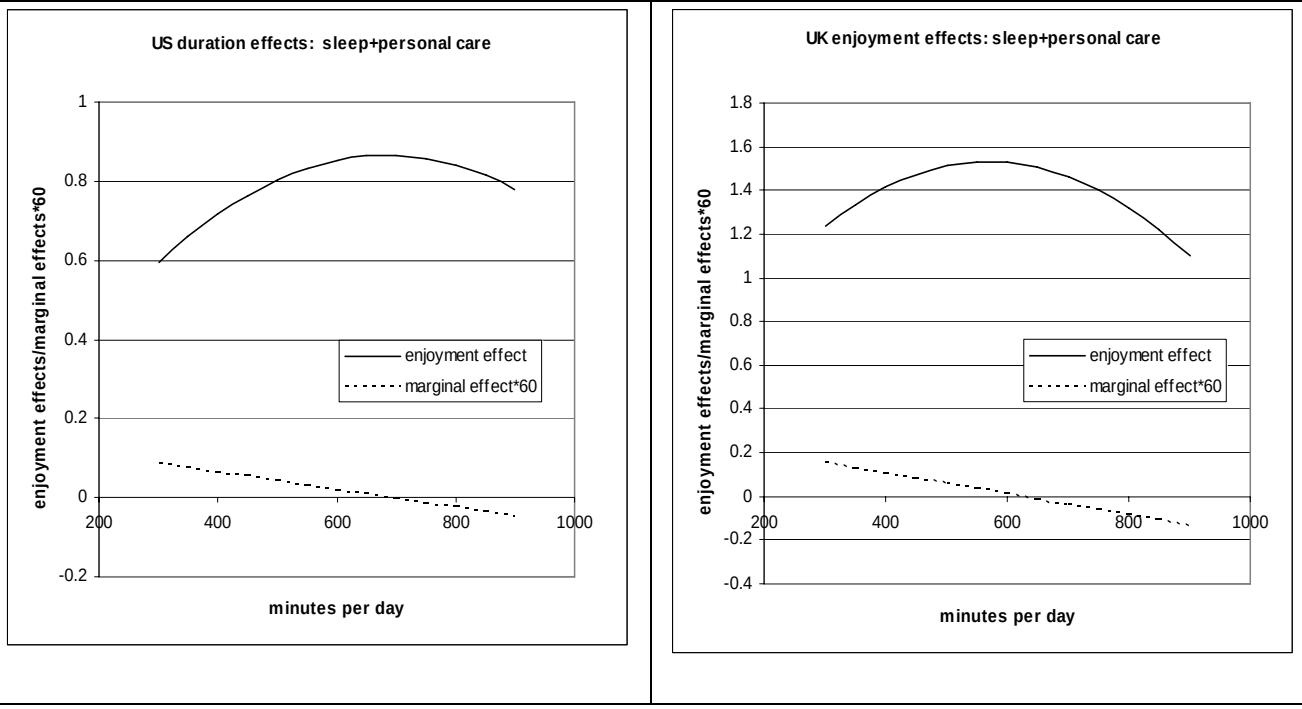


2.5.3 Cross sectional estimates of Marginal Utility (MU) from diary data

On this basis we may decide to treat the instantaneous utility measures as cardinal despite the ordinal nature of the scales. The data may then be used to estimate the marginal utility of time in each activity category[8].

The two datasets are analysed as separate event files for each of the nine categories of time-use. Each diary "event" (ie period during which all entries to diary fields remain unchanged) is considered as a separate record. Events are weighted proportionally to their duration, the weights being adjusted to give approximately the same total N of cases as in the original analysis sample. Then each respondent's daily *total* of time in the particular activity category is attached to each event. Finally the relevant daily time totals and totals-squared, together with controls, are regressed on the enjoyment ratings of each event. The overall saturated version of the model has a multiple correlation coefficient of .448 for UK, .385 for US.

Fig 7a Total and marginal utility: effect of time in activity on enjoyment of sleep and personal care)

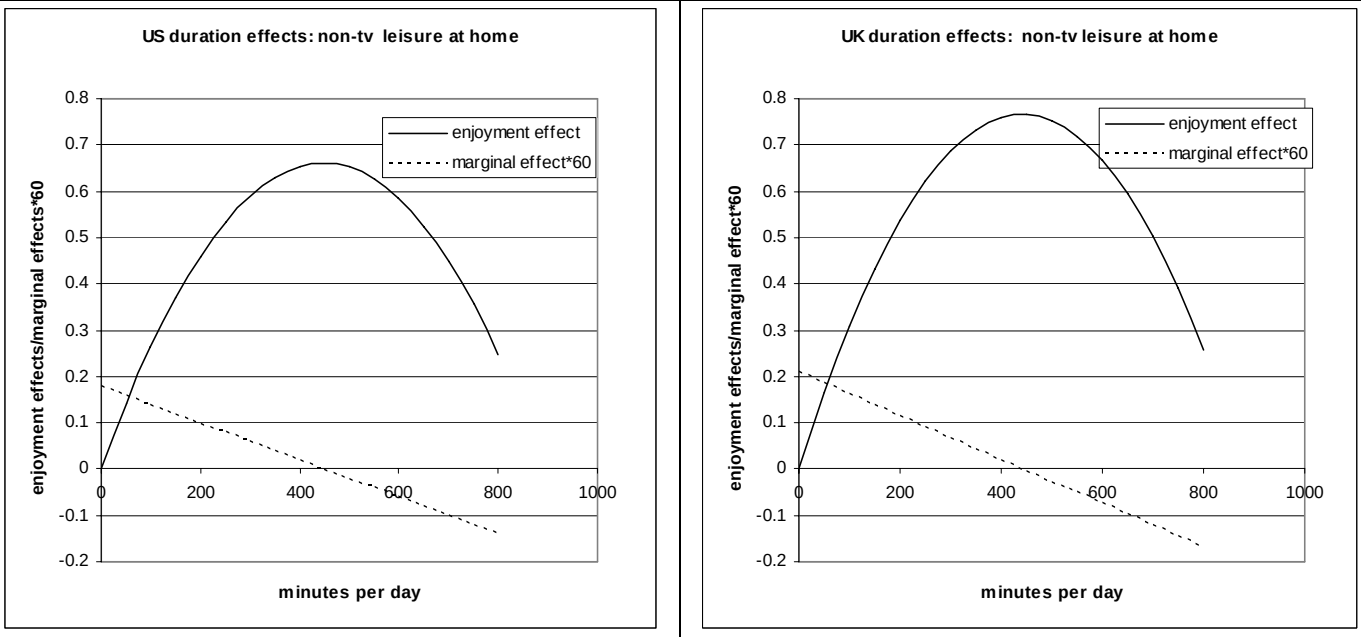


The regression results cannot directly estimate true individual-level marginal utility, for which we would need many more repeated events of varying durations for each respondent. But we can at least get cross-section based estimates, by comparing differences among instantaneous levels of enjoyment of particular sorts of event for individuals with varying daily totals of time spent in those particular activities. Figures 7a to 7c instantiate the absolute and marginal utility estimates for three of the activities for the two countries.

[8] More details of the calculations here and in the previous section, together with a much more detailed discussion of the results, are downloadable from:
www.sociology.ox.ac.uk/documents/working-papers/2009/2009-07.pdf,
The regression tables underlying this calculation are attached to this report as Appendix B.

The results are plausible, and remarkably similar between the two countries. In Figure 7a we see that the marginal utility of sleep plus personal care crosses the origin and becomes negative at just over 600 minutes in both the US and the UK. Personal care (bathing, shaving etc) occupies half to three quarters of an hour per day. So the implied 9-to-10 hours estimate for the start of diminishing absolute utility corresponds approximately to the medical evidence on sleep disturbance cited in Section 2.3.3. Time devoted to leisure at home (Figure 7b) crosses the origin at around 430 minutes per day in both countries. Seven-and-a-bit hours of home leisure per day seems a reasonable-enough estimate for the likely point of onset of cabin fever. Out-of-home leisure utility (Figure 7c), again showing very similar patterns across the two countries, also diminishes at the margin, but does not fall to zero within the general range of observations (and is indeed still substantially positive at an extreme level of five hours of out-of-home leisure in a day).

Fig 7b Total and marginal utility: effect of time in activity on enjoyment of non-tv leisure at home



Similar data are now being collected by the INSEE as an extension to the current French HETUS study. No other large nationally representative diary data sets with enjoyment fields are available at present, through there is a growing number of large local studies such as the Texas sample described in Kahneman et al 2004[9].

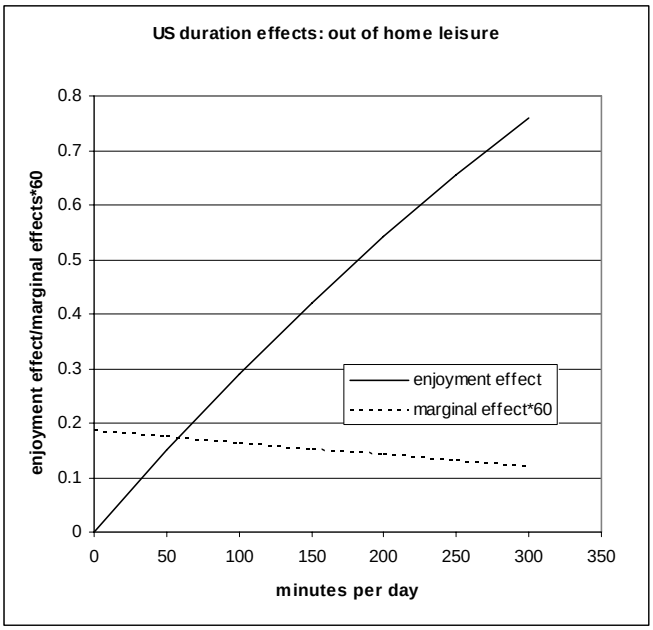
2.5.4 National Time Value (NTV) accounts

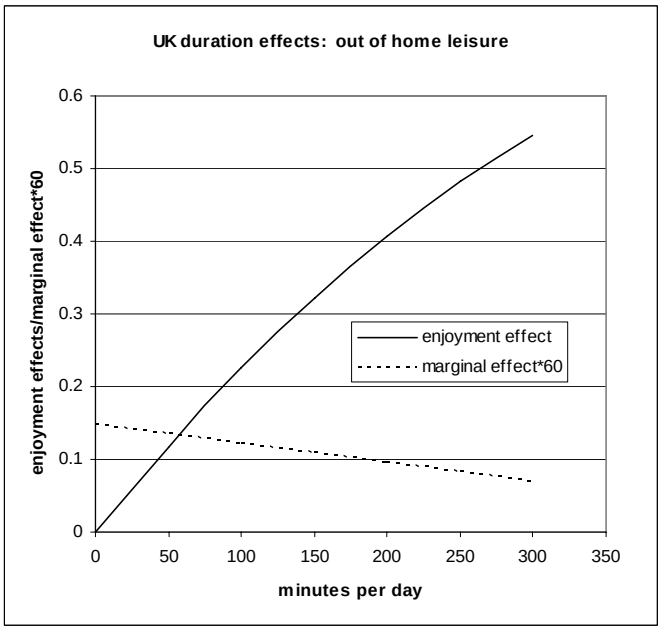
Enjoyment is the earliest but not the only instantaneous subjective measure that can be collected using a diary. Ehrlich (1987) also collected time scarcity information ("How much more or less time would you like in this activity?") in the same diary instrument, which, unsurprisingly given Kahneman's previously quoted equation of utility with a "disposition to

[9] Its designers classify this study as using the Day Reconstruction Method (DRM); this approach appears to be functionally equivalent to what is described in this report as a diary method.

continue or to interrupt the current experience" shows results somewhat parallel to those of the enjoyment measure. In the late 1980s Glorieux (1993) collected diary evidence of the subjective "meanings" of time. Most relevant for this report, Krueger et al (2009), using a random-digit telephone DRM or diary approach for samples of women in a US and a French city[10], collected, for three randomly sampled episodes during the day, six affect measures, three registering positive feelings ("happy", "enjoy myself", "friendly") and three registering negative feelings ("depressed", "angry", "frustrated"), each on a 0-6 intensity scale. Any episode in which the intensity of the highest-scored negative feeling is higher than that of the highest-scored positive feeling, is classified as "unpleasant". Each activity category will then produce a "U" index, the (time weighted) proportion or percentage of events classed as unpleasant.

Fig 7c Total and marginal utility: effect of time in activity on enjoyment of out of home leisure





The requirement for six subjective measures for each diary episode would make the approach very burdensome if it were required continuously for every episode in diary day. But it has the clear advantage that it avoids the problem of interpersonal variation in the range of intensity scoring. The American Time-use Study is currently collecting this information for just three events randomly selected from its respondents' diary days**. *(Note however that the "three randomly sampled episodes per day" approach necessitated by a multiple-affect-type instrument design effectively precludes the use of the method of calculation of marginal utility measures outlined in the previous section.)***

The U-indexes for various activities can be used as a basis for what Krueger calls "National Time Accounts" (NTA); perhaps the alternative "National Time Value" (NTV) accounts may be preferable, insofar as the former term fits more naturally as a description of a nationally representative time budget of the sort illustrated as Table 2 above. Krueger et al (2009 pp 76-77) produce synthetic NTV accounts for the US and France by multiplying a vector of U

[10] 810 women in Columbus Ohio, and 820 women in Rennes, collected during 2005.

scores for the various activities, by a vector of the amounts of time spent in each of those activities according to the respective national time budgets, and summing the products. On the basis of their calculations, and irrespective of whether French or US U-values are used for both calculations, France appears to be about 1% less unhappy than the US.

We can produce somewhat analogous NTV accounts from the 1980s UK and US enjoyment scores. And because the complete day enjoyment data allows us to model the determinants of enjoyment of each activity in at the individual level (producing similar regression coefficients to those in Appendix 2, but estimated for the two countries together with an added variable distinguishing US from UK cases) we can use these to impute enjoyment ratings to each respondent in other surveys on the basis of their individual time-use patterns and other social and economic characteristics. Indeed, having surveys from various dates from across the world we can use the 1980s UK/US enjoyment characteristics to impute affect scores to surveys from various different geographic regions and historical periods. Then multiplying each individual's imputed enjoyment ratings for each activity by the amount of time he or she spends in that activity we can calculate individual mean daily enjoyment levels.

The cross-time cross-national enjoyment figures allow us to see the implications for aggregate NTV if mid-1980s US and UK enjoyment levels were accompanied by different patterns of time-use. They allow us to ask the question: **"How do utility consequences vary as a consequence of national time budgets and other national economic and socio-demographic characteristics, and the associated historical changes in them?"**

Figure 8 and 9 provides a set of illustrative estimates, separately for men and women for 15 countries, spanning the period from the early 1970s to the present. The individual aggregate enjoyment levels for all fifteen countries have been normalised (to have a mean of zero and a standard deviation of 1), separately for the 157,753 men and 168,804 women whose day diaries are included (the survey data comes from the Multinational Time-use Study: Fisher 2011. Updated results will be included in the next draft of this report). The country grouping used is a version of the regime groups in Esping Andersen 1990 (Kan et al 2011).

The top pair of panels, referring to men and women from Anglophone countries, shows the UK, Canadian and Australian time-use patterns producing quite similar utility consequences, with a small historical reduction in mean normalised utility, ending at -.05 to -.1. The US men's and women's time-use trend leads to a substantial reduction in mean normalised utility, from just over zero in the mid 1970s, to -.03 in the 1980s, which is partly recovered over subsequent decades. The men and women have rather similar levels of utility, ending up with adjusted scores of -.1 or -.2 in the last decade.

The Nordic men's time-use pattern produces something of a historical decline also (except in Sweden) but from an overall higher level, while Nordic women show a generally high upward trend. The Nordic time budget appears to produce substantially positive utility consequences, particularly for women. Corporatist countries' trends have contradictory implications, Netherlands time-use and other changes reduce mean utility, but German changes increase it, both for men and for women.

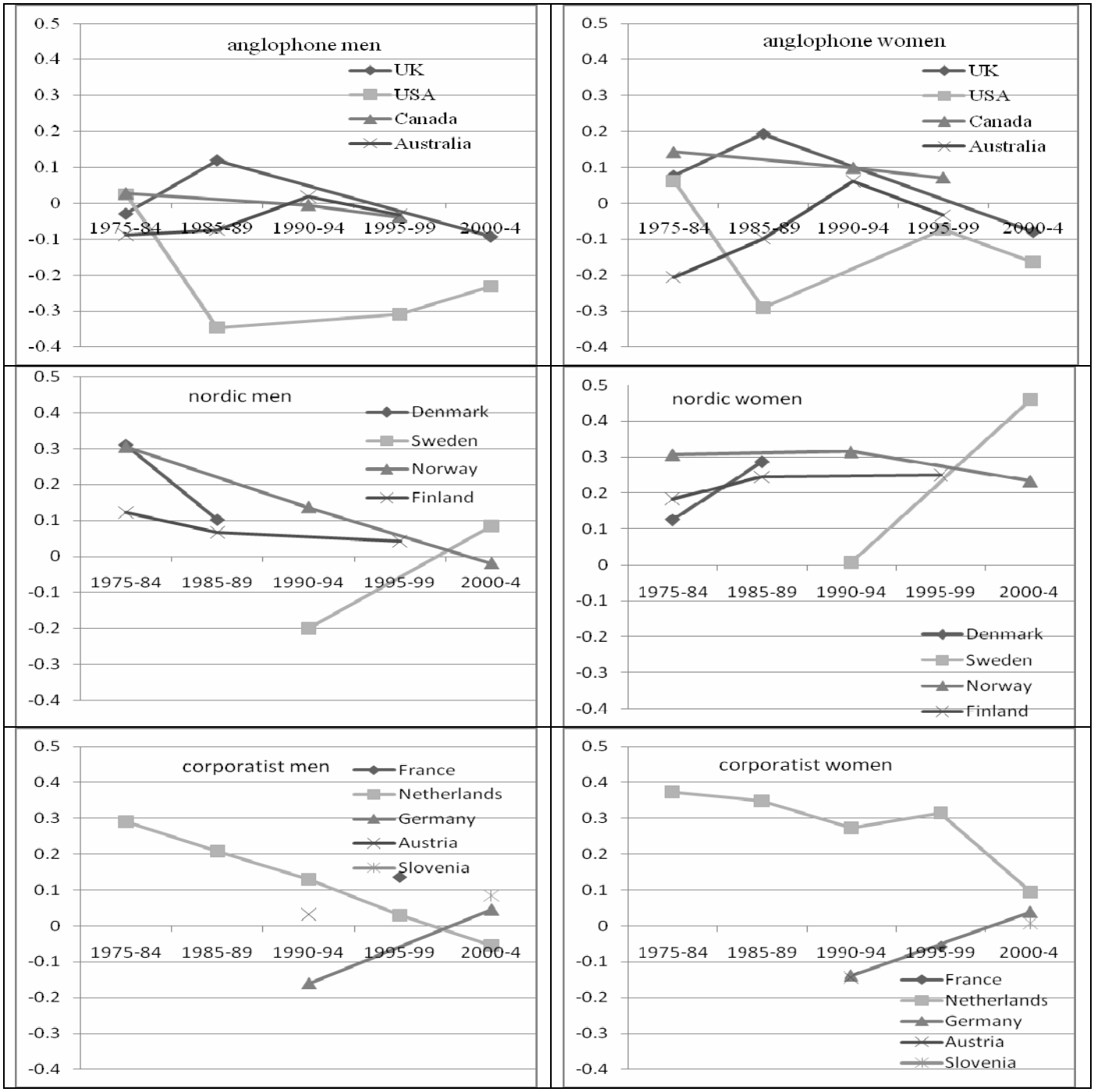
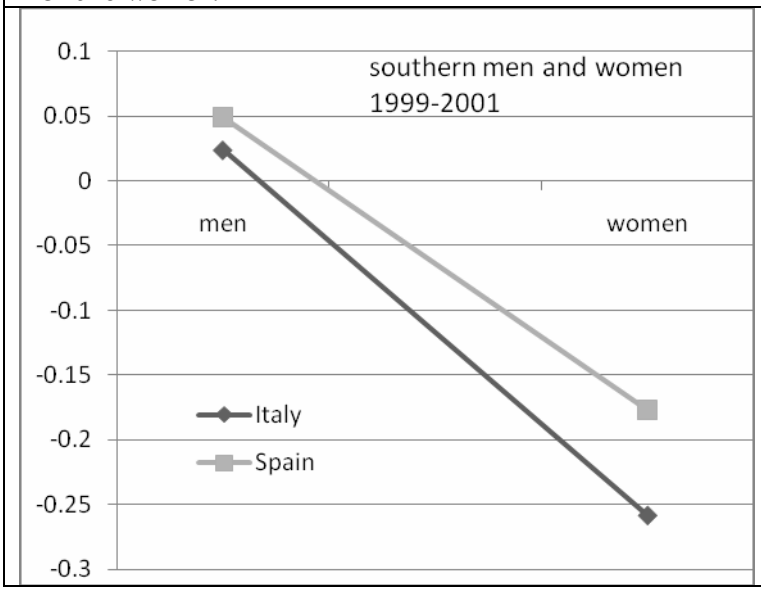


Figure 8 Hybrid Counterfactual National Time Value Accounts (Anglo, Nordic and Corporatist). Imputed enjoyment ratings using combined UK and US enjoyment data, normalised separately for men and women.

The most dramatic gender contrast comes from the time budget patterns from the two Southern European surveys in the dataset[11] (Figure 9). The Spanish and Italian time budget patterns produce slightly better outcomes for men than do the Anglo patterns, with means just above zero rather than just below. But the Anglo patterns of women's time-use would be strongly preferred to that of the Southern group of women. And overall, Nordic time budget patterns seem to produce the best utility consequences for both men and women, at least when viewed from the perspective of mid 1980s Anglo-American enjoyment patterns.

[11] Slovenian time budget patterns are much more similar to those of the central European "Corporatist" states.

Figure 9 Hybrid Counterfactual National Time Value Accounts (Southern).
Imputed enjoyment ratings using combined UK and US enjoyment data, normalised separately for men and women.



2.5.5 Multiple indicators of well-being

Krueger (2009 p3) approvingly quotes George Loewenstein's (2009 p91) suggestion that there is some "true welfare" to be discovered in the intersection of national product (NP) and national time-value (NTV) accounts. But this interpretation runs counter to Juster and colleagues' original "joint production" insight that, though both are constructed by multiplying elements of the same time budget by some value index — "(shadow) monetary value added" to produce national output measures, (shadow) final purchase costs to produce national consumption measures, and either the activity enjoyment or the "U" scores for the time value measures—they are actually measuring conceptually quite distinct things.

The essential difference between them depends ultimately on the implication of the "third person criterion". The money value NP calculation makes the strong assumption that all work is instrumental, a means to the end of "really final" consumption. So all of the experiential ("process") attributes of that large part of daily time devoted to paid and unpaid work is suppressed, and all that is counted for NP or eNP is **either** the market value of the "really final" output, **or** the—by definition identical—(money plus shadow) value-added of all the work. By contrast, the NTV counts **only** the immediate experiential attributes of **both** the work **and** the consumption time.

An alternative interpretation is that the (e)NP and NTV are to be considered as indicators of different, essentially independent, dimensions. Changes in the national time budget may be associated with different sorts of changes in the money value accounts and the time-value accounts. Increases in national income might be associated with decline in national (process-related) utility, as would be the case for example if paid or (particularly the less-enjoyed) unpaid work time increased over the same period. Much of what we see in the (admittedly rather preliminary) calculations in Figure 8 indeed corresponds to this. Only Nordic women (and, though at a lower level, Swedish men and Germans of both sexes) seem, on this

evidence of the recent past, to have managed the Paretian trick of reliably increasing both indicators[12].

However, these simple national aggregate means are not likely to be the main use made of these sorts of statistics. Until the now, the single-day, excess-zeros, characteristic of time diary data has inhibited the calculation of *distributional* statistics. Who has the least, and the most, enjoyable lifestyle? How does the enjoyability of daily life correlate with individual earnings, household income, health, family and class situation? With the techniques for establishing long-term time-use patterns from diary studies discussed previously, we can now start to answer those questions. The *combination* of a time diary with a field dedicated to an activity rating scale for all daily events with a questionnaire containing stylised participation items for a range of activities, will at last allow us to calculate exactly that measure of enjoyment summed over an appropriate period, which Kahneman (1999) associated with Bentham's (1789) concept of utility[13].

Then, beyond the narrow utilitarian consideration of the enjoyment of daily life, we may revert to those "distanced reflections on immediate conditions and experiences"—happiness in the fullest sense. Constituted out of individual utility in the limited sense expressed by the foregoing, and also by short term income, and by wealth in the broad sense that includes intangible embodied capitals as well as financial and other tangible resources, together with some degree of intuition about the conditions of others, and some understanding of the consequences of these conditions for the current and future conditions of the planet—our individual states of happiness, or unhappiness, our states of well- or ill-being, are collectively the appropriate basis for the selection of the future course of public policy.

[12]The concluding remarks from Krueger et al 2009 pp 77-80 concerning next steps in developing the NTA, apply almost without exception to the discussion of NTV accounts in this section.

[13] Though if we interpret the words "general suffrage" as meaning something as close to a randomly sampled social survey as is imaginable in mid-19c England, the real priority for the empirical measurement of utility goes to Mill (note also the congruence to the U index described above):

> "What is there to decide whether a particular pleasure is worth purchasing at the cost of a particular pain, except the feelings and judgement of the experienced?" ..."What means are there of determining which is the acutest of two pains or the intensest of two pleasurable sensations, except ***the general suffrage of those familiar with both***?"
>
> **JS Mill *Utilitarianism*** Chapter 2).

3 Other potential uses of time diaries

3.1 Behaviour-related environmental stressors

Human activity generates environmental stresses which impact on resource sustainability. Particular ways of spending time have implications for resource depletion (through for example the use of electricity in domestic equipment and individual transport use) and may also result in various sorts of environmental pollution (for example through demands on fossil fuel use). Sustainability issues have not previously been a major application for time-use research. But given the exhaustive coverage of all human activity, time budget accounts are an obvious means for integrating accounts of resource or pollution footprints into comprehensive accounts of environmental stress. Research along these lines has previously been undertaken at UC Berkeley (Schipper 1996), and a new project along these lines is currently restarting (Schipper: private communication).

The environment in turn places stresses on individuals, and diary materials. The location information in the diaries, in combination with the activities can provide the basis for estimating exposure to potentially harmful circumstances, such as passive cigarette-smoke exposure before public smoking control, or exposure to sunlight while outdoors (eg McCurdy et al 2011).

3.2 Tests and amplification of results from other survey instruments

The exhaustive coverage of time diary instruments also implies a degree of overlap with other survey materials, including among others the Labour Force Survey and the National Travel Survey. There is certainly no way that a time diary sample could displace either of these, since the very substantial cost and heavy respondent burden of diary studies restricts their size and frequency. But the diary studies may provide some amplification, providing detailed information not available from other instruments—as in the case of the LFS issues about work rhythms (time of day etc) mentioned previously.

There are also issues of the reliability of stylised work time estimates, first noted in 1990s (Niemi 1993, Robinson and Bostrom 1994), still disputed by some statisticians (Jacobs1998, Frazis and Stewart 2010), but nevertheless persistently reported. It is suspected that particularly long work hours are systematically and substantially overestimated as a result of asymmetric recall errors: long-work-hours respondents remember extra work time, but forget circumstantial interruptions—like taking children to medical appointments during their own *normal* work time (necessarily, since these overlap with the medical services' work-hours—that must disproportionately reduce their *actual* work hours.

A recent ILO meeting of experts on labour statistics concluded that time diary studies...

> ...can prove effective in measuring working time and certain aspects of working time arrangements, and in obtaining good-quality measures of absence from work hours when all activities are recorded. Time-use surveys may also be the more common collection method for working hours of unpaid non-market service work, including volunteer work activities.
>
> (ILO 2008 p25)

Diary data also provide checks for the effects of recall and other estimation error. For example, it is suspected that the National Travel Survey under-estimates short trips

(particularly walks) as a consequence of its discontinuous episodic approach to recall. The continuous recall approach of the time-use diary study may explain the higher prevalence of short walks in time-use studies.

3.3 Historical changes not registered elsewhere in the statistical system

One of the unique strengths of the time diary approach is its continuous sequential nature. All activities throughout the observation period should be present in some form in the diary record of an HETUS-type "own words" instrument. This means that—as long as the original diary materials are archived in an accessible manner—activities that may not have been recognised as significant at the time can be reconstructed subsequently. The real-time sequential nature of time diary studies means that—like astronomers scanning old photographs to detect relative movement in star clusters—we can identify phenomena for which the instrument was not originally intended. In particular we can use time diary materials to reconstruct changes that were not properly noticed at the time they got underway.

Table 8 Percent using home computer on random day, UK

	Whole sample			Sample aged 18-64		
	1985	2000	2005	1985	2000	2005
all	0.5%	12.3%	15.0%	0.5%	11.7%	16.9%
Men	0.8%	17.2%	20.3%	0.8%	15.4%	22.2%
Women	0.2%	8.2%	10.7%	0.2%	8.6%	12.6%

We can see, for example, the extraordinarily pervasive importance of computer-related activity in daily life–clearly visible in time-use studies but virtually nowhere else. Table 8 shows fewer than 1% of British men aged 18-64 using a computer on a randomly chosen day in 1985, while 22% did so in 2005. Yet those who use computers on the diary day spent about 2 hours doing it at both dates.

Table 9 Computing time in the UK

			men		women	
	all	users	all	users	all	users
1985	1	113	1	127	0	75
2000	11	91	16	105	6	70
2005	20	120	29	131	13	104

There has been very substantial increase in computer use over the last decade and this will greatly grow over the next. The ESRC national time-use surveys in the 1980s registered the very start of this process in UK (Table 9). But the lack of any ongoing programme of time diary collection means that we can neither track its progress, nor in the future will we be able to identify current activities that are not at present recognised as of interest. We may expect, as a result of technological innovations and environmental pressures, changes in patterns of life, over the next twenty or thirty years, that are quite as substantial as those of the mid-part of the 20th century. Some of these may, unrecognised, already be under way. A full national scale random sampled own-words diary study is the only means of documenting these: ***we cannot retrospectively reconstruct the details of daily life for empirical analysis, if we have not first recorded them***.

4. Proposal for new data collection

Various considerations inform this proposal:

Both the possibilities of comparison with previous UK surveys, and of UK time-use trends with those in other EU countries, and others that adopt similar approaches, argues strongly for maintaining compliance with HETUS design protocols (ie diary as in Figure 1, whole household coverage, two diary days per respondent, plus 7-day employment log).

The high cost of a large-scale HETUS study precludes its annual implementation on the pattern of the American Time-use Study (unless it becomes closely associated with the Labour Force Survey, as the ATUS is with its US equivalent). The approximately 10 year interval between many HETUS studies is arbitrarily chosen. Some countries (Netherlands, Australia) adopt 5 year intervals. But it is likely that different historical periods involve different rates of change in national time-use patterns.

The burdensome nature of the multiple affect fields in the U-measure, together with the poor fit of the "three random event" approach to the HETUS "own words" self report design, and the much wider analytic possibilities offered by the single "enjoyment" scale currently being collected by the INSEE in France, suggest strongly that the latter approach be adopted.

These suggest the adoption of a System of Time Indicator Monitoring (STIM), with infrequent large-scale HETUS-type studies backed up, by regular light diary time-use monitoring, and frequent programme review

- Every 10 years, HETUS pattern: whole year, 5k households, 10k respondents, achieved sample of 20k own-words day diaries plus 7-day work-grid; 1000 households to use diary form with additional "enjoyment" column, producing approximately 4000 day diaries with enjoyment scores.
- Every 3 years, sample of precoded light diaries, over several months, achieved sample of 2k days, review to check for indications of need for early repeat of HETUS study.

Approximate costings:

£1.25 per interview min*35 mins*14,286 interview respondents (to achieve 10,000 diarists assuming 30% attrition between interview and completed diary receipt) = £625K

£20 per diary for follow up, transcription and coding* 20,000 diaries	= £400K	
£20 per complete respondent for incentive	= £200K	
£1.25*8 minutes*2000 light diaries, £3 transcription per diary (2)	= £52K	
Total direct survey cost		£1.277M
Survey manager, full cost £70K per year for 2.5 years	= £175K	
Postgraduate studentships, £13K per year for 4 years (2)	= £104K.	
Total other survey costs		£279K
Total direct survey and other costs over 10 year cycle		£1,556M

APPENDIX A

Measuring long term time-use from short diaries

The shortness of the reference period for diaries does, as previously noted, potentially limit their usefulness for estimation of the distribution of activities across populations. If, as in the UK, and to choose just one example, fewer than 20% of the population as a whole engage in purposive exercise on any given day, statistics such as the interquartile range of exercise time, or the half-median daily exercise time are entirely uninformative. In these cases it is helpful to apply a recently developed statistical technique which combines dietary questionnaire and diary methods to produce improved long-term estimates of eating patterns (Tooze et al 2006, Kipnis et al 2009). A simplified summary of this approach is set out in the following paragraphs.

The 2000/1 HETUS design included a brief battery of questions asking respondents whether they had participated in each of a set of 40 specified leisure activities (cultural, spectatorship and sports participation) over the last month, and if so, how many times. Column 1 of Table A1 gives the expected probability of participating in just one of these activities, "taking walks or hikes > 2 miles", broken down by the answer to the "How many time in the last month?" question. If we were to take the last month's participation as the best available prediction of the probability of participation in this activity, then we might expect that the 77% of the sample who claimed not to have engaged in the activity at all to have a probability well below .03 (less than the inverse of the number of days in the average month) of engaging in this activity on a randomly chosen day in the present month. Those who once might be expected to have a probability of .03 of participating on a random day, twice, a probability of .07, four times, .13, and those who claimed 5 or more hikes to have a probability of participating in a hike on any random day, of well in excess of .16.

Now, the (randomly chosen) diary day, collected for the *same individuals* who answered the questionnaire, which we presume provides an accurate picture of all activities, tells us that the more hikes claimed by the respondents, the greater the gap between the participation probability and the actual participation rate. Fewer than one third of the expected proportion of those who *claimed* to have hiked five times in the previous month, *actually* hiked on the diary day. This exaggeration of exercise participation is the sort of dual social/personal desirability-related distortion that we might expect—though it could just as well be explained as a regression-to-the-mean phenomenon (an unusually high rate of hiking last month reducing to a more normal level this month). But the explanation is not at all important, because we need merely to *calibrate* the relationship of the stylised estimate question to the actual diary outcome: "five or more times in the last month" implies a participation probability of .05, "four times" means a probability of .13 and so on. The estimate question (plus other social, economic and demographic controls) can be used both to predict hiking *participation probabilities* for each respondent, *and* (from the evidence of diary participants in this activity) each respondent's *expected time spent hiking* if he or she participates in a hike on the diary day. The product of the participation probability and the expected time if a participant, gives a sensible estimate of the long-term mean of daily time spent in the activity by each respondent. This is the essence of the technique developed by the nutrition researchers.

Table A1 participation in walks & hikes <2 miles (UK 2000/1, adults aged > 17)					
	1	2	3	5	6
	expected participation probability (questionnaire)	actual participation rate (diary)	se actual participation rate	Cases	% of sample
not at all	0.00 - 0.03	0.02	0.001	13230	77
once	0.03	0.02	0.006	433	3
twice	0.07	0.03	0.007	589	3
three times	0.10	0.02	0.007	405	2
four times	0.13	0.04	0.008	549	3
five or more times	> 0.16	0.05	0.005	1904	11
N				17110	

Time diaries have an additional advantage as compared to nutrition diaries. Eating, or not eating, a cake on a given day has no necessary consequences for, say, consumption of soup on that day. But time, contrastingly, is *essentially* limited. Two hours spent hiking, mean that 120 of the 1440 minutes of the diary day cannot be devoted to any other primary activity. And since, as we see from Table A1, the answer to the questionnaire item on hiking does have a significant and positive relationship to the evidence of hiking in the diary, it has at least the potential to have a (probably negative) relationship to at least some of the other activities recorded in the diary. And conversely, time spent at the theatre (and also presumably the questionnaire item on theatre attendance) may have a *negative* association with evidence of hiking in a day diary. Thus, in the time-diary case, we can use *all* of the questionnaire-derived stylised estimate evidence as the basis for an improved estimate of long-term average daily time in *each* of the time-use categories

Three steps to long term time-use estimates:

1. Logistic regression estimates respondents' predicted ***participation probabilities***
2. OLS estimations of ***participants' time*** in each activity from diaries; generate ***predicted participants time*** for all resps.
3. ***Product*** of predicted daily participation probabilities and participants' time gives ***individual long-term means***.

Minor adjustments:

- Truncate negative estimates at zero (very few cases, only in care, paid work and exercise).
- Adustment for total time < or > 1440 mins:
  Adj factor = (estimated total mins)/1440
  Mean 1.00; sd .02; min .90; max 1.10
  Adjusted act time= (act time)/(adj factor)

Estimation structure:

Where T^a is diary estimate of minutes in activity a,
H^a is questionnaire participation estimate for activity a,
$C_1 \ldots C_n$ is a vector of i control variables:

(1) $T^a=f(C_1 \ldots C_i , H^a)$
$T^b=f(C_1 \ldots C_i , H^b)$
…….
$T^n=f(C_1 \ldots C_i)$

However:

(2) $T^a + T^b + T^c + \ldots . T^n = 1440$ minutes

Hence we may estimate:

(3) $T^a = f(C_1 \ldots C_i, H^a, H^b, H^c \ldots H^n)$
$T^b = f(C_1 \ldots C_i, H^a, H^b, H^c \ldots H^n)$
…….
$T^n = f(C_1 \ldots C_i, H^a, H^b, H^c \ldots H^n)$

Variables in the Model

Dependents variables:

33 activities (3 personal care, 6 work, 9 sports,16 other leisure) =1440 mins

Control variables:

Age, age squared, sex, marital status, carer/family status, educational attainment, occupation, diary day-of-week

Habit variables:

18 "how-many-times-last-month?" vars, normal paid work hours

Logistic regression: predict daily participation probability **P**

OLS regression: predict daily participants' time for all respondents **t**

Finally, estimate:

long term time-use = P * t

Table A2. Time spent popular culture (decile percentages): long term estimates								
	managers	medical & educational professions	other professions	clerical	assembly, security, sales	farming, fishery & forestry	no occupation	N
bottom decile	5	1	19	13	8	55	7	1699
2	8	2	14	13	10	6	8	1699
3	8	3	9	12	11	9	11	1698
4	10	6	9	10	11	4	12	1698
5	10	9	7	9	11	4	13	1700
6	11	12	8	8	11	4	10	1698
7	13	17	9	7	9	7	12	1699
8	10	13	10	9	10	6	12	1699
9	11	15	8	10	10	2	9	1697
top decile	15	22	6	8	9	4	6	1699
column %	100	100	100	100	100	100	100	
	2972	1151	2218	3123	5710	183	1631	16988

Table A3. Time spent in all cultural pursuits (decile percentages): long term estimates								
	managers	medical & educational professions	other professions	clerical	assembly, security, sales	farming, fishery & forestry	no occupation	N
bottom decile	4	3	16	8	14	70	1	1699
2	6	5	13	12	13	6	5	1699
3	7	7	9	12	13	2	6	1698
4	8	8	9	12	11	2	9	1698
5	10	11	9	10	10	5	13	1700
6	14	13	8	8	7	7	18	1698
7	14	12	9	10	7	3	14	1699
8	12	12	10	9	9	3	13	1699
9	11	13	10	11	9	2	9	1697
top decile	15	16	7	9	7	3	12	1699
column %	100	100	100	100	100	100	100	
	2972	1151	2218	3123	5710	183	1631	16988

Table A4. Time spent at all leisure (decile percentages): long term estimates								
	managers	medical & educational professions	other professions	clerical	assembly, security, sales	farming, fishery & forestry	no occupation	N
bottom decile	17	16	10	12	7	4	0	1699
2	13	14	10	11	10	6	1	1699
3	12	13	10	11	10	11	3	1698
4	11	10	10	11	10	9	6	1698
5	9	12	10	11	10	10	10	1700
6	8	11	9	10	11	8	13	1698
7	7	9	9	10	11	7	14	1699
8	7	8	9	10	10	12	16	1699
9	8	4	10	9	11	14	17	1697
top decile	9	2	13	6	10	20	20	1699
column %	100	100	100	100	100	100	100	
	2972	1151	2218	3123	5710	183	1631	16988

Table A5. Time spent in all non-tv leisure (decile percentages): long term estimates								
	managers	medical & educational professions	other professions	clerical	assembly, security, sales	farming, fishery & forestry	no occupation	N
bottom decile	7	6	1	11	17	15	4	1699
2	9	9	4	12	12	15	9	1699
3	8	11	5	13	12	8	9	1698
4	10	12	7	10	11	11	10	1698
5	11	12	9	10	9	10	11	1700
6	12	10	11	9	9	7	11	1698
7	8	12	13	9	9	9	12	1699
8	11	10	14	10	8	9	11	1699
9	12	9	16	9	8	10	10	1697
top decile	12	9	21	6	6	7	14	1699
column %	100	100	100	100	100	100	100	
	2972	1151	2218	3123	5710	183	1631	16988

Table A6. Time spent in all tv-type leisure (decile percentages): long term estimates								
	managers	medical & educational professions	other professions	clerical	assembly, security, sales	farming, fishery & forestry	no occupation	N
bottom decile	21	23	20	9	2	1	0	1699
2	15	13	15	13	6	2	1	1699
3	13	14	12	11	9	5	2	1698
4	10	12	10	12	10	10	6	1698
5	9	9	9	11	12	10	7	1700
6	8	8	9	11	11	11	11	1698
7	7	8	9	10	12	14	13	1699
8	6	8	7	9	12	10	18	1699
9	6	5	7	9	12	15	21	1697
top decile	5	2	4	7	15	23	21	1699
column %	100	100	100	100	100	100	100	
	2972	1151	2218	3123	5710	183	1631	16988

Appendix B. Estimating utilities from time diary surveys

Utility is often considered in an atemporal manner, as related to volumes or quantities of consumption of a commodity. But all acts of consumption take time. Utilities are produced in the minds of actors as the consequence of activities which generate affect in real time. Utility derives, not from the meal itself, but from the act of eating it (though the benefit may vary with the quality of the food). The extent of activities is measured by their duration, and the affect may differ over elapsed time in the activity. So utility is properly to be regarded as a *rate of delivery of a benefit in time*—just *so much* enjoyment over a specified period of time—and marginal utility is the *change in this rate over successive increments of tim*e.

Utility generated by activities may be estimated from diaries which are kept continuously throughout a given observation period, which list unbroken sequences of events together with their durations and the associated enjoyment ratings of each activity. We can assert that:

$$\mathbf{1)} \quad e_{ij} = a_{jk}X + b_j t_j + c_j t^2_j$$

where $\mathbf{e_{ij}}$ is the enjoyment rating of each element **i** in a continuous sequence of diary events which are classified into **j** exclusive categories of activity. The **j** types of activity (such as "sleep", "watching television" and so on) correspond to the "primary activities" in a time-diary survey. **X** is a vector of **k** (demographic and economic) control variables which may influence the enjoyment of activities, $\mathbf{a_{jk}}$ is the set of coefficients relating this vector to each of the categories of activity, and $\mathbf{t_j}$ is the *total* of all time devoted to activity-type **j** by the diary respondent *over the entire observation period.* Note that since each event **i** is classified into just one of the j activity categories, Equation 1 may be estimated as a set of j separate regressions. Hence, identifying enjoyment with utility, and assuming that inter-personal *differences* between respondents' totals corresponds intra-personal *increments or decrements,* we may estimate marginal utility with respect to time for each of the j categories as:

$$\mathbf{2)} \quad \delta e_{ij}/\delta t_j = b_j + 2c_j t_j$$

This approach to modelling enjoyment of diary activities corresponds closely to the Kahneman *et al* (2004b), Krueger et al (2009) formulation of overall time-weighted enjoyment (or aggregate utility):

$$\mathbf{3)} \quad u = \left(\sum_1^i \sum_1^j d_{ij}.e_{ij}\right)/T$$

where $\mathbf{d_{ij}}$ represents the duration of each of the diary events and **T** is the total length of the observation period (ie the sum of the $\mathbf{t_j}$ durations). Note that $\mathbf{d_{ij}}$ varies with each diary event, whereas the $\mathbf{e_{ij}}$ coefficient varies only with the activity and identity of the diary respondent.

Table B1 shows the (Equation 1) regression coefficients on the activity enjoyment scores in the 1980s surveys described in 2.5.2; Equation 2 corresponds to the marginal utility estimates in 2.5.3, and Equation 3 provides the NTV estimates in Section 2.5.4.

Table B1 OLS regressions. Dependent variable: enjoyment ratings: answers to "how much did you enjoy current activity?"

11 point (0-10) scale for US, 5 point (1-9) scale for UK, * p<.05 ** p<.005 ***p<.0005 Parentheses where significance levels are achieved with simple but not robust standard errors.

US (1985)	leisure out		Non-tv home leisure		sleep, personal		watching tv		paid work		domestic, other.unpaid		shopping		child care		travel	
Multiple R	*0.242*		*0.121*		*0.061*		*0.154*		*0.157*		*0.086*		*0.222*		*0.258*		*0.140*	
Mins in activity/100	**0.308**	**(*)	**0.296**	**(*)	**0.253**	(**)	-0.073		0.047		0.088		0.242		-0.083		-0.179	
Mins in acty sq/1000	**-0.002**		**-0.003**	*(*)	**-0.002**	(**)	0.002	(*)	-0.001		-0.001		0.065		0.008		0.003	
Woman	0.221	(*)	0.273	**(*)	0.029		0.092		0.266	*(**)	-0.096		0.273		-0.106		0.265	*
Age	0.014		-0.035		-0.013		0.009		-0.019		0.028		0.077		0.028		-0.115	*(**)
Age sq /100	0.010		0.357		0.226		-0.035		0.514	(*)	-0.320		-1.124		-0.387		1.555	*(**)
Employed fulltime	0.193		-0.073		-0.060		0.031		-0.070		0.163		-0.458		0.141		0.057	
Has cores. partner	-0.228	(*)	0.206	(*)	0.081	(*)	0.033		-0.063		0.096		-0.330		0.566		0.051	
Has child aged <5	0.326	**(*)	0.074		0.150	*(**)	0.228	*(*)	0.327	(***)	0.115		-0.179		0.025		0.089	
Has child aged 5-15	-0.033		0.007		0.033		0.020		-0.047		-0.151	*	-0.136		-0.258	*	0.143	(*)
Complete sec'ry ed	0.267		-0.078		0.078		-0.276	*(*)	0.411	(***)	-0.106		-0.317		-0.367		0.507	(**)
Some tertiary educ	-0.150		-0.077		0.055		-0.595	***	0.706	**(*)	-0.241		-0.735	(*)	-0.668		0.109	
Log hourly wage	0.005		0.019	(*)	0.008	(*)	0.010		0.023	(**)	0.005		0.007		0.013		0.001	
Constant	7.471	***	8.169	***	7.330	***	7.873	***	6.041	***	5.231	***	5.777	***	6.997	***	8.098	***
UK (1986)																		
Multiple R	*0.167*		*0.201*		*0.193*		*0.214*		*0.240*		*0.280*		*0.287*		*0.231*		*0.256*	
Mins in activity/100	**0.248**	*(**)	**0.347**	**(*)	**0.494**	*(**)	**0.483**	***	-0.075		-0.002		**1.164**	***	**0.467**	*(*)	0.188	
Mins in acty sq/1000	**-0.002**	*(**)	**-0.004**	***	**-0.004**	*(**)	**-0.006**	*(**)	0.002	(*)	0.002	(*)	**-0.016**	***	**-0.010**	**(*)	-0.001	
Woman	0.167	(*)	0.535	*(**)	0.228	(***)	0.135		0.509	***	-0.703	***	0.440	(*)	-0.160		0.277	(*)
Age	0.072	(**)	-0.072		-0.044	(***)	-0.030		-0.061	(*)	-0.058	(*)	-0.134	(*)	-0.237	**(*)	-0.202	*(**)
Age sq /100	-0.774	(*)	1.005	(*)	0.524	(**)	0.500		1.013	(**)	1.063	(**)	1.819	(*)	3.389	**(*)	2.698	*(**)
Employed fulltime	0.023		0.408	(***)	-0.049		0.148		-0.167		0.254	(**)	0.134		-0.016		-0.374	(*)
Has cores. partner	-0.041		1.948	***	1.010	*(**)	1.698	*(**)	1.804	(***)	-0.629	(*)	-0.698		0.525		-0.804	
Has child aged <5	0.194	(**)	0.286	(*)	0.244	*(**)	0.361	*(**)	-0.174	(*)	0.001		0.424	*	0.217		0.332	(**)
Has child aged 5-15	0.065		-0.082		0.143	(***)	0.023		0.570	(***)	-0.190	(*)	0.097		0.215		0.539	**(*)
Complete sec'ry ed	0.029		0.012		-0.072	(*)	0.135		0.240	(**)	-0.153		0.191		-0.564	**(*)	-0.442	*(**)
Some tertiary educ	0.023		-0.212		-0.119	(**)	0.002		0.493	(***)	-0.564	**(*)	0.387	(*)	-0.478	*(*)	-0.466	*(*)
Log hourly wage	0.097		-0.004		-0.004		-0.010	(*)	0.051	*(**)	-0.015	(**)	-0.014		0.015	(*)	-0.011	
Constant	6.172	***	5.813	***	6.076	***	5.334	***	4.679	*(**)	7.409	***	7.211	***	10.163	***	10.042	***

References

Basner M; Fomberstein KM; Razavi FM; Banks S; William JH; Rosa RR; Dinges DF. (2007) "American time-use survey: sleep time and its relationship to waking activities." **SLEEP**; 30(9):1085-1095.

Bentham, J [1789] **An introduction to the principles of morals and legislation** Oxford, Clarendon Press, 1876 Ch IV.

Bittman, M, J Fast, K Fisher and C Thomson. 2004. "Making the Invisible Visible: the Life and Time(s) of Informal Carergivers" In M Bittman and Nancy Folbre (ed). 2004. Family Time: The Social Organization of Care. New York, USA: Routledge.

Chandola, T, E Brunner, M Marmot (2006) "Chronic stress at work and the metabolic syndrome: prospective study**" British Medical Journal** 2006;332;521-525.

Chenu, A, and L Lesnard, 2006 'Time-use Surveys: a Review of their Aims, Methods, and Results' **European Journal of Sociology** XLVII, 3, 335-358.

Dow, GT and FT Juster, (1985) "Process Benefits and the Problem of Joint Production" Chapter 16, Juster and Stafford (eds) 1985.

Durkheim, E [1899] **The Division of Labour in Society**. Glencoe, Illinois: The Free Press, 1933.

Diener, E, JF Helliwell and D Kahneman , (2010) (eds) **International Differences in Well-being**, Oxford: Oxford University Press.

Diener, E, D Kahneman, W T and R Arora (2010) "Income's association with judgements of life versus feelings" in Diener et al (2010).

Easterlin, RA (1974), "Does Economic Growth Improve the Human Lot? Some empirical evidence" in **Nations and Households in Economic Growth: Essays in Honour of Moses Abramowitz** eds PA David and MW Reder New York: Academic Press 89-125.

Erlich, A (1987) **Time Allocation: Focus Personal Care**. Household Research Project, TIS No G87002, London: Uniliver Research.

Esping Andersen, G, (1999) **Social foundations of post industrial societies**, Oxford: Oxford University Press.

Esping Andersen, G, (1990) **The three worlds of welfare capitalism**, Cambridge: Polity Press.

Eurostat (1999) **Guidelines for the Harmonised European Time-use Study.**

Fisher, Kimberly, **An Overview of Time in Volunteering and Adult Care in the United Kingdom,** CTUR Technical Paper 2010-02.
<http://www.timeuse.org/files/cckpub/CTUR_Technical_Paper_2010-02.pdf>

Frazis, H, J Stewart, "How to Think About Time-Use Data: What Inferences Can We Make About Long- and Short-Run Time-use from Time Diaries?" **IZA Discussion Paper** No. 5306, November 2010.

Gershuny, J, (1977) "Post-industrial Society: The Myth of the Service Economy", **Futures** Volume 9, Issue 2, April 1977, 103-111.

Gershuny, J, (1983) **Social Innovation and the Division of Labour**, Oxford: Oxford University Press.

Gershuny, J, (1995) "Draft Proposal for the Methodology of the European Time-use Survey" **Statistics in Transition**, 2(4), pp. 529-551.

Gershuny, J, (2011) "Increasing Paid Work Time? A New Puzzle for Multinational Time-diary Research" **Social Indicators Research** Volume 101, Number 2, 207-213.

Glorieux, I, (1993) "Social interaction and the social meaning of interaction: a time budget approach", **Social Indicators Research** 30 (2-3):149-173.

Glorieux, I. and J. Minnen (2009), "How many days? – A comparison of the quality of time-use data from 2-day and 7-day diaries", in: **electronic International Journal of Time-use Research**, Vol. 6, No. 2, 313-326.

Gronau, R and DS Hamermesh (2006) "Time vs Goods: the Value of Measuring Household Production Technologies" **Review of Income and Wealth** Series 52, Number 1, March.

Harms, T (2004), **The day, at home and away: How 16 Danish five-year-olds spend their time**, PhD Thesis Rosskilde University.

Harvey AS (1993) 'Guidelines for Time-use Data Collection'**, Social Indicators Research** 30, 197-228.

Hawrylyshyn, O, (1974) "A Review of Recent Proposals for Modifying and Extending the Measure of GNP" **Statistics Canada Occasional Paper**, Cat. # 13-558, Ottawa.

Holloway, S, S Shor and S Tamplin (2002) **Household Satellite Account (Experimental) Methodology** London: ONS.

ILO (2008) Report 11 **Measurement of Working Time** Meeting of Experts on Labour Statistics ILO MELS/2008/11

Ironmonger, D, (2007) "Measuring Domestic Output" (mimeo).

Jacobs, JA. (1998). "Measuring Time at Work: An Assessment of the Accuracy of Self Reports" **Monthly Labor Review**. 121(12):42-53.

Jenkins, SP, (2008) **Marital splits and Income Changes over the Long Term** ISER Working Paper No. 2008-07, February.

Jones, D Caradog, with J.E. McCrindell, H.J.H. Parker, C.T. Saunders and N.L. Hume (1934) **The Social Survey of Merseyside** Liverpool: University Press of Liverpool.

Juster, FT and FP Stafford (1985) (eds), **Time, Goods and Well-Being**, Ann Arbor: Institute for Social Research.

Kahneman, D (1999) "Objective Happiness" in **Well-Being: The Foundations of Hedonic Psychology** eds DI Kahneman, E Diener and N Schwarz, New York: Russel Sage Foundation, 3-25.

Kahneman, D, AB Krueger, D Schkade, N Schwarz and A Stone (2004) "A Survey Method for Characterising Daily Life Experiences", **Science** 306 (5702) pp. 1776 to1780.

Loewenstein, G, (2009), in Alan B Krueger (ed) **Measuring the Subjective Well-Being of Nations: National Accounts of Time-use and Well-Being,** Chicago: University of Chicago Press/NBER

Kan, MY, O Sullivan and J Gershuny (2011) "Gender Convergence in Domestic Work: Discerning the Effects of Interactional and Institutional Barriers in Large-Scale Data" **Sociology** 45(2), 234–251.

Kipnis, V, D Midthune, DW Buckman, KW Dodd, PM Guenther, SM Krebs-Smith, AF Subar, JA Tooze, RJ Carroll, and LS Freedman "Modeling Data with Excess Zeros and Measurement Error: Application to Evaluating Relationships between Episodically Consumed Foods and Health Outcomes" , **Biometrics** 65, 1003–1010 December 2009.

Krueger, AB 2009 (ed) **Measuring the Subjective Well-Being of Nations: National Accounts of Time-use and Well-Being,** Chicago: University of Chicago Press/NBER.

Krueger AB, D Kahneman, D Schkade, N Schwarz, AA Stone, (2009) "National Time Accounting: The Currency of Life" in AB Krueger (2009), 9-86.

Larson, R. & Csikszentmihalyi, M. (1983). "The experience sampling method." In H. T. Reis (Ed.), **Naturalistic approaches to studying social interaction: New Directions for Methodology of Social and Behavioral Scienc***e.* San Francisco, CA: Jossey-Bass.

Layard, R, (2005) **Happiness: Lessons from a New Science**, London: Allen Lane.
Lesnard, L and MY Kan (2011) "Investigating Scheduling of Work: a Two-Stage Optimal Matching Analysis of Workdays and Workweeks." **Journal of the Royal Statistical Society**: Series A .
McCurdy, G and BJ Thomas. (2011) "Investigating the American Time-use Survey (ATUS) from an Exposure Modeling Perspective". **Journal of Exposure Science and Environmental Epidemiology** 21(1), 92-105.
Marsh, C (1991) **Hours of Work of Women and Men**, London: HMSO
Mill JS [1863] **Utilitarianism** Oxford: Oxford University Press, 1998.
Michelson, W, "On Adding Affect to Time Diary Accounts" **Social Indicators Research** Vol 93, 1,31-32.
Mortimer, D and L Segal (2008). "Comparing the Incomparable? A Systematic Review of Competing Techniques for Converting Descriptive Measures of Health Status into QALY-Weights", **Medical Decision Making 28** (1): 66–89.
Moser, C (1949) "Le budget-temps de la femme a Londres dans les classes laborieuses", **Populations** 4: 371-374.
Niemi, I. (1993). "Systematic error in behavioural measurement: Comparing results from interview and time budget studies." **Social Indicators Research** 30:229-244.
Pember-Reeves, M [1913] **Round About a Pound a Week** London: Virago 1979
Robinson, JP, (1977) **How Americans use time: A social-psychological analysis of everyday Behaviour.** New York: Praeger.
Robinson, JP. and A Bostrom (1994). "The overestimated workweek? What time diary measures suggest." **Monthly Labor Review** 117:11-23.
Robinson, JP., A Chenu, and AS Alvarez (2002) "Measuring the complexity of hours at work: the weekly work grid." **Monthly Labor Review** 125:44-54.
Robinson, JP and PE Converse (1972) "Social change reflected in the use of time" in A Campbell and PE Converse **The Human Meaning of Social Change** New York: Russell Sage Foundation, 17-86.
Robinson. JP and G Godbey (1998) **Time for Life: The surprising ways that Americans use their time**, University Park: Pennsylvania State Press.
Robinson, JP and W Michelson, (2010) "Sleep as a victim of the "time crunch" – A multinational analysis" **electronic International Journal of Time-use Research** Vol 7,1 61-71.
Schipper, L (1996) "Life-Styles and the Environment: The Case of Energy." **Daedalus** Vol. 125, No. 3, (The Liberation of the Environment), 113-138.
Simpson NS, Punjabi NM, Dinges DF. (2009) "Sleep and mortality." in: Chokroverty SM, Montagna P, editors. **Handbook of clinical neurology**. Elsevier;.
Sorokin, PA and CQ Berger (1939) **Time Budgets of Human Behaviour**, Cambridge: Harvard University Press.
Stiglitz, JE, A Sen and J-P Fitoussi (2009) **Report by the Commission on the Measurement of Economic Performance and Social Progress** www.stiglitz-sen-fitoussi.fr
Sullivan, O (1996) **"**Time Co-Ordination, the Domestic Division of Labour and Affective Relations: Time-use and the Enjoyment of Activities within Couples**", Sociology** February 1996 vol. 30 no. 1 79-100.
Szalai, A (1964) "Differential Work and Leisure Time-Budgets as a Basis for Intercultural Comparisons" **New Hungarian Quarterly**,
Szalai, A (1972) (ed) **The use of time. Daily activities of urban and suburban populations in twelve countries**., The Hague: Mouton.

Tudor-Locke, C, TL Washington, Ainsworth BE, et al. (2009) "Linking the American Time-use Survey (ATUS) and the Compendium of Physical Activities: methods and rationale." **Journal of Physical Activity and Health**. 6(3):347–353.

Tooze, JA. D Midthune, KW Dodd, LS Freedman, SM Krebs-Smith, AF Subar, PM Guenther, RJ Carroll, V Kipnis, (2006) "A New Statistical Method for Estimating the Usual Intake of Episodically Consumed Foods with Application to Their Distribution" , **Journal of the American Dietetic Association**, Volume 106 Number 10.

Vanek, J (1974) "Time Spent in Housework" **Scientific American** 11:116-120.

Vanek, J (1978) "Household technology and social status: Rising living standards and status and residence differences in housework" **Technology and Culture** 19, 361-75.

Van Praag, BMS (1968) **Individual Welfare Functions and Consumer Behaviour** Amsterdam: North Holland.

Van Praag, BMS and A Ferrer-i-Carbonel (2004) **Happiness Quantified: a satisfaction calculus approach**, Oxford: Oxford University Press.

Veenhoven, R, (1989) **Conditions of Happiness**, Dordrecht/Boston: Kluwer Academic.

Voorpostel, M, T van der Lippe, J Gershuny (2010) "Spending Time Together—Changes Over Four Decades in Leisure Time Spent with a Spouse**"** **Journal of Leisure Research** Vol. 42, No.2, 243–265.

Young M and P Willmott (1974) **The Symmetrical Family** London: Routledge and Kegan Paul.

Zuzaneck, J (1980), **Work and Leisure in the Soviet Union: a time budget analysis.** New York: Praeger.