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Leisure, Household Production, Consumption  
and Economic Well-being

by

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# Preface

This collection of essays constitute my Ph.D. thesis on “Leisure, Household Production, Consumption and Economic Well-being”. The research for the thesis was carried out while I was a Ph.D. student at University of Copenhagen.

I would like to take this opportunity to thank colleagues, friends and family for support and encouragement throughout the project. I am indebted to my supervisors, Martin Browning and Allan Würtz, for their inspiration and readiness to discuss numerous aspects of my papers. I also want to thank my colleagues at Centre of Applied Microeconometrics (CAM) for contributing to an inspiring and stimulating research environment.

During my time as a Ph.D. student I visited the Department of Economics at University of Michigan, Ann Arbor. I am grateful to Robert Willis for inviting me and for inspiring discussions of my research. I also want to thank colleagues at Department of Economics and Institute of Social Research (ISR) for valuable help, comments and feed-back. I thank the Euroclear Foundation, Knud Højgaards Fond, Oticon Fonden and Konsul Axel Nielsens Mindelegat for sponsoring my stay in Michigan.

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Copenhagen, January 2006

# Contents

|  |     |
|--|-----|
| Introduction   | 1   |
| <br><b>Chapter 1:</b>  |     |
| Household Production in the Family - Work or Pleasure?                         | 8   |
| <br><b>Chapter 2:</b>  |     |
| Spending Time and Money within the Household                                   | 45  |
| <br><b>Chapter 3:</b>  |     |
| Ageing and Well-being: Consumption and Time Use of Elderly Americans           | 82  |
| <br><b>Chapter 4:</b>  |     |
| Heterogeneity in Preferences and Productivity –<br>Implications for Retirement | 111 |

# Introduction

## Why use time on time use?

"Time is money" is a widely used expression. Still, the majority of economic theory and statistics on economic agents' allocation of time is devoted to the time spent in relation to the labour market. Other uses of time are usually calculated residually as leisure time. However, it is becoming increasingly acknowledged that time spent both in and outside the labour market is important from an economic perspective. Time spent on home production, transportation etc. is important from a production side perspective, and the calculation of "real leisure", i.e. people's spare time after correcting for housework, do-it-yourself, transportation etc. is important for welfare analyses. Time use data are essential for analysing household living standards and intra-household allocation of resources and distribution of real income. Furthermore, time use data are crucially important when analysing the effects of policy changes on household decisions with respect to labour supply decisions in the market, domestic production, consumption and saving. For a recent discussion, cf. Apps (2003).

The first systematic collection of time use data dates back to USSR 1924, but systematic attempts to collect methodologically comparable data for a large number of countries were not conducted until the 1960s, cf. Juster and Stafford (1991). There is an extensive literature on which methodologies are superior when conducting time use surveys. Basically, surveys are either conducted as "time diaries" or as "stylized" time use surveys. In time diaries, people are asked about their actual activities (by e.g. every 10 or 15 minutes) for the last 24 hours. In stylized time use surveys, people are asked more generally about their habits, i.e. "how much time do you normally spend on cooking/cleaning/transportation/do-it-yourself-work..." etc. Generally, time diaries give better (more reliable) information on average time spent on different activities, but with larger standard errors, especially for non-frequent activities as home-repairs and do-it-yourself work. Whereas stylized time use surveys show smaller variance at the individual level, but with a tendency of less reliable averages. In particular, stylized time use questions may lead to a higher time use on sub-activities than diary-based surveys. In certain cases, stylized methods may yield a week with considerably more than 168 hours of activity reported. For an extensive discussion of methodological issues, see Juster and Stafford (1991). In the 1990'es, much effort was put into developing unified methods at the European level. These methods have been implemented in more recent time use surveys. Bonke (2005) provides a discussion on drawbacks and advantages of diary and questionnaire techniques applied in a recent Danish time survey from 2001.

Time allocation data have served two main research purposes. At the macro level, time data have been used in social accounting systems. A large part of production takes

place outside the market, and the output of this production is therefore not priced in the market. Often there are no accounts of this production. Or the production is measured by its input, i.e. time spent in activities outside the market. The size of the non-market sector, i.e. home production, "black" labour market activities etc. varies across countries. As there are large cross-country differences on activities belonging to the market versus home production or the informal economy, studies attempting to measure and compare economic output and welfare across countries have tried to incorporate measures of production in all sectors. This aspect is particularly important when comparing industrialized versus developing countries. Thus, attempts to perform "satellite accounts" related to the formal national account systems have been performed in a number of countries.

At the micro level, time use data are increasingly used to describe and model household behaviour. Many of the earlier studies are of a descriptive nature. Juster and Stafford (1991) provide a survey of studies before 1990. In the last decade, a number of micro based studies on household time allocation have emerged. A recent survey is provided by Apps (2003). Hamermesh and Pfann (2005) underline the importance of more economic analysis of time use and emphasize that economists can contribute in describing individual allocation of time.

Becker (1965) made an important contribution to consumption theory by underlining the role of time in *consumption* of goods and services. For example, consuming a meal is not valued only as food expenditure, one has to add the value of the time spent consuming the meal. Likewise, the utility of going to the theatre is not merely the price of the theatre tickets, but also the time spent enjoying the play.

Gronau (1977, 1980, 1986) emphasized the need to deal more explicitly with time as an input in the *production* of goods and services consumed in the household than it had been done previously. Gronau developed the classical household production model which is a cornerstone in household production theory. Gronau's model provides an essential contribution by explicitly accounting for housework in a household production model. Much of the work in this thesis builds on Gronau's household production model.

## **Chapter 1: Household Production in the Family – Work or Pleasure?**

The classical household production model assumes that the household acts as one decision-making unit when it comes to decisions on consumption, allocation of time etc., i.e. a so-called "unitary" model. The unitary model is important as it sets the scene for analysing the important trade-offs between time spent in different activities. More recent extensions to the classical household production model have focused on possible recreational pleasures of performing household production, see Graham and Greene

(1984) and Kooreman and Kerkhofs (2003). Chapter 1 builds on the classical household production model and discusses the possible extensions related to benefits of household production beyond the “market” value of the household product. The extra utility may be in the form of leisure which is (primarily) enjoyed by the person undertaking the activity. We name these “activity benefits”. Examples of this include childcare, gardening and do-it-yourself projects. Chapter 1 applies a household production model which explicitly incorporates “activity benefits” in the joint allocation of time for husband and wife. The model is tested empirically on data from a Danish time use survey from 2001 which has information on time spent in household production for both partners in some 600 Danish households. The model is analyzed in two different estimation frameworks: the General Method of Moments for a system of equations (GMM 3SLS) and Full Information Maximum Likelihood (FIML), and we conclude that GMM is the most appropriate estimation tool. Thus, the paper suggests a more flexible estimation framework than used previously. There is no significant evidence of “activity benefits” for men in household production, but there are some weak signs of the presence of such extra benefits for women. The paper contributes to the existing literature on household production by providing an extensive discussion of the identification issues involved. One important problem is that the benefits we identify are not necessarily related to the household production *activity*, i.e. “activity benefits”, but could just as well be due to the fact that households may attach extra *value* to goods produced by themselves rather than by someone else. We call these “consumption benefits”. We illustrate that the outcome of “activity benefits” and “consumption benefits” may be observationally equivalent.

## **Chapter 2: Spending Time and Money within the Household**

In the last 15 years, there has been growing focus on the fact that households do not necessarily maximize one common utility function. More plausibly, the household members each have separate utility functions. This idea has led to a number of different approaches to intra-household decision making; see Browning, Chiappori and Lechene (2005) for references. One particularly popular approach is to assume that, however decisions are made, the outcome is always Pareto-efficient, see Chiappori (1988), Apps and Rees (1988) and Browning and Chiappori (1998). This assumption is central in the “collective” model where the distribution of “power” within the household is an important factor in determining intra-household allocation.

Chapter 2, which is a joint paper with Martin Browning, sets out to compare the predictions on household allocation in a unitary versus a collective setting. We argue in the paper that a full picture of the intra-household distribution of material well-being

requires information on the allocation of both time and expenditure. The research question we address in the paper is illustrated by the following example. Consider a household comprising of a married couple in which the wife works more (in the home and in the market) as compared to other women with similar characteristics, wage of husband and wife and household financial situation. If we observe that she receives more goods than we would predict, then we could attribute the observation to her having a high taste for goods relative to leisure. This explanation is fully consistent with the unitary model. If, on the other hand, she also receives fewer goods, then it looks as though she lacks “power” in the household, which is an indication of the collective framework being a better description of household decision making. We develop a theoretical framework for this problem and present an empirical analysis based on the Danish time use survey from 2001. The Danish time use survey is unique in having both time use data and information on the intra-household allocation of goods *for the same households*. Our results provide evidence in favour of the collective model being the most appropriate framework for describing the intra-household allocation of time and goods.

### **Chapter 3: Ageing and Well-being: Consumption and Time Use of Elderly Americans**

Chapter 3 and 4 further explore the importance of observing both time use and expenditure when measuring household well-being. This is particularly important when comparing welfare across individuals in different life stages. Chapter 3 and chapter 4 use data from the Consumption and Mail Activities Survey (CAMS, which is part of the US Health and Retirement Study, HRS) to study trends in consumption and time use around retirement in the US.

The main objective of chapter 3 is to study how the value of time spent in household production and leisure affects economic well-being. Based on the 2003 Consumption and Mail Activities Survey (CAMS), we observe that the level of expenditure is lower for non-retired people, while levels of housework and leisure are higher. Expenditure and housework are decreasing with age, while leisure is increasing with age for both groups. Inequality in expenditure is higher for the group of retired households as compared to the group of non-retired households. However, while the elderly and retired seem to be less well off in terms of consumption goods bought in the market, they are generally “richer” in terms of time for household production or leisure. Thus, broadening our concept of economic well-being to include first the value of household production and secondly the value of leisure reduces economic inequality among the elderly.



## **Chapter 4: Heterogeneity in Preferences and Productivity – Implications for Retirement**

Several studies identify a fall in expenditure around retirement which seems difficult to explain in the context of the standard lifecycle model. Chapter 4 discusses the determinants of the retirement decision and the implications of retirement on economic well-being. The main contribution of the paper is to formulate the role of individual heterogeneity explicitly. There may be individual heterogeneity in 1) Productivity of market work versus housework, 2) Preferences for leisure versus consumption, 3) Marginal utility of wealth. We argue that unobserved heterogeneity in preferences, productivity and the marginal utility of wealth is correlated with the retirement decision.

Data from CAMS for 2001 and 2003 are applied to study the differences in individual choices of expenditure, household production and leisure over age and across the groups of retired versus non-retired. The unobserved individual heterogeneity factor is isolated by comparing cross-sectional evidence and panel data estimates of the effects of retirement on consumption and time allocation. Based on cross-section data, we can identify a lower consumption for the retired, but when we exploit the panel nature of the data, the negative effect of retirement on consumption is smaller and insignificant. Moreover, the analysis points to a large positive effect of retirement on household production. Our results contribute to the discussion of the so-called retirement-consumption puzzle which has most often been analyzed with cross-section or pseudo-panel data.

Many analyses of the retirement-consumption drop assume that the retirement decision is exogenous. However, many people probably partly base their decision on when to retire on the expected changes in consumption and time allocation. This suggests that the retirement decision is endogenous. To test this, we apply an instrumental variables methods in the treatment effects tradition.

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# **Chapter 1**

## **Household Production in the Family – Work or Pleasure?**

# Household Production in the Family – Work or Pleasure?

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## Abstract

According to the classical household production model, an individual decides how much time to spend in household production based on the shadow price of his/her time spent in the labour market. This prediction has sometimes been criticized based on the reflection that some housework activities provide extra benefits beyond the consumption value of household production. The extra utility may be in the form of leisure which is (primarily) enjoyed by the person undertaking the activity, so-called “activity benefits”. Examples of this include childcare, gardening and do-it-yourself projects. This paper investigates the question of what is work and what is pleasure in household production. We apply a household production model which explicitly incorporates “activity benefits” to model the joint allocation of time for husband and wife. The model is tested on data from a Danish time use survey from 2001 which has information on time spent in household production for both partners in some 600 Danish households. On the empirical side, the paper suggests using a GMM 3SLS estimator instead of the more restrictive Full Information Maximum Likelihood (FIML) estimator which has been used in previous empirical studies. We do not find significant evidence of “activity benefits” for men in household production, but we do find some weak signs of the presence of such extra benefits for women. The paper provides an extensive discussion of the identification issues involved. One important problem is that the benefits identified are not necessarily related to the household production *activity*, but might just as well be due to the fact that households may attach extra value to goods produced by themselves rather than by someone else, i.e. “consumption benefits”. We show that the outcome of “activity benefits” and “consumption benefits” may be observationally equivalent.

Keywords: Household production, GMM, FIML

JEL classification: C3, D1, J1, J2

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# 1 Introduction

According to the classical household production model, an individual decides on how much time to spend in household production based on the shadow price of his/her time spent in the labour market. Thus, household members derive utility from consuming the output of household production. Implicitly, this implies that home produced goods are perfect substitutes for market goods. The output of household production is usually thought of as a public good.

An important consideration when debating what determines individual allocation of time between the market and household production is the idea that some housework activities may provide extra benefits beyond their consumption value.<sup>1</sup> One obvious example is childcare. The time spent caring for one's children contributes to household production, but (usually) parents also derive utility from spending time with their children. Other examples include do-it-yourself spells, gardening etc. which some people may partially consider as leisure activities. The discussion underlines that it is difficult to draw a line between what is housework and what is leisure.

In general, it is widely recognized that people like to work. Beside the pure income/production side, work is perceived as giving pleasure, self esteem and a feeling of identity - in short, utility - to people. For example, in the Swedish HUS study of 1984 and 1993, respondents were asked to state how enjoyable they found various activities on a scale from 0-10, cf. Hallberg and Klevmarken (2003). The answers to these questions indicate that playing with one's own children and being in charge of one's children produced the highest enjoyment for both men and women measured on the popularity scale (around 8), closely followed by market work (around 7). Making dinner or repair and maintenance tasks were given a 6 on the scale, whereas cleaning the house got the lowest scores (around 3-4) among all activities.<sup>2</sup> This concept has been named "process benefits" (Juster, 1985) or "joint production" (Graham and Green, 1984, Kerkhofs and Kooreman, 2003). In this paper, we will choose an alternative name, "activity benefits", for the phenomenon. Activity benefits are close substitutes to leisure and are therefore predominantly a private good enjoyed by the person undertaking the activity.

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<sup>1</sup> In this paper, we use the term "housework" for all types of activities that lead to a higher household product, including do-it-yourself work, gardening, child care etc.

<sup>2</sup> An indication of the fact that different types of work differ in popularity for individuals is people's purchases of household services which they are unwilling to do themselves - e.g. cleaning - at an hourly pay which is sometimes higher than their own after-tax hourly wage. Part of the explanation for this phenomenon is differences in productivity between individuals doing housework in their own homes and professionals. However, in low-productivity jobs like cleaning, differences in productivity between professional cleaning assistants and individuals cleaning their own house will hardly explain why people tend to buy cleaning in the market.

A supplementary - or alternative – explanation for why households may choose a higher level of household production than what is suggested by the classical household production model is that households may attach a higher value to goods produced by one of the household members rather than to similar goods bought in the market. In this sense, the value of home produced goods is not comparable across households. Some households may have a higher preference for home-made goods than others, and these preferences may also diverge within the household. For example, the household may attach a higher value to spending leisure time with children whom they have raised themselves. The higher value of home made goods may also be due to the household members possessing skills that are specific to housework in their own house. While the effect of a higher value of home-made goods may be difficult to distinguish empirically from the “activity benefits” above, they are inherently different since this extra utility from home production may be enjoyed by either of the spouses independently on who did the housework. We shall refer to these benefits as “consumption benefits” in the following. We illustrate in the paper that household production outcomes with “activity benefits” and with “consumption benefits” respectively may be observationally equivalent. This raises an important identification issue.

This paper investigates the question of what is work and what is pleasure in household production. The theoretical setup builds on a model by Kerkhofs and Kooreman (2003) which explicitly includes “activity benefits”. The model is an extension of Gronau’s classical model (Gronau, 1977, 1980, 1986). The model is tested empirically on a time use dataset of Danish households in 2001. We estimate our two-equation model using a GMM 3SLS estimator, and we compare the results with the results found using a FIML estimator which was used in Kerkhofs and Kooreman (2003). Given our data, we find that the residuals are not normally distributed and consequently FIML is an inconsistent estimator under the assumption of normality. Provided correct moment conditions and without any assumptions about the functional form for the error terms, GMM 3SLS is consistent and efficient. Thus, the paper contributes by suggesting a less restrictive estimation method than previous analyses in this field.

For the model without “activity benefits” in household production, we find complementarity between housework of husband and wife. We find no significant evidence of activity benefits for men, but we do see a weak sign of the presence of activity benefits for women (p-value=0.12). We also illustrate that the model may be able to establish the *presence* of activity benefits, but the model is not convincing in identifying the actual *size* of these benefits. We discuss the interpretation and the identification issues related to the results, in particular under what circumstances we are able to distinguish “activity benefits” from “consumption benefits” in the results.

## 2 Theoretical model

In classical economic theory, households maximize utility over a bundle of goods purchased in the market subject to a budget constraint. Becker (1965, 1994) developed this framework by assuming that households combine time and market goods to consume some basic commodities that directly enter their utility functions. For example, consuming a meal is not valued only as the costs of buying food; one has to add the value of the time spent consuming the meal. Likewise, the utility of going to the theatre is not merely the price of the theatre tickets, but also the time spent enjoying the play.

Gronau (1977) developed the classical household production model which is a cornerstone in household production theory. The model provides an essential development of Becker's framework by explicitly accounting for household production. According to Gronau, "An intuitive distinction between work at home (i.e., home production time) and leisure (i.e., home consumption time) is that work at home (like work in the market) is something one would rather have somebody else do for one (if the cost was low enough), while it would be almost impossible to enjoy leisure through a surrogate. Thus, one regards work at home as time use that generates services which have a close substitute in the market, while leisure has only poor market substitutes." Essential assumptions in Gronau's model are that home produced goods are perfect substitutes for market goods and that home production is subject to diminishing marginal productivity. Often, diminishing marginal productivity is thought to be due to fatigue or changes in input proportions. In Gronau's model, diminishing marginal productivity is also due to the fact that as an individual increases housework, the composition of housework changes as he/she undertakes more activities with cheap market substitutes.

Gronau's central assumption of perfect substitutability between home-produced commodities and market goods has been the subject of some discussion. One point of criticism is that people do not always spend their time exclusively on one activity at a time, see e.g. Pollak and Wachter (1975). On the contrary, it will often be the case that part of the time people spend on housework can partly be considered as leisure. This observation is the background for Graham and Green's (1984) extension of Gronau's model where they introduce so-called "joint production" which they define as housework also partly being leisure. Implicitly, this extension modifies the strong assumption of perfect substitutability between market goods and home products. Graham and Green (1984) use the American Panel Study of Income Dynamics (PSID) and find substantial "jointness" between home production time and leisure.

Kerkhofs and Kooreman (2003) continue the development of a household production model which explicitly deals with the problem of household activities which are partly work, partly leisure activities. Kerkhofs and Kooreman (K&K) build on Graham and Green's idea of "joint production", but employ a different specification of the household production function. Their empirical application is based on Swedish time-allocation



data from the 1984 wave of the HUS survey. K&K look at both single and two-person households.

This paper uses the K&K model as a starting point. The analysis concentrates on households with two adult members. We assume that the household members share one common utility function, i.e. a unitary utility function. In the classical Gronau household production model, households derive utility from the consumption of market goods,  $X_M$ , commodities produced at home,  $Z$ , and leisure for the man and the woman,  $l_m$  and  $l_f$ . As in the classical Gronau model, it is assumed that market goods and goods produced in the household are perfect substitutes.

$$U = U(X_M + Z, l_m, l_f) \quad (1)$$

Household production,  $Z$ , is a function of time spent in housework,  $h_m$  and  $h_f$ , for male and female respectively, and auxiliary inputs,  $X_Z$ . For example,  $Z$  could be a meal produced with time inputs of the man and/or the woman,  $h_m$  and  $h_f$ , and intermediate inputs as food products,  $X_Z$ :

$$Z = Z(h_m, h_f, X_Z) \quad (2)$$

The household budget consists of non-labour income,  $y$ , and labour income, where  $w_m$  and  $w_f$  are hourly wages, and  $m_m$  and  $m_f$  are market labour supply in hours, for male and female respectively. This gives the following budget constraint:

$$X_M + X_Z = y + w_m m_m + w_f m_f \quad (3)$$

It is assumed that both partners participate in the labour force. This assumption ensures that we have observations on individual wages. Evidently, this assumption also entails the risk of selecting households with both spouses having a relatively high productivity in the market and/or low productivity in household production. Thus, individuals with high productivity at home could be *underrepresented* in the sample. On the other hand, productivity at home and in the market might be positively correlated through various (observed as well as unobserved) characteristics that affect both productivities in the same direction, suggesting that individuals with high productivity are *overrepresented* in the sample. It is difficult to determine the net direction of the selection bias in advance. We return to the discussion of selection problems in section 5, but note that our results apply for the large group of households where both spouses are in full-time employment.

Each member of the household has a personal time constraint.  $T$  is total time endowment (e.g. 24 hours on a daily basis).

$$h_i + l_i + m_i = T, \quad i = m, f \quad (4)$$

The household maximizes utility (1) subject to (2), (3) and (4), giving the following Kuhn-Tucker conditions:

$$\begin{aligned}
\frac{\partial Z}{\partial X_z} &= 1 \\
\frac{\partial U}{\partial Z} \frac{\partial Z}{\partial h_m} &= \frac{\partial U}{\partial l_m} = \frac{\partial U}{\partial Z} \frac{\partial Z}{\partial X_z} w_m + \xi_m \\
\frac{\partial U}{\partial Z} \frac{\partial Z}{\partial h_f} &= \frac{\partial U}{\partial l_f} = \frac{\partial U}{\partial Z} \frac{\partial Z}{\partial X_z} w_f + \xi_f
\end{aligned} \tag{5}$$

where  $\xi_m$  and  $\xi_f$  denote shadow prices of the inequality constraints on labour time. If both partners participate in the labour force ( $m_m > 0$ ,  $m_f > 0$  and  $\xi_m = \xi_f = 0$ ), then we will find an interior solution, and (5) simplifies into:

$$\begin{aligned}
\partial Z / \partial X_z &= 1 \\
\partial Z / \partial h_m &= w_m \\
\partial Z / \partial h_f &= w_f
\end{aligned} \tag{6}$$

The optimum can be viewed as the result of a two-stage decision process. In the first stage, the household decides on its requested level of household production. In the second stage, the household decides how to allocate non-production time and the purchase of consumption goods. Therefore, the household production model can be analysed only with the help of the production function, whereas the utility function does not appear until in the second stage of the decision process. It is a both necessary and sufficient condition that the production function  $Z$  is strictly concave to ensure a local maximum. The conditions in (6) are referred to as the so-called dichotomy in Kerkhofs and Kooreman (2003). For the dichotomy property to hold, it is important that the net marginal wage rate is exogenous. Moreover, the model does not take labour supply decisions into account. Thus, the model takes the non-random sub-sample of two-earner households as given. We would need to specify a utility function if we were to develop a full structural model including an endogenous labour supply choice.

The interpretation of (6) is that an individual will choose a level of housework where her marginal product of time equals her wage rate in the market. If the marginal product of housework is lower than her wage rate, she will choose to work more in the market (and perhaps buy household production in the market). The model predictions in (6) correspond to the classical household production model where the “activity benefits”, i.e. the utility in the form of leisure value to the person performing the activity, are zero.

In the following, we include the possibility of “activity benefits” in the model. Thus, we allow for the possibility that undertaking housework can both enhance household production and function as a sort of recreation activity for the person doing the work. For example, garden work provides utility through two channels: First, it enhances the household product,  $Z$ , which can be enjoyed by both partners in the household. Secondly, it may be seen as a sort of leisure activity for the person who works in the garden. This feature is included in the model in the following way: If a person spends  $h_i$  hours on home production, he or she considers a certain part of this time,  $g_i(h_i)$ , as a perfect substitute for leisure. The activity benefit function  $g_i$  is increasing, twice

differentiable and concave in  $h_i$ ,  $g_i' \leq 1$  and  $g_i' \rightarrow 0$  as  $h_i \rightarrow T$ , meaning that the marginal utility of housework is decreasing in  $h$  (see figure 1).

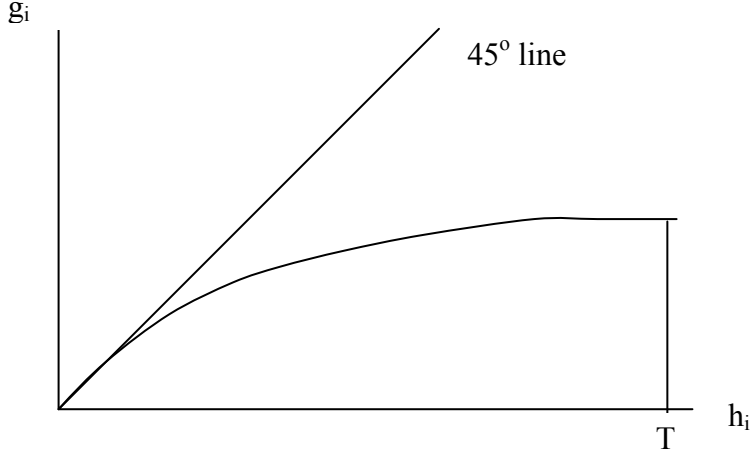


Figure 1: Activity benefit function for individual  $i$

Introducing activity benefits, we get the following extended utility function for the household:

$$U = U(X_M + Z, l_m + g_m(h_m), l_f + g_f(h_f)) \quad (7)$$

In this setting, the dichotomy property still holds. The partial optimization problem for household production changes into:

$$\max_{0 \leq h_m, h_f \leq T; X_Z \geq 0} Z(h_m, h_f, X_Z) + w_m g_m(h_m) + w_f g_f(h_f) - w_m h_m - w_f h_f - X_Z \quad (8)$$

And the first-order conditions are then:

$$\begin{aligned} \partial Z / \partial X_Z &= 1 \\ \partial Z / \partial h_m &= w_m (1 - g_m'(h_m)) \\ \partial Z / \partial h_f &= w_f (1 - g_f'(h_f)) \end{aligned} \quad (9)$$

Compared to the predictions in (6), we see that with the inclusion of activity benefits, the individual members of the household will choose a housework level where the marginal product of their housework equals their wage rate corrected for the part of individual housework activity which is perceived as leisure. By taking account of activity benefits, we achieve an explanation of why the chosen level of individual housework is sometimes higher than what the traditional labour supply model would predict. This is illustrated in figure 2 below. Individual  $i$ 's hourly wage rate is  $w_i$ . Household production  $Z$  is an increasing function of  $i$ 's work in household production,  $h_i$ , and the marginal product of  $h_i$  is decreasing with  $h_i$ . According to the classical household production model, person  $i$  will choose to increase her work in household production until the point,  $h_i^*$ , where her marginal product in household production is

equal to her wage rate,  $\partial Z / \partial h_i = w_i$ . However, for given wage  $w_i$  and given marginal production in household production,  $\partial Z / \partial h_i$ , we may observe that she works more in the household than the classical household production model would predict. If we observe that she works  $h_i^{**}$  hours in the household, where  $h_i^{**} > h_i^*$ , we may interpret the difference between  $h_i^{**}$  and  $h_i^*$  as a consequence of her deriving utility in the form of leisure from performing the housework. We may therefore identify the extent of this extra utility – activity benefits – from observations on her wage and her household production.

If  $Z$  is strictly concave, we still have a unique solution (a local maximum). However, strict concavity of  $Z$  in  $h_m$  and  $h_f$  is a sufficient condition, but it is no longer a necessary condition, as both the left-hand and the right-hand side of the first-order conditions change when  $h_m$  or  $h_f$  changes. Thus, (7) allows for increasing returns to scale in household production provided the curvature of the  $g_i$ -function is sufficiently high. To formulate this more intuitively, we can find a solution to the optimization problem with increasing returns to scale if the dis-utility of performing housework rises fast enough when  $h_i$  increases to ensure that the combined utility of consuming and performing household production for each individual has a local optimum.

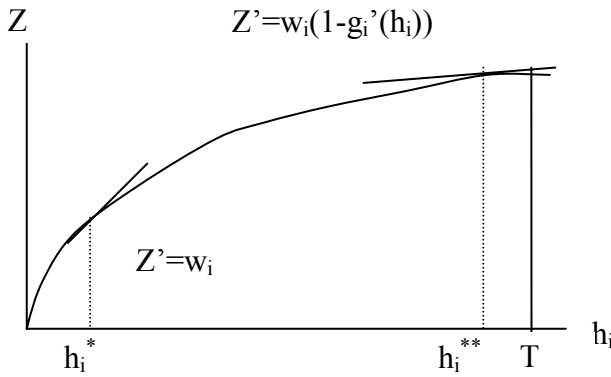


Figure 2: Household production as a function of input of time,  $h_i$

## Identification

Usually, we observe neither the *output* of home production,  $Z$ , nor the input of auxiliary goods,  $X_Z$ . The amount of household production therefore has to be based on information about the input of time in household production, and identification of the model is based on the first-order conditions. This poses a number of identification questions.

An important identification problem which has not been given much attention in the literature on household production models relates to the character of the “extra” benefits in household production. As discussed in the introduction to this paper, a higher household production than what the classical household production model predicts does not necessarily have to be ascribed to “activity benefits”. An alternative explanation may be that households attach a higher value to goods produced by one of the household members rather than similar goods bought in the market, and that the value the household puts on home-made goods is higher than the price they would get for them in the market. This higher value of household production may be due to several factors. Household members may have a higher preference for home-made goods. Or household members may possess household-specific skills which are important in the production of goods that they consume themselves; see Chiswick (1982) for a discussion of the value of a housewife’s time. In this sense, the value of home produced goods is not comparable across households. For example, both spouses in the household may attach a higher value to spending leisure time with children for whom one or both of them have cared themselves. These benefits are inherently different from the “activity benefits” described above since they may be enjoyed by either of the spouses irrespective of who did the housework. We name them “consumption benefits”. Thus, while the “activity benefits” through their leisure character are mainly private goods, “consumption benefits” are public goods. Some households may have a higher preference for home-made goods than others, and these preferences may also diverge within the household.

Figure 3 illustrates that household production with “activity benefits” and with “consumption benefits” respectively may be observationally equivalent. Assume we can observe the true value the household puts on their own household production,  $Z_{obs}$ . According to Gronau’s classical household production model, we expect person  $i$  to work  $h_i^*$  hours in the household. But we observe that she works  $h_i^{**}$ . As we argued above, the higher input of housework may be due to “activity benefits”, i.e. the pleasure of undertaking household production activities. Since household production generates this extra, leisure-like benefit, she is willing to increase her housework to a point where her marginal product of household production is lower than her wage rate.

Usually, we can not observe the value of household production, but the household can. Suppose we think that the value of household production is  $Z_{obs}$  and again, we expect  $h_i^*$  where  $\frac{\partial Z_{obs}}{\partial h_i} = w_i$ . However, the household attaches an additional value to consuming home-made products, i.e. “consumption benefits”, so  $Z = Z_{hh}$ . Suppose individual  $i$  does not particularly enjoy working in the house, so there are no activity benefits. She therefore chooses her optimal housework where  $\frac{\partial Z_{hh}}{\partial h_i} = w_i$ . In our example, this corresponds to an optimal housework of  $h_i^{**}$ . We therefore see that the two cases with “activity benefits” and “consumption benefits”, respectively, may be

observationally equivalent. This raises an important identification issue which we shall return to in the empirical part of the paper.

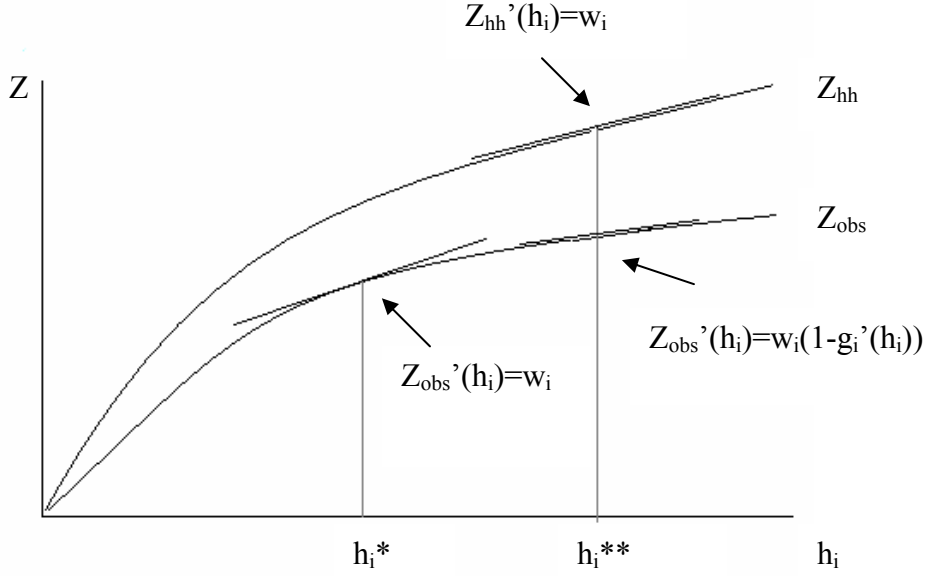


Figure 3: Identification in household production model

A number of additional identification issues may arise. These have already been thoroughly discussed in Kerkhofs and Kooreman (2003), and we shall only refer the main points from this discussion. First, we only observe allocations which are optimal for input vectors  $(w_m, w_f, y)$ . Non-labour income,  $y$ , influences labour supply, but since we only observe households where both spouses have a paid job, we assume that we can identify unique optimal allocations  $(h_m^*, h_f^*, X_Z^*)$  based on observations of  $(w_m, w_f)$ .

Secondly, since  $X_Z$  is not observed, we have to formulate our first-order conditions in terms of the *net* product value function,  $\tilde{Z}(h_m, h_f)$ , where:

$$\tilde{Z}(h_m, h_f) \equiv \max_{X_Z \geq 0} Z(h_m, h_f, X_Z) - X_Z \quad (10)$$

Values of  $X_Z$  that could be in agreement with a maximization of the net product  $\tilde{Z}(h_m, h_f)$  would also have to satisfy the first of the first-order conditions in (9). It is assumed that (10) has a unique finite, non-zero solution for all pairs of  $(h_m, h_f)$ . It is therefore also assumed that  $\partial Z / \partial X_Z$  is continuously differentiable. A sufficient condition is that the marginal product of auxiliary goods is a strictly decreasing function

of  $X_Z$ , is greater than one for  $X_Z=0$ , and eventually falls below one when  $X_Z$  is increased for all  $(h_m, h_f)$ .

Another question is whether we can find different functional forms of the housework activity benefit specification with observationally equivalent outcomes in terms of housework, wages etc. Kerkhofs and Kooreman (2003) provide evidence that in general, the *presence* of activity benefits is identified. Moreover, if the activity benefit functions are restricted to some parametric function as e.g. the functional form chosen in section 4, it is generally also possible to establish the *magnitude* of the activity benefits for couples. K&K point out that in general, the model has limited power for identification of activity benefits in single earner households. In the following, we restrict the analysis to couples.

### 3 Data

The data are from the Danish Time Use Survey for 2001 (DTUS). The DTUS complies with methodologies developed at the EU level for conducting time use surveys; see Bonke (2005) for a detailed description. For married and cohabiting respondents, the partner in the household was also asked to participate in the survey. We have detailed information about time use of both spouses for a good 1700 couples. There are two sources of information on time use. First, each respondent filled in a diary stating their activities at a detailed level every 10 minutes in two 24-hour days, one a week-day and the other a weekend day. Second, the questionnaire asked the respondents about their “usual” time use. The questionnaire also contained questions about personal and household characteristics. This background information is combined with information from register (administrative) information from Denmark's Statistics on the respondent and partner, giving access to further personal and household information. The wage measure used in this paper is from the register data and is therefore not directly linked to the information given in the time use survey.

As mentioned, as well as keeping a time diary, respondents were asked about the time they normally spend on housework and in the labour market in a typical week. Housework time includes normal housework such as cleaning, laundry, shopping, cooking etc. and gardening, repairs, other do-it-yourself work and child care. As always the classification of child care as housework is difficult, as discussed above. Since respondents were only asked one question on usual housework, we cannot break out child care separately.

In general, it is observed that surveys asking about normal time use have a smaller variance, but perhaps a more imprecise mean of time use, while diary information gives more precise means, but with a larger variance, see Juster and Stafford (1991). We have

chosen to use normal time use rather than the diary information to avoid the very serious infrequency problems in the latter.

Table 1 shows the time spent in household production for couples, broken down by the work status of the two partners. We define full-time market work to be at least 30 hours per week, including commuting time. Thus a respondent may be unemployed in the survey week and still report more than 30 hours per week of market work. Part-time work is not very prevalent in Denmark so that “not full-time” generally means “out of the labour force” (particularly for men). The “neither full-time” group is mostly made up of older, presumably retired, couples. Table 1 shows familiar patterns with men doing less housework than women who have the same work status. One should also note that there is a wide within category dispersion in household production, as shown by the standard deviations.

|                    | Male household production,<br>minutes/day |      |        | Female household production,<br>minutes/day |       |        |
|--------------------|---|------|--------|---|-------|--------|
|                    | Mean                                      | Std. | Median | Mean  | Std.  | Median |
| Both<br>(#=804)    | 93.2                                      | 65.1 | 85.7   | 134.0                                       | 74.8  | 128.6  |
| Female<br>(#=112)  | 118.5                                     | 80.9 | 85.7   | 111.9                                       | 65.8  | 90.0   |
| Male<br>(#=342)    | 80.6                                      | 58.6 | 68.6   | 155.7                                       | 100.8 | 128.6  |
| Neither<br>(#=343) | 109.8                                     | 92.6 | 85.7   | 161.7                                       | 100.6 | 128.6  |

Table 1: Household production and labour market status (full-time or not)

In the following, we focus on the sample of households in which *both* husband and wife work full-time in the labour market. The load of housework (including child care) for full-time couples naturally depends on the number and ages of children within the household. Table 2 presents time use broken down by child status for the full-time households. We see that the load of housework increases with the number of children, also when we condition on both partners being in full-time work.



|                        | Male household production,<br>minutes/day |      |        | Female household production,<br>minutes/day |       |        |
|------------------------|---|------|--------|---|-------|--------|
|                        | Mean                                      | Std. | Median | Mean  | Std.  | Median |
| No children<br>(#=349) | 80.5                                      | 54.9 | 68.6   | 116.6                                       | 65.1  | 102.9  |
| 1 child<br>(#=180)     | 90.8                                      | 63.6 | 85.7   | 128.0                                       | 63.4  | 120.0  |
| 2 children<br>(#=207)  | 104.8                                     | 64.5 | 85.7   | 150.7                                       | 68.6  | 128.6  |
| 3+<br>(#=68)           | 129.7                                     | 94.3 | 111.4  | 187.6                                       | 120.1 | 171.4  |

Table 2: Household production and number of children

The determination of household production based on the wage rate is central in the theoretical model. When a person decides how much time to allocate to housework, the shadow price of time is obviously the wage rate *net* of taxes on labour. In the data, we only have information on the gross wage rate. To arrive at a very crude estimate of net wages, we performed a simple imputation of individual marginal tax rates.<sup>3</sup> In our estimation of the model, we present results with both the imputed net wage and the gross wage rate.

Figure 4 shows the distribution of housework and wages for men and women. Out of the sample of full-time employed people, we have information on wage rates for both husband and wife for 629 couples. This is the dataset used in the econometric estimations below. For both men and women, the correlation between housework (in hours per day) and wages (in kroner per hour) is small and negative. For men, the OLS-estimate from regressing housework on net wage is -0.0014 (t-value is -0.73) which is not significant. For women, the OLS-estimate is -0.012 (t-value is -3.35), which implies that for two randomly selected women with a difference in hourly wage of 10 kroner, the woman with the highest wage rate will work approximately 7 minutes less in the house per day. This is without controlling for any individual or household characteristics.

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<sup>3</sup> The imputation of the marginal tax rate was based on the gross wage for a person who works full-time for the whole year. Details are given in the Appendix. We also tried to calculate individual specific marginal tax rates based on register information about total gross income, but unfortunately our net wage rate estimates based on these imputed marginal tax rates seem to be very noisy and the relationship between gross and net wages seems somewhat difficult to explain.

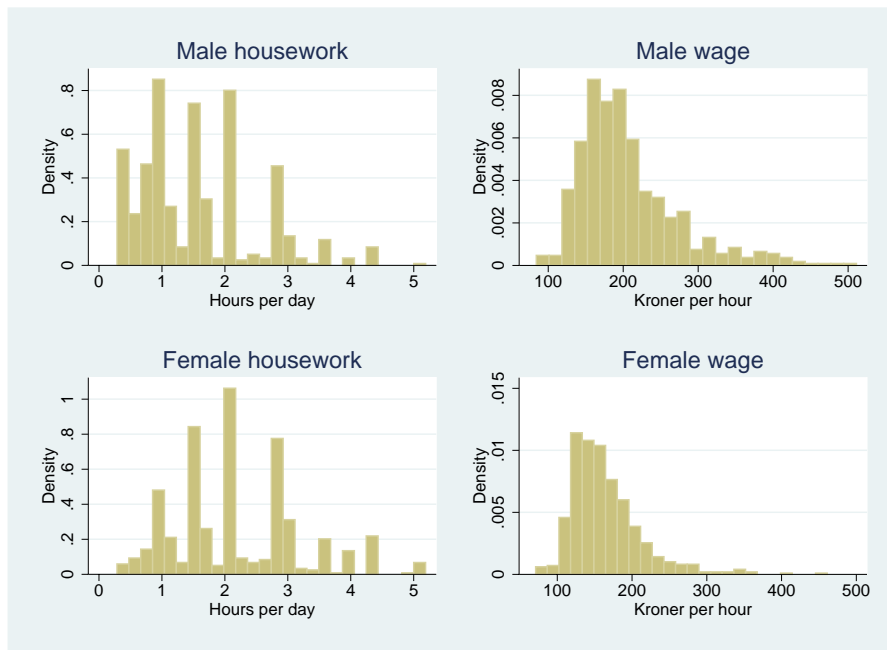


Figure 4: Housework and wages for men and women

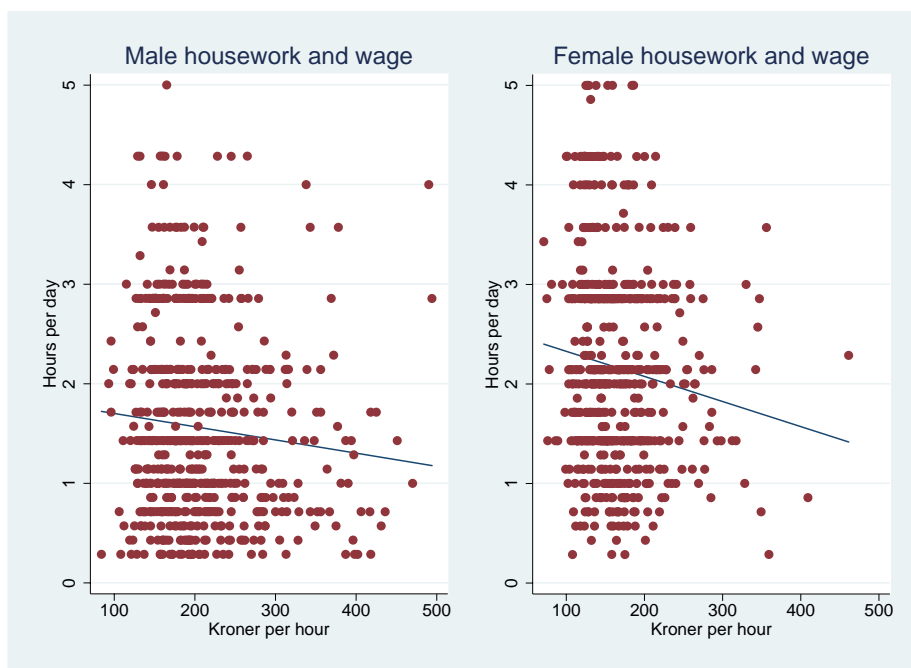


Figure 5: Housework and wages for men and women

Both household production and wage rates show a strong positive correlation for the two spouses in figure 6. This is probably partly due to positive assortative mating, i.e. the well-established observation that people seem to find a partner that looks very much

like themselves in terms of observable characteristics as background, age, education, wage rates etc. See Becker (1991) or Weiss (1997) for a discussion. The positive correlation in household production is also very likely to be due to the presence of children in the household (which is obviously strongly correlated between the partners).

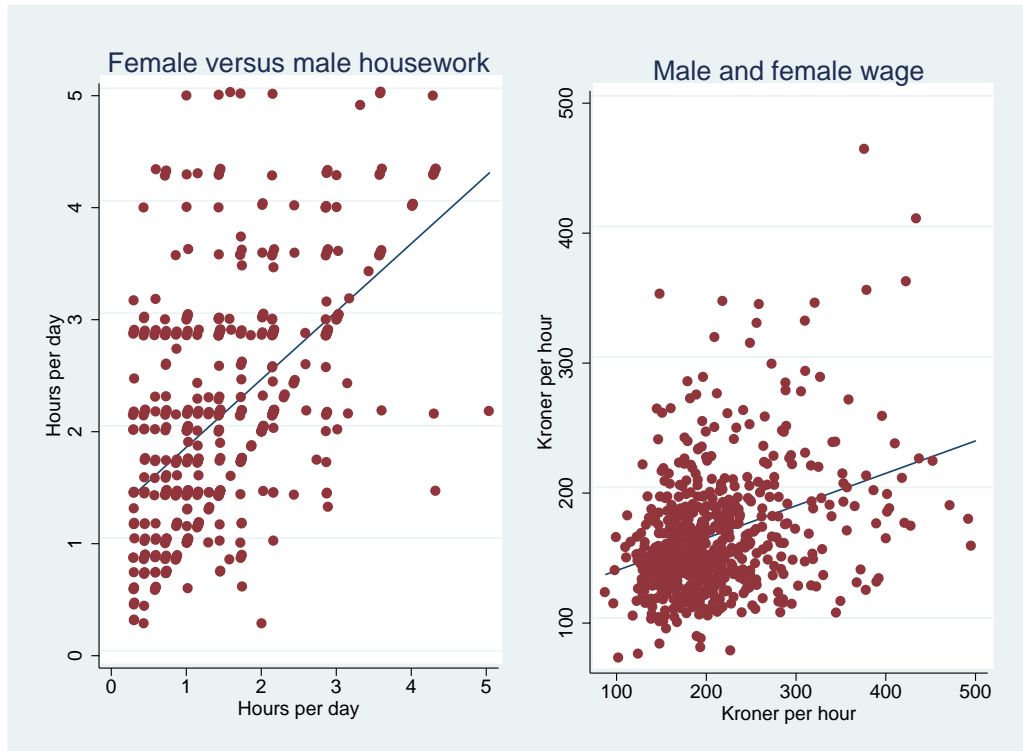


Figure 6: Intra-household correlation in household production and wages

Despite the strong correlation of housework within the family, we still find that women do the majority of the household production, see figure 7. On average, women do 59 percent of the housework, and the median wife does 58 percent of the housework. In 7 percent of the households, the woman does less than half of the housework. The wife takes on more than 75 percent of the housework in more than 11 percent of the households.

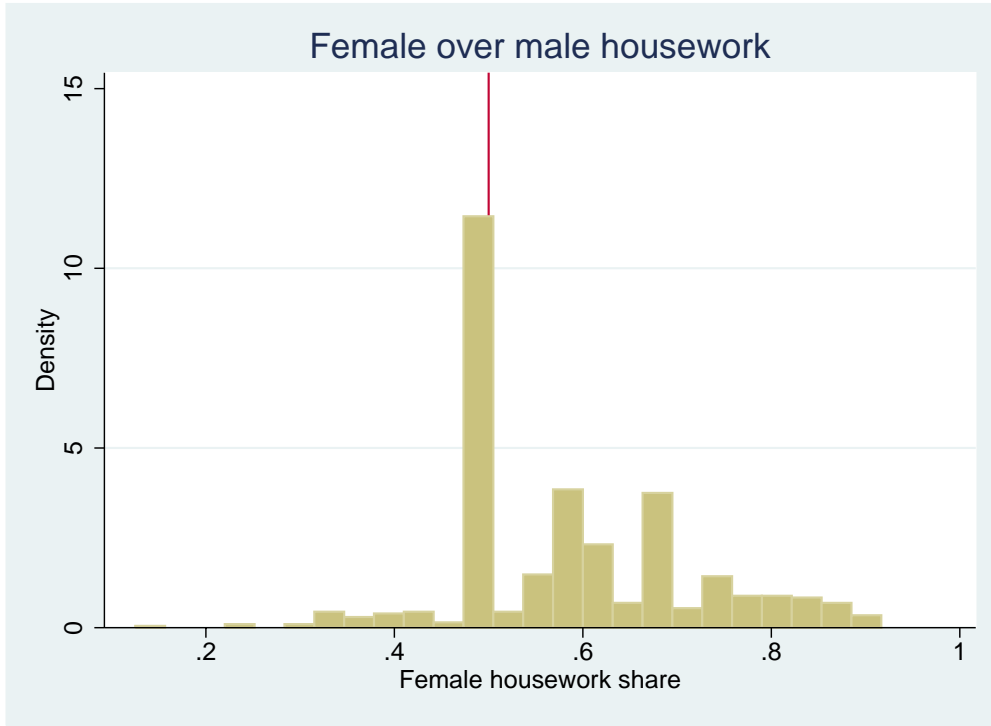


Figure 7: Female share of household production within the family

## 4 Econometric specification

In the following, we empirically investigate the theoretical first-order conditions (6) and (8). In the theoretical model, we assumed that household production is a function of housework time,  $h_m$  and  $h_f$ , and intermediate inputs into household production,  $X_Z$ . As discussed previously, time use surveys usually do not contain any measure of the output of household production, and due to the imperfect substitution possibilities of household production for comparable market goods it is difficult to find comparable market prices for the output from household production. Furthermore, as we have no information on auxiliary goods used in the production of household production,  $X_Z$ , we analyse the net product value function,  $\tilde{Z}$ , below instead of the (gross) production function found above:

$$\tilde{Z} = b_m h_m + b_f h_f + \frac{1}{2} c_{mm} h_m^2 + \frac{1}{2} c_{ff} h_f^2 + c_{mf} h_m h_f \quad (11)$$

$b_m$  and  $b_f$  are strictly positive. The C-matrix,  $C = \begin{pmatrix} c_{mm} & c_{mf} \\ c_{mf} & c_{ff} \end{pmatrix}$ , has to be negative definite to ensure a well-behaved production function. Housework of the two spouses,  $h_m$  and  $h_f$ , can be substitutes or complements; substitutes if  $c_{mf} < 0$  and complements if

$c_{mf} > 0$ . As mentioned above, we concentrate on households where both spouses are employed. First-order conditions (for employed people) when activity benefits are *not* accounted for are:

$$\begin{aligned}\partial \tilde{Z} / \partial h_m &= b_m + c_{mm} h_m + c_{mf} h_f = w_m \\ \partial \tilde{Z} / \partial h_f &= b_f + c_{ff} h_f + c_{mf} h_m = w_f\end{aligned}\quad (12)$$

And first-order conditions when we *do* take activity benefits into account are:

$$\begin{aligned}\partial \tilde{Z} / \partial h_m &= b_m + c_{mm} h_m + c_{mf} h_f = (1 - g_m'(h_m)) w_m \\ \partial \tilde{Z} / \partial h_f &= b_f + c_{ff} h_f + c_{mf} h_m = (1 - g_f'(h_f)) w_f\end{aligned}\quad (13)$$

Furthermore, we assume that individuals are heterogeneous in their marginal productivity of housework. Thus, we let  $b_m$  and  $b_f$  depend on household and individual specific characteristics captured in  $x_m$  and  $x_f$ , respectively:

$$\begin{aligned}\ln(b_m) &= x_m' \beta_m + u_m \\ \ln(b_f) &= x_f' \beta_f + u_f\end{aligned}\quad (14)$$

Therefore, the marginal productivity of housework time for a married man,  $h_m$ , depends on the parameters  $b_m$ ,  $c_{mm}$  and  $c_{mf}$  as well as the level of both his own and his wife's housework. Parallel for a married woman. The household chooses a level of household production time for wife and husband depending both on these factors as well as wages and utility of housework as reflected in the  $g$ -function.

For the model *without* activity benefits, the system of equations expressed in errors is:

$$\begin{aligned}u_m &= b_m - x_m' \beta_m = \ln(w_m - c_{mm} h_m - c_{mf} h_f) - x_m' \beta_m \\ u_f &= b_f - x_f' \beta_f = \ln(w_f - c_{mf} h_m - c_{ff} h_f) - x_f' \beta_f\end{aligned}\quad (15)$$

$w_m$ ,  $w_f$ ,  $x_m$ , and  $x_f$  are assumed to be exogenous. To estimate the model *with* activity benefits, we specify a specific functional form for the activity benefit function that captures the characteristics for  $g$  set out above. As in Kerkhofs and Kooreman (2003) and Graham and Greene (1984), we assume the following functional form for  $g$ :

$$g_i(h_i) = h_i \left( 1 - \frac{1}{1 + \delta_i} \left( \frac{h_i}{T} \right)^{\delta_i} \right), \quad i = m, f \quad (16)$$

Where  $\delta_m, \delta_f \geq 0$ . If  $\delta_m = \delta_f = 0$ , we are in the classical household production framework. As  $\delta_m, \delta_f \rightarrow \infty$ , all household production time is perceived as leisure. After differentiating  $g_i$  with respect to  $h_i$ , we arrive at a system of equations with activity benefits:

$$\begin{aligned}u_m &= \ln(b_m) - x_m' \beta_m = \ln((h_m / T)^{\delta_m} w_m - c_{mm} h_m - c_{mf} h_f) - x_m' \beta_m \\ u_f &= \ln(b_f) - x_f' \beta_f = \ln((h_f / T)^{\delta_f} w_f - c_{mf} h_m - c_{ff} h_f) - x_f' \beta_f\end{aligned}\quad (17)$$

## 5 Estimation and results

### 5.1 Classical household production model - no activity benefits

In this section, we concentrate on the classical household production model in (15). That is, we assume  $\delta_m = \delta_f = 0$ . Kerkhofs and Kooreman (2003) estimated this system by maximum likelihood, which is the efficient estimator if the error terms are joint normally distributed:

$$\begin{pmatrix} u_m \\ u_f \end{pmatrix} | x_m, x_f \sim N(0, \Sigma_{uu}) \quad (18)$$

We follow the specification of the non-linear likelihood function for a linear system of equations in a Full Information Maximum Likelihood model as can be found in Davidson and MacKinnon (1993, chapter 18). See appendix A2.

Normality of the error terms is often a strong assumption. Alternatively, we can apply the General Method of Moments (GMM) for systems, i.e. the GMM 3SLS estimator. The advantage of GMM 3SLS is that we obtain consistent estimates under much weaker assumptions, since we do not have to assume anything about the functional form of the distribution of the error terms. We use the efficient GMM estimator for a system of equations formulated in Wooldridge (2001, chapter 14). See appendix A3.

In estimating the system in (15), we use our imputed measures of net wages for the wage rates as net wages are the most correct measure for the shadow price of time. Results with the gross wages are shown in appendix 4. The individual and household characteristics captured in the X-matrices consist of individual age, individual education in years, dummies for homeownership, the presence of younger and older children and non-labour income. We can think of (15) as  $h_f$  being endogenous in the first equation and  $h_m$  being endogenous in the second equation. As instruments for female household production,  $h_f$ , we use her gross wage, her gross wage squared, her age, her age squared, and her education (measured through five education dummies). Thus, we assume that the error term in equation 1 is uncorrelated with these instruments. As instruments for male household production,  $h_m$ , in the second equation we use his gross wage, his gross wage squared, his age, his age squared and his education (measured through five education dummies). Our moment conditions are therefore constructed under the assumption that the error terms in equation 2 are uncorrelated with the instruments. The reason for using gross wages as instruments (rather than net wages as above) is that they have higher explanatory power of  $h_m$  and  $h_f$  and thus serve as stronger instruments. Both sets of instruments are jointly significant in explaining the variation in household production, although their explanatory power as measured by  $R^2$  is low (see appendix A3). On the other hand, these instruments make us accept the null hypothesis of the overidentifying

restrictions test that the instruments are uncorrelated with the error terms. More details about choice of instruments are given in appendix A3. The estimations results for GMM 3SLS and FIML are shown in table 3 below.

|                        | GMM 3SLS | t-value | FIML      | t-value |
|------------------------|----------|---------|-----------|---------|
| $c_{mm}$               | -272.116 | -2.15   | -643.542  | -1.52   |
| $c_{ff}$               | -88.629  | -3.53   | -1597.810 | -1.75   |
| $c_{mf}$               | 14.143   | 0.76    | -422.431  | -0.95   |
| <b>Male equation</b>   |          |         |           |         |
| Constant               | 5.322    | 8.78    | 7.159     | 7.99    |
| Age                    | 0.002    | 0.93    | 0.002     | 1.16    |
| Education, years       | 0.158    | 1.25    | 0.025     | 0.49    |
| Homeownership          | 0.120    | 1.91    | 0.166     | 3.26    |
| Dummy young children   | 0.218    | 3.92    | 0.200     | 4.54    |
| Dummy children 7-17    | 0.079    | 1.70    | 0.127     | 3.13    |
| Non labour income      | 0.004    | 0.32    | 0.020     | 1.72    |
| <b>Female equation</b> |          |         |           |         |
| Constant               | 5.670    | 17.10   | 8.340     | 15.66   |
| Age                    | 0.004    | 2.19    | 0.002     | 1.36    |
| Education, years       | -0.209   | -2.41   | -0.153    | -1.68   |
| Homeownership          | 0.115    | 2.87    | 0.180     | 3.60    |
| Dummy young children   | 0.161    | 4.29    | 0.203     | 4.60    |
| Dummy children 7-17    | 0.109    | 3.72    | 0.145     | 3.67    |
| Non labour income      | 0.022    | 2.75    | 0.028     | 2.55    |

Table 3: Estimation results for GMM 3SLS and FIML

Apart from the elements in the C-matrix, the two sets of estimates show similar characteristics. The signs and sizes of the coefficients estimated are of the same order of magnitude. Based on the residuals from the FIML estimation, we reject individual normality of the error terms (and therefore also joint normality).<sup>4</sup> Therefore FIML is inconsistent.<sup>5</sup> GMM 3SLS is consistent if the moment conditions apply. Moreover, in our case without normally distributed error terms, GMM 3SLS is efficient among

<sup>4</sup> Details on normality tests and histograms for the residuals from the FIML estimation can be found in appendix A.2.

<sup>5</sup> For normally distributed disturbances, GMM 3SLS has the same asymptotic distribution as the FIML estimator, which is in this case asymptotically efficient among all estimators, cf. Greene (2003, chapter 15). Moreover, Hausman (1975, 1983) shows that the FIML estimator is also an IV estimator.

estimators which rely only on moment conditions. In the rest of this paper, we apply GMM 3SLS when estimating the household production model.

The estimates of  $c_{mm}$  and  $c_{ff}$  are negative, as assumed, and significant. We find a positive (though insignificant) estimate of  $c_{mf}$  which is an indication of complementarity between housework of husband and wife. In this respect, our results deviate from Kerkhofs and Kooreman (2003) who found that male and female home-production are q-substitutes. The C-matrix is negative definite (the eigenvalues of the C-matrix are negative) which is in agreement with a well-behaved production function in the classical household production model.

## 5.2 Activity benefits – allowing for the pleasure of housework

In the previous section, it was assumed that there are no “activity benefits” in household production, i.e. that the activity benefit parameters,  $\delta_m = \delta_f = 0$ . In this section, we look at the consequences of allowing for activity benefits. We performed a grid search within a range of “reasonable” activity benefit parameters ( $\delta_m$  and  $\delta_f$  between 0 and 1.5). The GMM problem was difficult to solve for high values of  $\delta_f$  where  $b_f$  became negative for low observations of  $h_f$  or  $h_m$ . In order to obtain estimates in the grid search, we took out observations where  $h_f$  or  $h_m$  were less than 20 minutes per day. We therefore performed the activity benefit estimations with a subset of 596 observations as compared to the original dataset used above of 629 observations. The objective function for the GMM problem was consistently minimized in the region where  $\delta_m < \delta_f$ , and we found an optimum for  $\hat{\delta}_m = 0.7$  and  $\hat{\delta}_f = 1.3$ . We tested the joint significance of the estimates by using the GMM distance statistic, cf. Wooldridge (2001, chapter 8), which is  $\chi^2$  distributed with 2 degrees of freedom under the null hypothesis  $\delta_m = \delta_f = 0$ . We found that we cannot reject the null hypothesis that both parameters are equal to 0 at a p-value of 0.10. However, for  $\delta_m$  restricted to 0, we found an optimal value of  $\hat{\delta}_f = 0.8$  with a p-value of 0.12. We use this result to conclude that there is some evidence of the *presence* of activity benefits for women, although the *size* of activity benefits is poorly estimated since values for  $\delta_f$  within the range of 0.4 and upwards produce almost the same value of the objective function. See details of the tests in Appendix 5.

Inserting the parameter estimate of  $\hat{\delta}_f = 0.8$  into the  $g_i$ -function formulated in (14) and using the observation that the time spent in housework is around 10 percent of the total time for women, we find that on average the fraction of housework that is also



perceived as leisure is close to 90 percent. If we instead enter  $\hat{\delta}_f = 0.4$ , we find that on average around  $\frac{3}{4}$  of women's housework time is a substitute for leisure. This seems like an unlikely high leisure value of household production.

The result of the estimation with the value of  $\hat{\delta}_f = 0.8$  found by grid search is shown in the appendix table A3. The estimate of  $c_{ff}$  is negative but, as we discussed above, increasing returns to scale (positive  $c_{ff}$ ) is not necessarily a problem in the extended household production model that allows for activity benefits. What matters for the optimization is that the contribution of the second order derivative of the g-function (which is negative) is large enough to counteract the contribution of the positive second-order derivative of the Z-function, see appendix 6.

To conclude on the above, there is some evidence of activity benefits for women in our sample of full-time employed couples, but the estimates are imprecise and insignificant even at a 10 percent level. A natural question to ask is whether it is more likely to find activity benefits in households where a larger part of household production could be perceived as partly leisure. This could be the case for families with children where a relative high proportion of time use is child care. Out of the 629 full-time couples used in this analysis, 370 families had children below 17 years. Since this is a rather small sample, we will not present the results for the families with children dataset.

### 5.3 Interpretation of results

In order to interpret the parameter estimates in table 3, we reformulate the model in reduced form:

$$\begin{aligned} h_m &= \frac{1}{c_{mm}} w_m - \frac{c_{mf}}{c_{mm}} h_f - \frac{1}{c_{mm}} \exp(x_m' \beta_m + u_m) \\ h_f &= \frac{1}{c_{ff}} w_f - \frac{c_{mf}}{c_{ff}} h_m - \frac{1}{c_{ff}} \exp(x_f' \beta_f + u_f) \end{aligned} \quad (19)$$

An increase in female housework by one hour will increase male housework by  $-\frac{\hat{c}_{mf}}{\hat{c}_{mm}} = -\frac{14.143}{(-272.116)} = 0.05$  hours. And an increase in male housework by one hour

will increase female housework by  $-\frac{\hat{c}_{mf}}{\hat{c}_{ff}} = -\frac{14.143}{(-88.629)} = 0.16$  hours. A male wage

increase of 10 DKr per hour decreases his daily time in household production with  $\frac{1}{\hat{c}_{mm}} * 10 = -\frac{1}{272.116} * 10 = 0.037$  hours or around 2 minutes per day, while a similar

wage increase for the wife decreases her daily time doing housework with

$$\frac{1}{\hat{c}_{ff}} * 10 = -\frac{1}{88.629} * 10 = 0.11 \text{ hours or 7 minutes per day. Thus, women's time in}$$

housework is more sensitive to wage changes which is reasonable since women's average housework is higher than men's and therefore corresponds to a flatter segment on the household production curve. Having children affects both male and female household production positively. Homeownership also has a positive effect, and age is positively correlated with housework. Education has opposite effects on male and female housework. While education increases his housework (although the effect is not significant), more educated women tend to do less housework. This apparent paradox probably also is a sign of positive assortative mating in education. Thus, women with a higher education marry men with a higher education. This also suggests that his and her housework are substitutes on the margin.

## 5.4 Discussion

The analysis above investigates “activity benefits” in household production. It is argued that one can not compare one hour worked at home with one hour worked in the market without taking into account the activity benefits of performing household production. It is hereby implicitly assumed that there are no activity benefits connected to performing market work. However, this is not necessarily the case. As argued in the introduction, Hallberg and Klevmarken (2003) analyzed the Swedish HUS study of 1984 and 1993 and found that market work was considered nearly as enjoyable as being with one's own children and more enjoyable than most household chores. Juster and Stafford (1985, 1991) found similar trends in American data. As a pragmatic solution to this conceptional problem, we may interpret the estimates as a measure of the *relative* activity benefits from carrying out household production compared to working in the market.

In figure 3, we illustrated how a household production model with “activity benefits” or with “consumption benefits” may be observationally equivalent. We will therefore try to interpret our results in a “consumption benefit” framework. Suppose the value of household production is  $Z_{hh}$  for the household,  $j$ , producing it. If  $Z_{hh}$  is higher for household  $j$  than another household would attach to the production by household  $j$ , then  $X_M$  and  $Z_{hh}$  cannot be perfect substitutes. We assume that we can observe the value other households put on household production by household  $j$ ,  $Z_{obs}$ . We may formulate the relationship between  $Z_{obs}$  and the “true” value of household production for household  $j$ ,  $Z_{hh}$ , as a form of multiplicative “premium” for home-made products. Since we cannot observe  $X_Z$ , we concentrate on net household production,  $\tilde{Z}$ :

$$\tilde{Z}_{hh} = k * \tilde{Z}_{obs}, \quad \text{where } \tilde{Z}_{obs} = \tilde{Z}(h_m, h_f) \quad (20)$$

In optimum, we find that:

$$\begin{aligned}\frac{\partial \tilde{Z}_{hh}}{\partial h_i} &= k * \frac{\partial \tilde{Z}_{obs}}{\partial h_i} = w_i \Rightarrow \\ \frac{\partial \tilde{Z}_{obs}}{\partial h_i} &= \frac{1}{k} * w_i\end{aligned}\tag{21}$$

Comparing this with (9) where  $\frac{\partial \tilde{Z}_{obs}}{\partial h_i} = (1 - g_i'(h_i)) * w_i$ , we find that:

$$\frac{1}{k} = (1 - g_i'(h_i))\tag{22}$$

With our empirical specification of the model, (22) is equivalent to:

$$\frac{1}{k} = \left(\frac{h_i}{T}\right)^{\delta_i} \Leftrightarrow k = \left(\frac{T}{h_i}\right)^{\delta_i}\tag{23}$$

In this simple parameterization where both spouses attach the same premium,  $k$ , to household production, (23) implies that if  $\delta_m = 0$  then  $\delta_f = 0$ . This is not the case in our empirical estimations. From (23) we also note that  $\frac{\delta_f}{\delta_m} = \frac{\ln(T/h_m)}{\ln(T/h_f)}$  in the case where the extra benefits are in the form of “consumption benefits”.

To illustrate, suppose we have  $\hat{\delta}_f = 0.4$  which is not too far from the empirical results above, and we use the observation that around 10 percent of women’s time is devoted to housework. Then  $\hat{k} \approx (1/0.1)^{0.4} \approx 2.5$ , implying that the value for the household of household production is 2.5 times larger than what we would expect based on observed household production, if we assume that there are no “activity benefits”. Above, we noted that  $\delta_i$  is estimated with a high standard error. If we instead assumed  $\hat{\delta}_i = 0.1$ , we would find  $\hat{k} \approx (1/0.1)^{0.1} \approx 1.25$ .

The above discussion does not allow us to determine whether there are “activity benefits” or “consumption benefits” in play but is primarily intended to illustrate the identification problems. A more comprehensive modelling would include the possibility of the two partners having different preferences for household production. This would probably accommodate our empirical finding that  $\hat{\delta}_m \neq \hat{\delta}_f$ .

A further step to obtain a fuller picture of the process of allocating time to household production within the household would be to develop a model that incorporates the distribution of “power” within the household, i.e. a “collective” model as proposed by Chiappori (1988, 1992, 1997), or the intra-household allocation model proposed by Apps and Rees (1988, 1996, 1997). We postpone this challenge for future analysis.

Our selection consists of couples where both spouses work more than 30 hours a week including commuting time. Thus, the sampling is based on labour market status which is endogenous in the model. This gives rise to selection bias. *On the one hand*, we might experience an *under-representation* of more home-productive individuals in the sample, since these individuals are relatively more likely not to have a paid job. *On the other hand*, it might be that the personal characteristics which determine productivity in the market and thus enhance the chances of being employed also lead to a relatively high productivity at home. Thus, we might see an *over-representation* of people who are productive at home in the sample. Gronau and Hamermesh (2001) show that there is a positive correlation between the level of education and demand for variety in time-use activities. They interpret this result as evidence that people with higher levels of education have a higher productivity, not only in market work, but also in housework. The net direction of the selection bias is difficult to predict.

Although the possible selection bias is potentially important, we postpone the treatment of this matter for future analysis. Selection is only a problem if we generalize our results beyond the group of full-time employed. The results found above still apply for the full-time employed. We note that the labour force participation rate is very high for both women and men in Denmark, and the incidence of part-time employment is low.

## 6 Conclusion

In this paper, we build on the classical household production model developed by Gronau (1977, 1980, 1986) with an extension allowing for “activity benefits” (“process benefits” due to Juster, 1985, or “joint production” due to Kerkhofs and Kooreman, 2003). We estimate the parameters of the model empirically on Danish time use data with interpretable results.

First, we estimate the model without “activity benefits”, i.e. without allowing for the possibility that some of the activities which we characterize as household production also provide benefits per se for the person performing the activity. For this formulation of the model, we find that housework by husband and wife show the expected diminishing returns to scale and that his and her time in housework are complements. In this respect, our results differ from a previous study by Kerkhofs and Kooreman (2003) who found that housework by husband and wife are q-substitutes.

Secondly, we estimate the household production model with activity benefits. We find some evidence of the *presence* of activity benefits in household production for women, but the effect is not significant on a 10 percent level (p-value is 0.12). Furthermore, we find that the *size* of the extra benefit is measured with a large

imprecision. The results are in line with previous analyses by Graham and Green (1984) and Kerkhofs and Kooreman (2003).

In the paper, we discuss alternative interpretations and identification issues related to our results. We note that the model only deals with activity benefits in household production, while possible intra-household differences in the taste for market work are ignored. Moreover, we argue that extra benefits related to household production may be related to households having a higher preference for home-made products rather than household products bought in the market. We call these “consumption benefits” to be able to distinguish them from “activity benefits”. We illustrate that these two types of benefits can be observationally equivalent. However, the benefits are inherently different in the sense that “activity benefits” (in the form of leisure) are private goods, while “consumption benefits” is a public good which directly enhances the utility of the two spouses, irrespective of who carried out the housework.

In general, the model’s explanatory power is low. Housework of husband and wife are strongly correlated, and the exogenous explanatory variables can only explain a modest part of the variations in housework across households. Thus, there is probably considerable unobserved heterogeneity in housework. We leave this question for future research.

# Appendices

## A.1 Data

Table A1 contains summary statistics for the selection of 629 households where both spouses work in the labour market and where the wage rate is observed in the data.

| Variable                         | Mean   | Std.  | Min   | Max     |
|----------------------------------|--------|-------|-------|---------|
| <b>Male characteristics</b>      |        |       |       |         |
| Housework, hours per day         | 1.56   | 0.93  | 0.29  | 5.00    |
| Wage, DKr per hour               | 210.81 | 78.06 | 84.00 | 649.00  |
| Age                              | 42.57  | 9.76  | 22.00 | 66.00   |
| Education in years               | 13.10  | 2.52  | 10.00 | 18.00   |
| <b>Female characteristics</b>    |        |       |       |         |
| Housework, hours per day         | 2.16   | 1.01  | 0.29  | 5.00    |
| Wage, DKr per hour               | 164.24 | 47.79 | 71.00 | 461.00  |
| Age                              | 40.58  | 9.58  | 20.00 | 61.00   |
| Education in years               | 13.34  | 2.56  | 10.00 | 18.00   |
| <b>Household characteristics</b> |        |       |       |         |
| Homeownership                    | 0.85   | 0.36  | 0.00  | 1.00    |
| Dummy young children (0-6)       | 0.29   | 0.45  | 0.00  | 1.00    |
| Dummy children 7-17              | 0.39   | 0.49  | 0.00  | 1.00    |
| Non labour income, 1000 DKr      | 23.41  | 63.87 | 0.00  | 1003.14 |
| Number of observations           | 629    |       |       |         |

Table A1: Summary statistics

## Construction of net wages

Net wages are constructed on the basis of gross wage rates for a full-time person who works 1500 hours per year. Based on rules on marginal tax rates and labour market contributions for 2001, we assume that a person with an imputed total gross wage income below 178,000 DKr (US\$ 28,000) pays around 50 percent in marginal tax, for total gross wage incomes between 178,000 DKr and 277,000 (US\$ 45,000), the marginal

tax rate is 55 percent, and for gross wage incomes beyond 277,000 DKr, the marginal tax rate is 68 percent.

## A.2 Full Information Maximum likelihood (FIML)

### Likelihood functions in FIML

The likelihood function for the non-linear FIML estimator is, according to Davidson and MacKinnon (1993) (formula 18.85):

$$\begin{aligned}
 l(\theta, \Sigma) &= \sum_{i=1}^n l_i(\theta, \Sigma) = \\
 &= -\frac{ng}{2} \log(2\pi) + \sum_{i=1}^n \log |\det J_i| - \frac{n}{2} \log |\Sigma| - \frac{1}{2} \sum_{i=1}^n h_i(Y_i, X_i, \theta) \Sigma^{-1} h_i(Y_i, X_i, \theta)' \\
 &\text{where} \\
 &h_i(Y_i, X_i, \theta) = U_i, \quad U_i \sim \text{NID}(0, \Sigma) \\
 &J_i \equiv \partial h_i(\theta) / \partial Y_i
 \end{aligned} \tag{24}$$

Thus, central assumptions behind FIML are that the error terms follow a normal distribution, and are homoskedastic (and serially independent).  $Y_i$  is  $1 \times g$ ,  $\Gamma$  is  $g \times g$ ,  $X_i$  is  $1 \times k$  (where  $k$  is the number of explanatory variables),  $U_i$  is  $1 \times g$ , and  $\Sigma$  is  $g \times g$ . In our case with a two-equation model,  $g=2$ .

### Normality tests

Figure A1 shows histograms for the residuals from the FIML estimation. Normality tests (skewness-kurtosis test and Shapiro-Wilkinson test) for the residuals reject the null that the error terms are normally distributed. Especially, the test for skewness contributes to the rejection which is also suggested by figure A1.

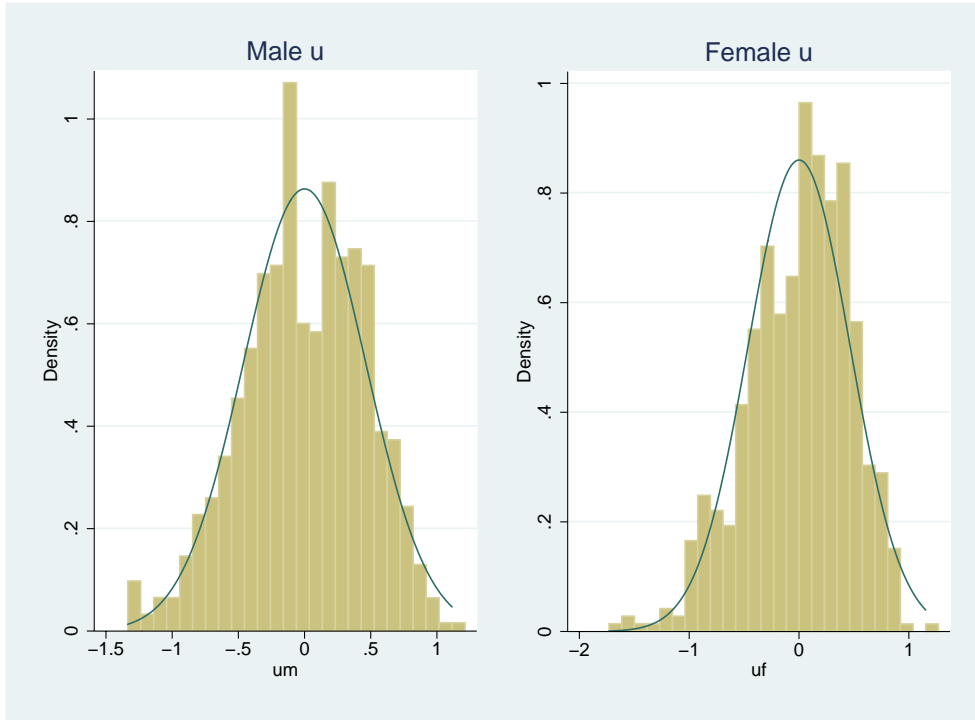


Figure A1: Distribution of residuals from FIML estimation

### A.3 GMM-3SLS

In formulating our moment conditions for the GMM-3SLS estimator, we follow Wooldridge (2001, ch. 14). The efficient GMM-3SLS estimator solves:

$$\min_{\theta \in \Theta} \left[ \sum_{i=1}^n Z_i q_i(\theta) \right]^T (n^{-1} \sum_{i=1}^n Z_i' \hat{u}_i \hat{u}_i' Z_i)^{-1} \left[ \sum_{i=1}^n Z_i q_i(\theta) \right] \quad (25)$$

Where  $Z$  is a matrix of instruments for the endogenous variables. In the first equation, we instrument female household production by her wage, her wage squared, her age, her age squared and education dummies. In the second equation, we use the same procedure and instrument male household production by his wage, his wage squared, his age, his age squared and education dummies. Table A2 shows that the explanatory variables in both equations are jointly significant with a very low p-value for the  $\chi^2$  test. The  $R^2$ 's are low in both equations. With these instrument, we can accept the null in the overidentifying restrictions test that the instruments are uncorrelated with the error terms.



|                        | Coefficient | t-value |
|------------------------|-------------|---------|
| <b>Female equation</b> |             |         |
| Female wage            | -0.007      | -2.09   |
| Female wage squared    | 0.010       | 1.4     |
| Female age             | 0.117       | 3.6     |
| Female age squared     | -0.001      | -3.51   |
| Female education 2     | 0.096       | 0.52    |
| Female education 3     | -0.142      | -1.47   |
| Female education 4     | -0.293      | -1.87   |
| Female education 5     | -0.122      | -1.13   |
| Female education 6     | -0.351      | -2.31   |
| Constant               | 0.719       | 1.05    |
| R <sup>2</sup>         | 0.050       |         |
| Chi <sup>2</sup>       | 38.550      |         |
| p-value                | 0.000       |         |
| <b>Male equation</b>   |             |         |
| Male wage              | -0.004      | -2.78   |
| Male wage squared      | 0.005       | 2.04    |
| Male age               | 0.084       | 2.86    |
| Male age squared       | -0.001      | -2.85   |
| Male education 2       | 0.023       | 0.14    |
| Male education 3       | 0.118       | 1.34    |
| Male education 4       | 0.044       | 0.31    |
| Male education 5       | 0.166       | 1.49    |
| Male education         | 0.151       | 1.16    |
| Constant               | 0.406       | 0.66    |
| R <sup>2</sup>         | 0.029       |         |
| Chi <sup>2</sup>       | 21.080      |         |
| p-value                | 0.012       |         |

Table A2: SUR estimation of instruments for  $h_m$  and  $h_f$

### Overidentifying restrictions tests

In order to test whether the instruments are uncorrelated with the error terms, we perform the overidentifying restrictions test. Under the null hypothesis that the residuals are uncorrelated with the error terms, the value of the objective function of the GMM problem is  $\chi^2$ -distributed with 8 degrees of freedom (equal to number of instruments minus number of explanatory variables). The value of the objective function in the optimum is 7.05. Thus we accept the null hypothesis that the instruments are uncorrelated with the error terms.

#### A.4 Results with gross wages

In the paper, we used imputed net wages (see appendix A1) as the net wage is in principle the most correct measure of the shadow price of time. In order to arrive at the imputed net wages, we had to use a rather crude method to impute the marginal tax rates. This imputation might add to measure error of the wage rate which people use when deciding how to allocate their time. For comparison, we present the regression results with gross wages in table A3.

|                        | <b>GMM-3SLS</b> | <b>t-value</b> |
|------------------------|-----------------|----------------|
| $c_{mm}$               | -786.285        | -3.11          |
| $c_{ff}$               | -469.875        | -3.01          |
| $c_{mf}$               | -22.996         | -0.26          |
| <b>Male equation</b>   |                 |                |
| Constant               | 6.476           | 12.21          |
| Age                    | 0.003           | 1.13           |
| Education, years       | 0.158           | 1.39           |
| Homeownership          | 0.130           | 2.24           |
| Dummy young children   | 0.220           | 4.44           |
| Dummy children 7-17    | 0.093           | 2.17           |
| Non labour income      | 0.008           | 0.64           |
| <b>Female equation</b> |                 |                |
| Constant               | 7.260           | 17.65          |
| Age                    | 0.004           | 2.16           |
| Education, years       | -0.219          | -2.30          |
| Homeownership          | 0.145           | 3.10           |
| Dummy young children   | 0.198           | 4.82           |
| Dummy children 7-17    | 0.129           | 3.84           |
| Non labour income      | 0.025           | 2.68           |

Table A3: Regression results with gross wages

#### A.5 Jointness

We test the joint significance (2 restrictions) of the activity benefit parameters by a  $\chi^2$  test with 2 degrees of freedom. The value of the objective function is 11.45 under the null hypothesis (restricted version) and 8.84 for the unrestricted estimation. Thus, the value of the J-test which is the reduction in the objective function from going from the restricted to the unrestricted version of the model is around 2.6. The critical value of the  $\chi^2(2)$  distribution is 4.61 for a significance level of 0.10. The null hypothesis is therefore accepted, and we reject joint significance of the activity benefit parameters.

We also tested the significance of the activity benefit parameters individually. If we restricted  $\delta_f \equiv 0$  and performed a grid search for  $\delta_m$ , we found the optimum for  $\hat{\delta}_m = 0$ . On the other hand, if we restricted  $\delta_m \equiv 0$ , we found an optimum for  $\hat{\delta}_f = 0.8$  where the value of the objective function is 9.06. The value of the J-test is then around 2.4 with a p-value=0.12. The critical value of the  $\chi^2(1)$  distribution is 2.71 for a significance level of 0.10. Thus, we are close to concluding that our estimate of  $\delta_f$  is significant. Figures A2 and A3 below illustrate that the the objective function is almost flat for a broad range of values of  $\delta_m$  and  $\delta_f$  respectively, so the activity benefit parameters are estimated with great imprecision. Table A4 below shows the estimation results under the null (restricted version) and for  $\hat{\delta}_f = 0.8$ .

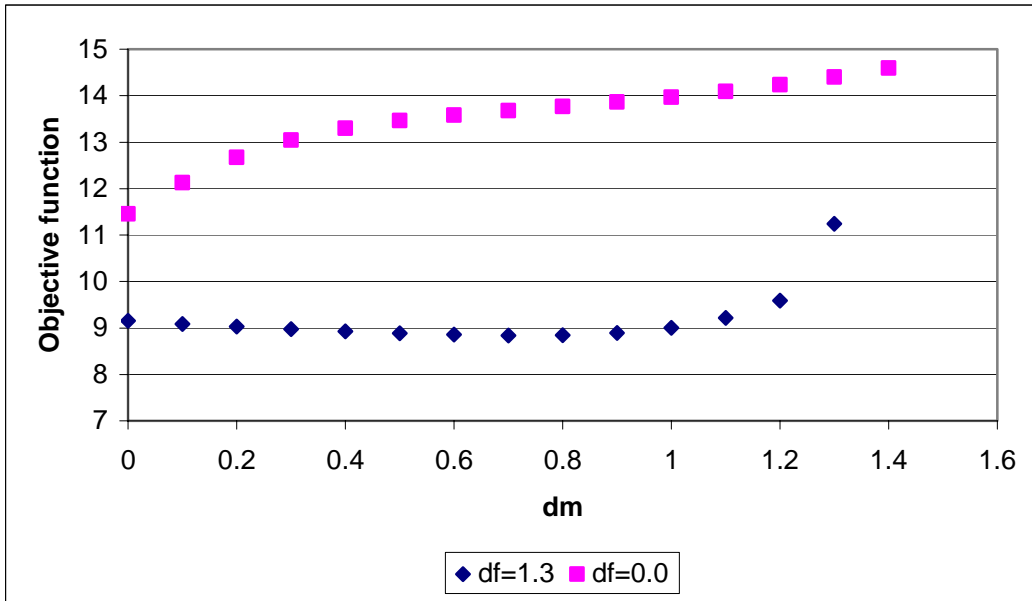


Figure A2: Values of objective function for fixed levels of  $\delta_f$

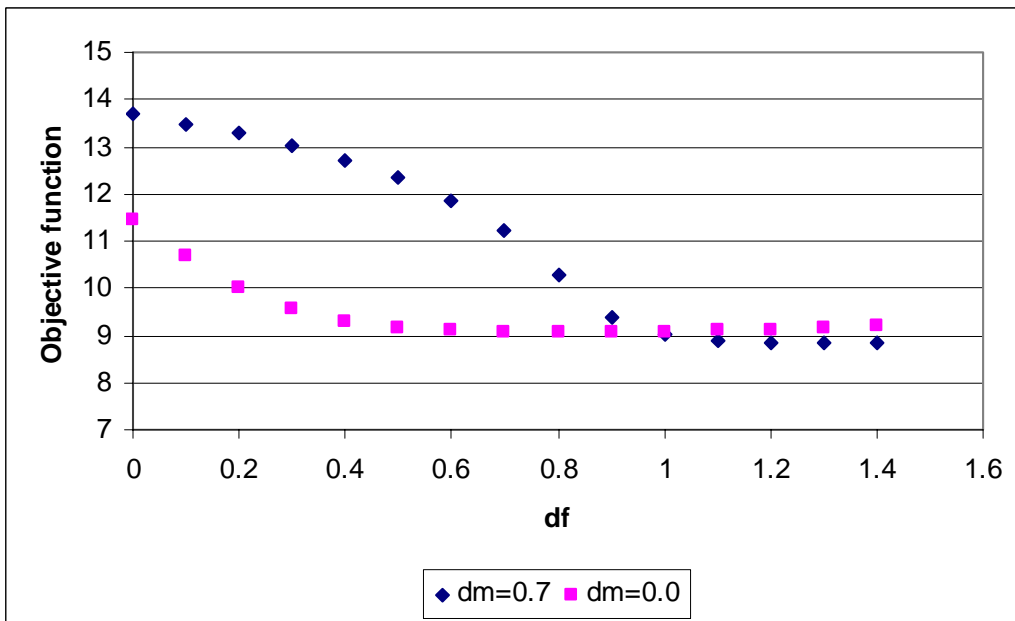


Figure A3: Values of objective function for fixed levels of  $\delta_m$

|                        | No activity benefits |         | Activity benefits for women |         |
|------------------------|----------------------|---------|-----------------------------|---------|
| $c_{mm}$               | -270.804             | (-2.15) | -278.280                    | (-1.99) |
| $c_{ff}$               | -99.981              | (-3.11) | -11.402                     | (-2.04) |
| $c_{mf}$               | 18.602               | (0.92)  | 4.219                       | (1.66)  |
| <b>Male equation</b>   |                      |         |                             |         |
| Constant               | 5.446                | (9.09)  | 5.593                       | (10.26) |
| Male age               | 0.003                | (1.09)  | 0.003                       | (1.38)  |
| Male education         | 0.143                | (1.19)  | 0.115                       | (1.10)  |
| Dummy home owner       | 0.088                | (1.47)  | 0.086                       | (1.50)  |
| Dummy for children     | 0.174                | (3.41)  | 0.176                       | (3.61)  |
| Dummy for teenagers    | 0.056                | (1.24)  | 0.065                       | (1.63)  |
| Non labour income      | 0.011                | (0.99)  | 0.012                       | (1.11)  |
| <b>Female equation</b> |                      |         |                             |         |
| Constant               | 5.746                | (15.35) | 3.595                       | (6.65)  |
| Female age             | 0.003                | (1.89)  | 0.004                       | (1.56)  |
| Female education       | -0.196               | (-2.21) | -0.273                      | (-2.37) |
| Dummy home owner       | 0.094                | (2.23)  | 0.140                       | (2.34)  |
| Dummy for children     | 0.136                | (3.62)  | 0.177                       | (3.50)  |
| Dummy for teenagers    | 0.115                | (3.68)  | 0.161                       | (3.66)  |
| Non labour income      | 0.019                | (2.36)  | 0.028                       | (2.40)  |

Note: t-values in parentheses.

Table A4: Results for model without and with activity benefits

## A.6 Finding an optimum with increasing returns to scale

In the household production model without activity benefits, we have to assume decreasing returns to scale, i.e.  $\tilde{Z}''(h_m), \tilde{Z}''(h_f) < 0$  or - for the specific functional form of net household production -  $c_{mm}, c_{ff} < 0$  as a necessary condition for finding an optimum. However, increasing returns to scale is not in conflict with finding an optimum in the model with activity benefits. Thus,  $c_{mm}, c_{ff} < 0$  is a sufficient but not a necessary condition. What matters for the possibility of finding an optimum is the curvature of the activity benefit function,  $g_i(h_i)$ . In order to find an optimum for one of the spouses in the house, the following condition must be fulfilled for the model in its general form:

$$\begin{aligned} \partial \frac{\tilde{Z}'(h_i)}{(1 - g_i'(h_i))} / \partial h_i < 0 &\Rightarrow \\ \frac{\tilde{Z}''(h_i) * (1 - g_i'(h_i)) + \tilde{Z}'(h_i) * g_i''(h_i)}{(1 - g_i'(h_i))^2} < 0 &\Rightarrow \\ \frac{g_i''(h_i)}{(1 - g_i'(h_i))} < - \frac{\tilde{Z}''(h_i)}{\tilde{Z}'(h_i)} \end{aligned} \quad (26)$$

Using our specific functional form for  $\tilde{Z}$  and applying the above condition to both male and female, this implies that:

$$c_{mf} > \max \left( -\frac{b_m}{h_f}, -\frac{b_f}{h_m} \right) \quad (27)$$

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## **Chapter 2**

# **Spending Time and Money within the Household**

# Spending Time and Money within the Household

|                          |                          |
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## Abstract

We consider theoretically and empirically the allocation of time and money within the household. The novelty of our empirical work is that we have a survey which provides information on both time use and the allocation of some goods within the household, for the same households. Thus we can consider whether a partner who enjoys more leisure also receives more consumption, which looks like the outcome of 'power' within the household, or receives less consumption, which looks like differing tastes across households.

Keywords: Intra-household allocation, household production  
JEL classifications: C3, D1, J1, J2

## 1 Introduction

The most consistent finding regarding time use across countries and over time is that, *on average*, married men do more market work and less housework than married women. It has also been found that, *on average*, married men and women enjoy much the same leisure.<sup>1</sup> These averages, however, mask

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<sup>1</sup>The major exception to this is Italy.

very marked heterogeneity in time use within individual households. Thus we find some households in which one partner does a good deal more work (in the market and in the home) than the other partner and enjoys less leisure. There are a number of possible rationale for this. First, there may be heterogeneity in the tastes for work (relative to the output from the work) within the household. Second, wages and/or productivity in home production may vary, which would induce differences in the leisure taken. Finally, ‘power’ may be distributed unevenly within the household and the ‘low power’ individual may be required to work more. Data on time use alone do not suffice to identify the relative importance of these three factors. To identify this, we need to observe other outcomes within the household. The distribution of material welfare within the household depends on two elements: individual time use and the allocation of expenditures. Time use surveys give a good picture of the distribution of time to market work, housework, leisure and personal care between partners but do not have comparable information on expenditures. This means that we cannot convincingly make the mapping from time use to welfare.

As an example that we shall often return to below, consider a household comprising of a married couple in which the wife works more (in the home and in the market) as compared to other women with similar characteristics, wage of husband and wife and household financial situation. To make the link to her material welfare relative to other women, we need to know what is happening to the distribution of goods within the household. If we would observe that she receives more goods than we would predict, then we could attribute the observation to her having a high taste for goods relative to leisure.<sup>2</sup> If, on the other hand, we observed that she also receives less goods then it looks as though she lacks ‘power’ within the household and that the distribution of material well-being within the household is skewed towards the husband. Clearly, we need to observe both sets of outcomes (the allocation of time and money) to calculate the intra-household distribution of material well-being and its determinants.

The traditional focus of welfare analysis has been on the distribution of material well-being *across* households - the *inter-household* distribution. The household has been viewed as one unit, and it has implicitly been assumed that household members do not have conflicting interests. This description is usually referred to as the ‘unitary’ model. In the past two decades there

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<sup>2</sup>We shall formalize this in the theory section below.

has been a number of analyses of the situation in which household members have conflicting objectives and a growing interest regarding the distribution of material well-being *within* the household; that is, the *intra-household* distribution of material well-being. A number of different approaches have been suggested; see Browning, Chiappori and Lechene (2005) for references. One particularly popular approach is to assume that, however decisions are made, the outcome is always Pareto-efficient, see Chiappori (1988), Apps and Rees (1988) and Browning and Chiappori (1998). This assumption is central in the ‘collective model’ where the distribution of ‘power’ in the household contributes to determining intra-household distribution. This paper explores and compares the implications of adopting a ‘unitary’ versus a ‘collective’ framework to describe the allocation of well-being.

The intra-household allocation of *expenditures* has been the principal focus in a number of theoretical and empirical studies during the last two decades, (see, for example, Browning *et al* (1994), Lundberg *et al* (1996) and Phipps and Burton (1998)). Other studies have dealt with the intra-household allocation of *time*, see Chiappori (1992) and (1997) and Apps and Rees (1996) and (1997). Apps and Rees address the question of whether household members exchange time for consumption and stress the need for data on the simultaneous allocation of time and consumption within households.

Below we present an empirical analysis based on a survey of Danish households that was specifically designed for the research reported in this paper. The survey is unique in the sense that it collects both time use data and information on the intra-household allocation of goods *for the same households*. As far as we are aware, this is the first time that data on time use and the allocation of goods within the household have been available in the same survey. This gives us the opportunity to present a much fuller picture of the distribution of material well-being within the household than has been possible in the past. In the next section we give a description of our data collection and some descriptive results for time use and individual expenditures. In section 3 we present a simple theoretical model designed to isolate the effects discussed above. We choose a simple parameterisation for two reasons. First, it allows us to discuss clearly what we think are the main theoretical issues without excessive concern for perverse effects due to strong substitutability or complementarity between the consumption of different goods and time use. Second, our parameterisation leads to a structural model that yields linear reduced forms that can be taken to the data. Also in section

3, we discuss how to account for observed and unobserved heterogeneity and present our identification scheme. An important aspect of our identification scheme is that we can allow that wages are endogenous through their correlation with unobservable tastes for work. In section 4 we present an empirical structural analysis of the data on time use and the allocation of goods within the household.

## 2 The Danish Time Use Survey

### 2.1 Background

Our data are from the Danish Time Use Survey for 2001 (DTUS). This survey provides detailed information on time use for more than 2700 Danish individuals in 2001 of whom about 1700 lived with a partner. The DTUS complies with methodologies developed at the EU level for conducting time use surveys; see Bonke (2005) for a detailed description. For married and cohabiting respondents, the partner in the household was also asked to participate in the survey. We have two sources of information on time use. First, each respondent filled in a diary stating their activities at a detailed level every 15 minutes in two 24-hour periods, one a week-day and the other a weekend day. The second source is from the questionnaire in which respondents were asked about their ‘usual’ time use.

A unique feature of the data collection is that respondents were also asked about their and their partner’s expenditures on three categories of goods, bought for their own consumption. The details of the expenditure module are given below. The module was designed by Jens Bonke and Martin Browning in collaboration with Denmark’s Statistics who ran the survey. Browning, Crossley and Weber (2003) present a discussion of the pros and cons of using information on ‘usual’ expenditures from general purpose surveys. The broad conclusion from their analysis is that although survey measures are noisy as compared to diary measures, they do contain a useful signal. The questionnaire also asked about personal and household characteristics as well as about the usage of domestic appliances and individual perception of their economic situation.

Finally, these survey data were linked to register (administrative) information from Denmark’s Statistics on the respondent and partner, giving access to further personal and household information and information on hous-

ing. Particularly important in this respect is that the register data contains a wage measure for employed individuals that is constructed independently of the time use collected in the survey so that we do not have the familiar division bias when considering time use and wages. The DTUS is unique in having information on time use, individual expenditures and wages for the same household.

## 2.2 Time use

As well as keeping a time diary, respondents were asked about the time they *normally* spend on housework and in the labour market in a typical week. Housework time is specified to include normal housework such as cleaning, laundry, shopping, cooking etc. and also gardening, repairs, other do-it-yourself work and child care.<sup>3</sup> Market work time includes commuting. In general, it is observed that surveys asking about *normal* time use have a smaller variance, but perhaps a more imprecise mean of time use, see Juster and Stafford (1991). Diary information gives more precise means, but the variance is larger, especially when including time for home repairs etc. We have chosen to use *normal* time use rather than the diary information to avoid the very serious infrequency problems in the latter. In the Appendix we provide a comparison of the diary records and the normal times reported.

Table 1 shows the time usage of couples, broken down by the work status of the two partners. We define full-time market work to be at least 30 ‘normal’ hours per week, including commuting time. Thus a respondent may be unemployed in the survey week and still report more than 30 hours per week of market work. Part-time work is not very prevalent in Denmark so that ‘not full-time’ generally means ‘out of the labour force’ (particularly for men). The ‘neither full-time’ group is mostly made up of older, presumably retired, couples. Table 1 shows familiar patterns with men doing less housework than women who have the same work status, but with leisures being roughly equal (in mean) for those with the same status. Being full-time employed has a dramatic effect on mean leisure with about 30 hours per week less for women and 35 hours less for men. For our purposes, a particularly important feature of the time uses shown is their wide within category dispersion, as shown by the standard deviations.

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<sup>3</sup>As always the classification of child care as housework is contentious. No one seriously argues that it cannot also be an important leisure activity. Since respondents were only asked one question on housework, we cannot break out child care separately.

Figure 1 shows the details of leisure for the ‘both full-time’ group. The left hand panels show the levels for wives and husbands.<sup>4</sup>. As can be seen there is considerable dispersion. The top right hand panel shows the wife’s relative leisure, defined as the wife’s leisure relative to the husband’s leisure. The median and mean are 0.98 and 0.99 respectively but about 10% of couples have a leisure relative below 0.8 and 7% have above 1.25. The scatter plot in the bottom right panel indicates a positive correlation between the two leisures with a slope less than unity (the OLS value is 0.51 with a t-value of 14.9). There are many candidate explanations for this positive correlation, including assortative mating on wages (so that two partners with high wages will both take less leisure), assortative mating on preferences for leisure or complementarities in leisure.

|   | Females       |                |                | Males          |                |                |
|---|---------------|----------------|----------------|----------------|----------------|----------------|
| Full-time   | $m$           | $h$            | $l$            | $m$            | $h$            | $l$            |
| Both<br>(# = 813)   | 40.5<br>(6.0) | 15.7<br>(8.7)  | 55.8<br>(10.3) | 44.7<br>(9.1)  | 10.9<br>(7.6)  | 56.4<br>(11.1) |
| Wife<br>(# = 114)   | 40.2<br>(4.9) | 13.1<br>(8.1)  | 58.6<br>(10.1) | 2.0<br>(6.8)   | 13.1<br>(8.1)  | 96.3<br>(12.2) |
| Husband<br>(# = 311)  | 5.7<br>(10.6) | 18.1<br>(11.9) | 88.2<br>(16.6) | 45.1<br>(10.5) | 9.3<br>(6.7)   | 57.5<br>(12.2) |
| Neither<br>(# = 284)  | 1.1<br>(5.2)  | 18.9<br>(11.7) | 91.9<br>(12.9) | 0.7<br>(3.9)   | 13.0<br>(10.9) | 98.2<br>(11.2) |
| $m, h$ and $l$ are market hours, housework hours<br>and leisure hours per week. Sd’s in brackets. |               |                |                |                |                |                |
| Note: $m + h + l + 42 = 168$  |               |                |                |                |                |                |

Table 1: Time use of wives and husbands

In the following, we analyse only the sample of households in which both husband and wife work full-time in the labour market. This is to allow us to focus on the role of relative wages on the intrahousehold allocation of time and money. The analysis of the disparity in leisures between partners who do not have the same full-time status is left for future work. The load of housework for full-time couples (which we define to include child care) naturally depends on the number and ages of children within the household. Table 2

<sup>4</sup>With values below 40 set to 40 for the sake of presentation.



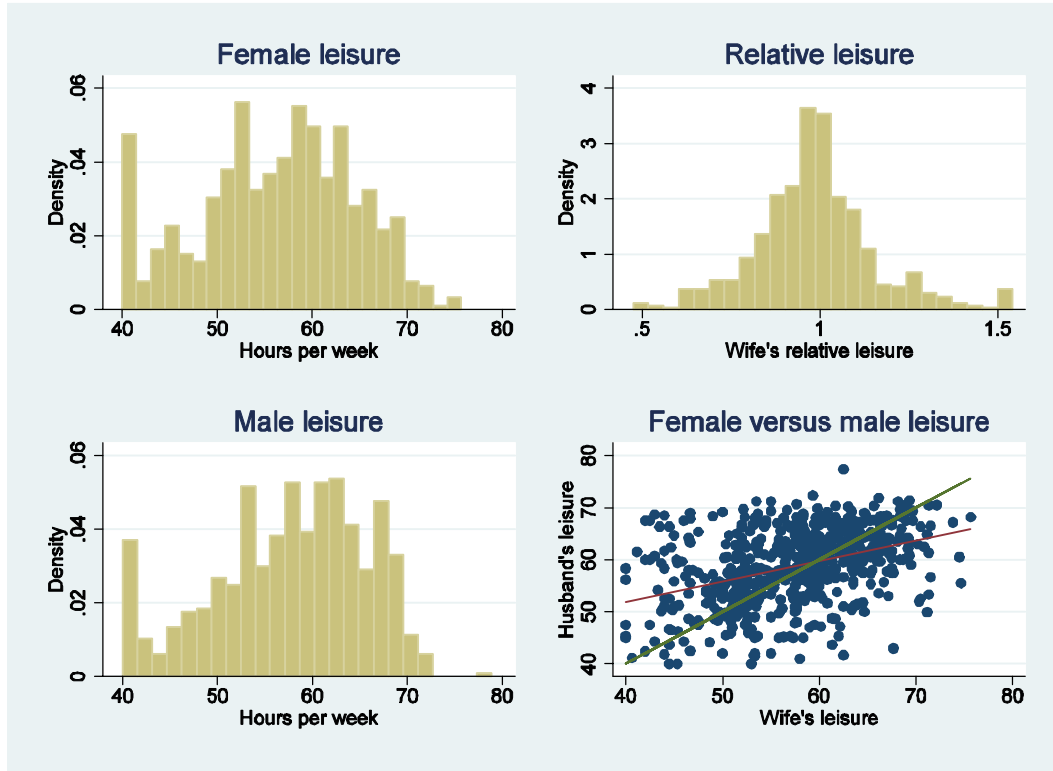


Figure 1: Leisure for husband and wife.

presents time use broken down by child status. This table indicates that although children have some effect (in the expected directions) the differences are not large, once we condition on both partners being in full-time work. In particular, parents do not have drastically lower leisures which suggests that they may even have more leisure is we re-categorise some time spent with children as leisure.

### 2.3 Personal expenditures

As mentioned above, the primary objective of the DTUS was to collect information on time use and we could only collect limited information on personal expenditures. The following questions were asked of the respondent:

‘When you think of your own personal expenditures, how large do you estimate it normally is on the following items during one month’:

|                    | Females       |               |                | Males          |               |                |
|--------------------|---------------|---------------|----------------|----------------|---------------|----------------|
| # children         | <i>m</i>      | <i>h</i>      | <i>l</i>       | <i>m</i>       | <i>h</i>      | <i>l</i>       |
| 0<br>(# = 357)     | 41.0<br>(6.3) | 13.5<br>(7.5) | 57.5<br>(9.9)  | 44.5<br>(10.1) | 9.4<br>(6.5)  | 58.0<br>(11.4) |
| 1<br>(# = 175)     | 40.7<br>(6.3) | 15.1<br>(7.5) | 56.2<br>(9.3)  | 43.7<br>(7.0)  | 10.7<br>(7.5) | 57.6<br>(8.8)  |
| 2+<br>(# = 281)    | 39.9<br>(5.4) | 18.8<br>(9.8) | 53.3<br>(10.9) | 45.5<br>(8.8)  | 13.0<br>(8.5) | 53.5<br>(11.5) |
| Notes: see Table 1 |               |               |                |                |               |                |

Table 2: Time use by child category

- ‘Clothing and shoes’
- ‘Leisure activities, hobbies etc.’
- ‘Other personal consumption’

The respondent was then asked the same questions for their spouse/cohabitant. It is very rare to have survey information on expenditures for individuals within the household and questions can be raised about the validity of the information obtained in this way. Fortunately, in Denmark we have a reliable survey of within household allocations from the Danish Household Expenditure Survey (DHES) which can be used to check the validity of our responses. The DHES is a conventional diary based survey of expenditures with the unconventional feature that respondents keeping an expenditure diary record who the item was bought for (‘her’, ‘him’, ‘the household’, ‘children’ and ‘other’).<sup>5</sup> Since the DHES has very detailed categories for goods we can construct aggregates that correspond to our three aggregates. Comparing the information in our survey (the DTUS) and the DHES we find that for ‘clothing’ and ‘recreation’, the expenditure shares are very close to the corresponding groups from DHES. For ‘other personal consumption’, there is some divergence, but this may very well be attributed to differences in the definition of this group. In future work we shall combine the information from both surveys but this raises statistical issues (mainly dealing with the infrequency in the DHES data) that would take us too far from the analysis presented here.

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<sup>5</sup>This is also due to a data initiative of Bonke and Browning.

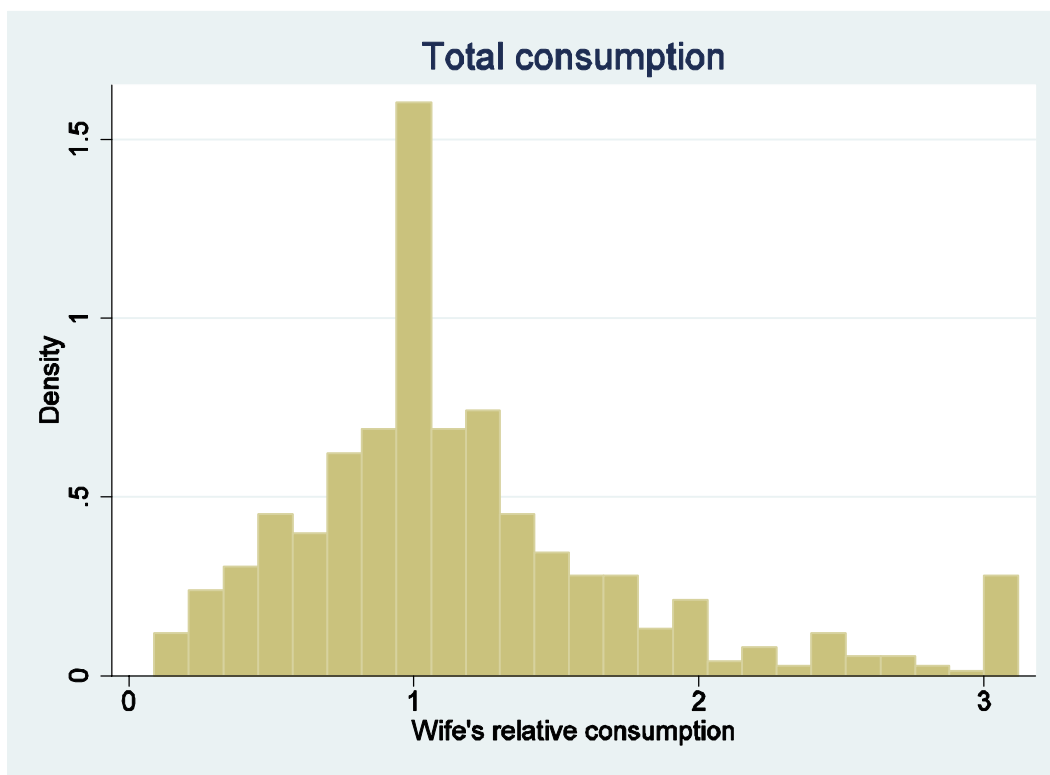


Figure 2: Wife's expenditure relative to husband's.

Many households did not give consumption information and some had missing wage information in the administrative data. In the end we have 615 households in which both partners are in full-time work and for which we have all of the necessary time use, expenditure, wage and demographic information. Appendix A.5 gives details of the sample selection. Figure 2 shows the distribution of the wife's relative expenditure (with values above 3 set to that value) for that sample. As can be seen the mode is close to unity and, indeed, many households report exactly the same expenditures on the three goods for husband and wife. This clearly indicates some reporting error but informal analysis (which assumes that the 'same value' reports are due to rounding) suggests that this does not lead to significant bias. In the data 20% of households have an expenditure relative above 1.5 and 18% have a value below  $1/1.5$ .

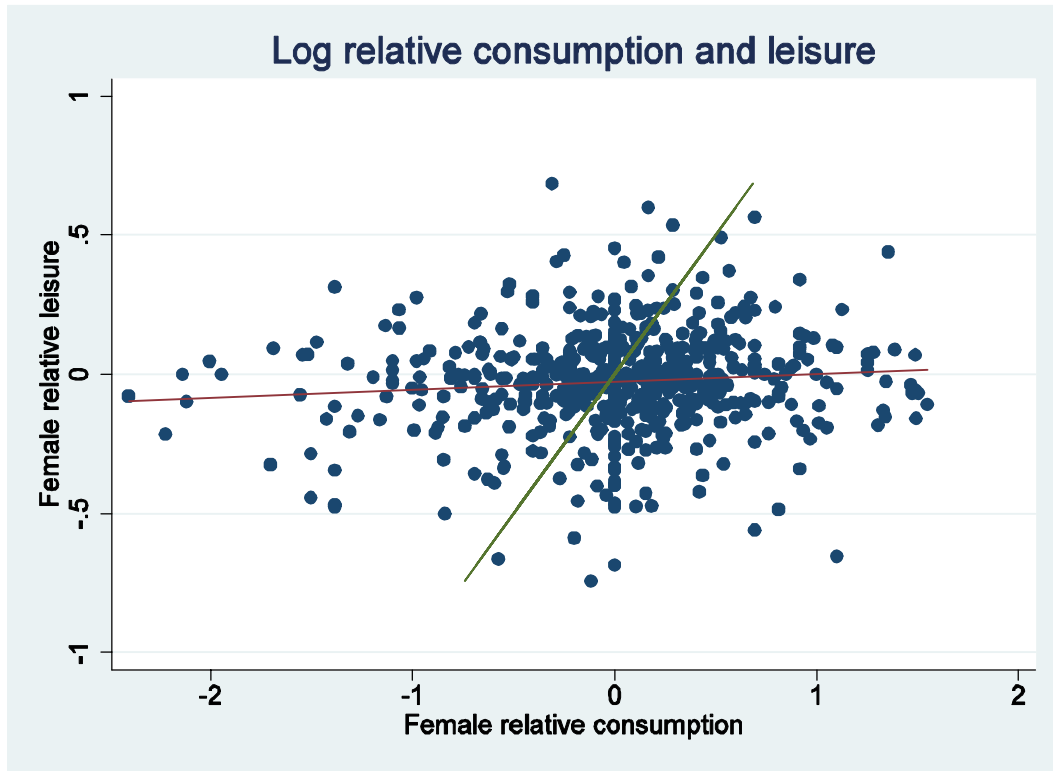


Figure 3: Expenditure and leisure

Figure 3 shows the scatter plot of relative leisures against relative expenditures for our sample. This is at the heart of our research question. If within household heterogeneity dominates then, conditional on relative wages, the two relative measures should be negatively correlated. If, on the other hand, power dominates then the correlation should be positive. The scatter diagram shows a mild positive association (the OLS value is 0.029 with a t-value of 2.35) but this does not take account of differences in relative wages. To do that we need a structural model.

## 3 Theory

### 3.1 Allocation within the household

In this section we develop a simple model of the allocation of time and money within the household. We consider a two person household with  $A$  being ‘she’ and  $B$  being ‘he’. The two members of the household sell labour on a labour market at fixed wages and they buy private goods which are distributed between the two partners. The members of the household also engage in housework which produces a public good that is consumed jointly. Table 3 presents our notation and the following equations give the constraints the household faces.

$$x_H + x_A + x_B = w_A m_A + w_B m_B + y \quad (1)$$

$$l_A + h_A + m_A = T \quad (2)$$

$$l_B + h_B + m_B = T \quad (3)$$

$$Q = F(h_A, h_B, x_H) \quad (4)$$

In these constraints we assume that the household public good,  $Q$ , is produced with inputs of time and physical inputs for household production (equation (4)). We assume that  $F(\cdot)$  is smooth with  $F_A$ ,  $F_B$  and  $F_x$  (the partials with respect to the respective levels of housework and money inputs) all positive.

|  |   |
|--|---|
| $x_A$  | $A$ ’s total expenditure on private goods |
| $x_H$  | Expenditure on household production       |
| $Q$  | Household public good                     |
| $l_A$  | $A$ ’s leisure time                       |
| $h_A$  | $A$ ’s housework time                     |
| $m_A$  | $A$ ’s market work                        |
| $w_A$  | $A$ ’s wage                               |
| $y$  | Household ‘other income’                  |
| We adopt the convention of denoting relative values by the notation without subscripts. For example: |   |
| $x$  | $A$ ’s relative expenditure $= x_A/x_B$   |
| $w$  | $A$ ’s relative wage $= w_A/w_B$          |

Table 3: Notation

Given the constraints the household faces, we have to model how the two people make decisions over the ten choice variables:

$$(x_H, x_A, x_B, Q, l_A, l_B, h_A, h_B, m_A, m_B)$$

We assume that each person has private preferences over their own goods, represented by the felicity function:

$$\begin{aligned} u^A &= u^A(x_A, Q, l_A) \\ u^B &= u^B(x_B, Q, l_B) \end{aligned} \tag{5}$$

This formulation explicitly assumes that there are no externalities so that, for example,  $A$ 's valuation of her leisure is independent of her husband's leisure. The 'no externalities' assumption is undoubtedly unrealistic but is widely used since it allows us to infer individual welfares from potential observables. We will return to the discussion on complementarity in leisures below. We are also assuming that the two partners are indifferent between time spent in housework and time spent in market work. If we wished to allow for differential preferences over the two time uses then we would need to include  $h_A$  in  $A$ 's utility function, and similarly for  $B$ .

We extend preferences by allowing that each person cares for the other (or 'defers to' the other, to use a term suggested by Pollak) and that the respective social welfare functions for the household are given by:

$$\Psi_A = u^A + \lambda_A u^B \tag{6}$$

$$\Psi_B = u^B + \lambda_B u^A \tag{7}$$

where we shall assume that the weights  $\lambda_A$  and  $\lambda_B$  are non-negative. Given these preferences there are a number of ways of modelling the interactions between the two partners that lead to household outcomes. Here we adopt a collective framework in which the two partners agree that they will maximise the weighted sum of their individual social welfare functions to generate a household social welfare function,  $\Psi$ , according to:

$$\begin{aligned} \Psi(x_A, x_B, Q, l_A, l_B) &= \tilde{\mu} \Psi_A + (1 - \tilde{\mu}) \Psi_B, \tilde{\mu} \in [0, 1] \\ &= \mu u^A(x_A, Q, l_A) + u^B(x_B, Q, l_B) \end{aligned} \tag{8}$$

where the second expression follows from a convenient re-normalisation, using (6) and (7). The Pareto weight  $\mu$  is a composite of the distribution of power

within the household (the parameter  $\tilde{\mu}$ ) and the degree of caring (given by  $\lambda_A$  and  $\lambda_B$ ). This brings out explicitly that one person caring for the other has a similar effect for observables as a lack of power. If we assume that the Pareto weight for  $A$ ,  $\mu$ , is a fixed constant then we have a ‘unitary’ model. As opposed to this, an important idea in the ‘collective’ framework is that the Pareto weight (which is here defined as the weight put on the woman’s individual utility in the household utility function) is positively related to the ‘power’ of the wife. Generally, the intra-household distribution of ‘power’ may depend on so-called *distribution factors*. These are potential observables such as relative wages and extra-household factors such as the sex ratio in the population and unobservables such as the degree of caring and the personalities of the two partners.

Given the constraints (equations (1) to (4)) and (8) we have the following four equations (the derivations are given in the Appendix):

$$\frac{u_x^B}{u_x^A} = \mu \quad (9)$$

$$\frac{u_l^B}{u_l^A} = \mu \frac{w_B}{w_A} = \frac{\mu}{w} \quad (10)$$

$$\frac{u_l^B}{u_x^B} = w_B \quad (11)$$

$$\frac{u_l^A}{u_x^A} = w_A \quad (12)$$

From (11) and (12) we see that each partner acts as an individual for their choice of private consumption and leisure, conditional on a given level of  $Q$ . This is the familiar result that if there are no externalities then we can decentralise any allocation by a redistribution of initial endowments. In this case it is as though, given  $Q$ ,  $A$  solves:

$$\max_{x_A, l_A} u^A(x_A, Q, l_A) \text{ subject to } x_A + w_A l_A = y_A$$

where  $y_A$  is  $A$ ’s allocation of income for private expenditure and leisure. The term  $y_A$  is known as the *sharing rule* in the intra-household literature. Note that we have:

$$y_A + y_B = (y - x_H) + (T - h_A)w_A + (T - h_B)w_B$$

so that the individual notional incomes sum to full income for the household, net of the costs of inputs to the public good. In the analysis here where we explicitly consider time use, the sharing rule is for the sharing of *full* income; that is, both time and money (net of expenditures on the public good). Once we have empirical estimates of the utility and Pareto weight functions we shall present results for the sharing rule for full expenditures.

### 3.2 A convenient parameterisation

In the following treatment of the model for the household equilibrium set out in equations (9) through (12), we focus on the first two of these conditions. These can be used to derive expressions for relative expenditure and relative leisure that we discussed in the introduction to this paper. This expression will generally contain the unobservable level of home produced good,  $Q$ , so that we have to assume some separability in the utility function in our empirical work. We choose to work with a particularly simple parameterisation that incorporates this assumption. As discussed in the introduction, this simple parameterisation allows us to derive key theoretical results and also to derive a tractable structural model to take to the data. The model also implies some over-identifying assumptions which we shall test. The value of having an explicit structural model for the empirical analysis is that it allows us to state our identifying assumptions clearly and it allows us to interpret the estimated parameters.

We assume that the utility functions are additive over the three arguments:

$$\begin{aligned} u^A &= \theta_A \ln(x_A) + \tau_A \left( \frac{\rho}{\rho-1} \right) (l_A)^{\left(\frac{\rho-1}{\rho}\right)} + f(Q) \\ u^B &= \theta_B \ln(x_B) + \tau_B \left( \frac{\rho}{\rho-1} \right) (l_B)^{\left(\frac{\rho-1}{\rho}\right)} + f(Q) \end{aligned} \quad (13)$$

where, without loss of generality, we have normalised the preferences on the public good to be the same for both partners. This parameterisation has two major restrictions: the additivity and the use of power forms for consumption and leisure. The additivity is restrictive, but not as much as might first be thought. For example, it is reasonably well established that consumption and market work are complementary (see Browning, Hansen and Heckman (1999) for a survey of empirical results). This is usually assumed to be



because there are costs of going to work and because agents can substitute housework for market goods in household production. The additive forms given in (13) imply the observed non-separabilities of total expenditure and market work; details are given in the Appendix A.2. Thus the additive form is more flexible than it first appears.

The second restrictive feature of our parameterisation is the use of the power form. This is frankly for convenience since it allows us to derive closed form expressions for relative leisure and relative expenditure. If we took other forms then we would have four equations (for each partners level of leisure and expenditure) rather than two. The power form taken for the sub-utility function for leisure is to allow that labour supply in a unitary model may not be very responsive to changes in wages. Concavity requires  $\rho > 0$  and some leisure is always required if  $\rho < 1$ . The parameter  $\rho$  is the negative of the Frisch (or  $\lambda$ -constant) elasticity of leisure with respect to the wage; details are given in Appendix A.3. Reliable estimates of this parameter are in short supply (see Browning *et al* (1999)) but a low value (of about 0.1) is thought appropriate.<sup>6</sup>

Within household heterogeneity is captured by the parameters  $\theta_A, \theta_B, \tau_A$  and  $\tau_B$ ; we postpone discussion of between household heterogeneity until the next subsection. From (9) we have:

$$\mu = \frac{u_x^B}{u_x^A} = \frac{\theta_B x_A}{\theta_A x_B} = (\theta^{-1}) \frac{x_A}{x_B} \quad (14)$$

where  $\theta = \theta_A/\theta_B$  symbolizes A's preferences for private consumption relative to B's preferences for consumption. Denoting A's relative consumption by  $x$  we have:

$$x = \frac{x_A}{x_B} = \theta \mu \quad (15)$$

The distribution of leisure in the household is given by (10). It is straightforward to show that A's relative leisure,  $l$ , is given by:

$$l = \frac{l_A}{l_B} = \left( \mu \tau \frac{w_B}{w_A} \right)^\rho = (\mu \tau)^\rho w^{-\rho} \quad (16)$$

where  $\tau = \tau_A/\tau_B$  is A's relative weighting for leisure.<sup>7</sup>

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<sup>6</sup>We could replace the log for private consumption by a similar formulation, but this turns out not to be necessary in the empirical analysis.

<sup>7</sup>Note that if we allowed the curvature parameter  $\sigma$  to vary across the partners then we would not have a simple form for the relative leisures.

We consider first comparative statics results for a unitary model. For variations in  $(\mu, \theta, \tau)$  these are:

$$\frac{\partial x}{\partial \mu} > 0, \frac{\partial l}{\partial \mu} > 0 \quad (17)$$

$$\frac{\partial x}{\partial \theta} > 0, \frac{\partial l}{\partial \theta} = 0 \quad (18)$$

$$\frac{\partial x}{\partial \tau} = 0, \frac{\partial l}{\partial \tau} > 0 \quad (19)$$

The first result states that  $A$ 's consumption and leisure both increase if her Pareto weight increases. The other two pairs of equations show that we can sensibly interpret  $\theta$  and  $\tau$  as being pure consumption and leisure heterogeneity terms. More interesting is the effect of changes in distribution factors for a non-unitary model. We denote the distribution factors by  $(z_1, \dots, z_D, w)$  where we distinguish between unspecified distribution factors (the  $z_d$ 's) and the relative wage. We have (denoting the partial of  $\mu$  with respect to  $z_d$  by  $\mu_d$ ):

$$\frac{\partial x}{\partial z_d} = \theta \mu_d \quad (20)$$

$$\frac{\partial l}{\partial z_d} = \rho \mu^{\rho-1} \tau^\rho w^{-\rho} \mu_d \quad (21)$$

and

$$\frac{\partial x}{\partial w} = \theta \mu_w \quad (22)$$

$$\frac{\partial l}{\partial w} = -\rho (\mu \tau)^\rho w^{-\rho-1} + \rho \mu^{\rho-1} \tau^\rho w^{-\rho} \mu_w \quad (23)$$

Equations (20) to (23) have two interesting corollaries. The first considers the reactions to two different non-wage distribution factors,  $z_i$  and  $z_j$ . Dividing one by the other we have the following proportionality result:

$$\frac{\partial x}{\partial z_i} / \frac{\partial l}{\partial z_i} = \frac{\partial x}{\partial z_j} / \frac{\partial l}{\partial z_j} \quad (24)$$

This extends the proportionality results of Browning *et al* (1994) and Bourguignon *et al* (2005) which derive similar restrictions for demands. Those papers show that these restrictions are necessary and sufficient for a collective

model. The restriction (24) is testable if we have at least two distribution factors.

The second interesting implication of the responses to changes in distribution factors is the result for the variation of the relative leisure,  $l$ , with respect to the relative wage, equation (23). The first term on the right hand side is the familiar labour supply response which is the only effect in the unitary model. Here we shall call this effect the unitary effect. It is negative which implies that an increase in  $A$ 's relative wage leads to a *fall* in her relative leisure. In a unitary setting the Pareto weight is unaffected by the change in relative wages ( $\mu_w = 0$ ), so that she will be relatively worse off (as compared to her husband) even though her relative wage has increased. Of course, she may be absolutely better off since the total expenditure increases. If we assume that a higher relative wage increases the Pareto weight ( $\mu_w > 0$ ) then the second expression on the right hand side of (23) is positive. This represents the collective effect, over and above the unitary effect. Formally the collective effect will dominate if the elasticity of the Pareto weight with respect to the relative wage is greater than unity:

$$\frac{\partial l}{\partial w} > 0 \Leftrightarrow \frac{\partial \ln \mu}{\partial \ln w} > 1 \quad (25)$$

Once again, this is a testable condition. The relative expenditure response to a change in the relative wage (22) is positive if the Pareto weight is positively related to the relative wage ( $\mu_w > 0$ ). In a unitary framework, relative expenditure is unaffected by a change in the relative wage ( $\mu_w = 0$ ). This is also a testable condition.

### 3.3 Heterogeneity

In our empirical work we shall use a cross-section of Danish households. In this subsection we discuss informally how heterogeneity in the population relates to observables such as the distribution of private expenditures within the household. In our data we observe:  $\{x_A, x_B, w_A, w_B, l_A, l_B, m_A, m_B, h_A, h_B\}$ .<sup>8</sup> We also observe demographics such as the age, education and work status of the partners, household composition (mainly the number and ages of children) and household income. In our empirical work below we shall

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<sup>8</sup>Actually, we only observe three sub-components of expenditures for each partner on private goods; we postpone how we deal with the missing information until the empirical section.

concentrate on the female relative leisure,  $l$ , and household expenditure,  $x$ . In particular, we will investigate how these variables relate to observable characteristics and to each other through unobservables.

We begin our discussion assuming that we have a sample of households from a population who all have the same observable characteristics, including wages  $w_A$  and  $w_B$ . In the model of the last subsection, equations (15) and (16), we had three parameters for each household:  $\{\mu, \theta, \tau\}$ . These parameters are distributed across our population. Given particular assumptions on the joint distribution of household parameters, we ask what are the implications for the joint distribution of  $\{x, l\}$  for the population? The important implications are the following.

**Proposition 1** *If there is variation in power across the population so that  $\mu$  has a non-degenerate distribution and  $\theta$  is independent of  $\tau$  then  $x$  and  $l$  will be positively correlated.*

This corresponds to the case in our introduction in which variations in expenditure and leisure shares derive from variations in the ‘power’ parameter  $\mu$ . The converse case is given by:

**Proposition 2** *If there is no variation in  $\mu$  but  $\theta$  and  $\tau$  are negatively correlated then  $x$  and  $l$  will be negatively correlated.*

That is, if the relative taste (between husband and wife) for leisure and the relative taste for private expenditure are negatively correlated then shares will also be negatively correlated. This corresponds to the ‘taste difference’ case discussed in the introduction. In general, of course, we must allow that all three factors are heterogeneous and interdependent.

Having considered unobserved heterogeneity we can now consider observable heterogeneity. In our sample, households differ widely in their observable characteristics and we have to allow that the household parameters depend on these. To accommodate this, we assume that the parameters depend on observables. In the case of the Pareto weight  $\mu$ , the dependence is on what are termed *distribution factors* as well as on unobservable factors. Candidates for the observable distribution factors are household income and the relative wages, relative ages and relative educational levels of the two partners. The unobservables could include, for example, the outside options the two partners have (contained in  $\tilde{\mu}$  in equation (8)) and how much they care

for each other ( $\lambda_A$  and  $\lambda_B$  in (6) and (7)). The other two parameters,  $\theta$  and  $\tau$ , are taste parameters that may depend on unobservables such as the idiosyncratic taste for work and an observable vector of *preference factors* such as the age and education of the two partners and the presence of children.

One weakness of our model is that we have assumed away complementarities between female and male time use. Previous contributions, using unitary models, by Hamermesh (2000), Hallberg (2003) and Ruuskanen (2004) address the issue of couples synchronising their time in both market work, housework and leisure and analyze the effects of economic and demographic variables on jointness in time-use. A central feature in these contributions is the distinction between a general time synchronization in society, due to the organisation of the labour market, shop opening hours etc., and the intended synchronization of couples' time based on their wish to spend some time together. This distinction is usually analyzed based on the difference between synchronization of time in 'pseudo couples' who have been matched based on a number of observable characteristics and in real couples, see Hallberg (2003). Based on Finnish time-use data with a highly detailed level of activities, Ruuskanen (2004) finds that couples tend to spend around 20%–25% of their leisure together during weekdays, while around one third of the leisure is spent together during weekends. The overall conclusion in the contributions by Hamermesh (2000), Hallberg (2003) and Ruuskanen (2004) is that jointness in the timing of leisure and housework is important. However, the evidence regarding the sign and size of the effects of economic and demographic variables is somewhat mixed. Allowing for complementarity by extending the collective model we use leads to a much more complicated model and we leave it for future work. However, some simulations of our model suggest that introducing complementarity would not change the *sign* of the effects discussed above, but would only tend to diminish the numerical *size* of the effects since the two partners will tend to make their individual leisure choice approach the leisure approach of their partner.

### 3.4 Empirical specification

As mentioned above, in our empirical work, we concentrate on the female relative expenditure and leisure share, see equations (15) and (16). We have information on wages,  $w_A$  and  $w_B$ , but we do not, of course, have any measures for  $\mu$ ,  $\theta$  and  $\tau$ . In the household allocation literature, it is usually suggested that the Pareto weight  $\mu$  depends on a set of distribution factors

including the differences in age, education and wage between the two spouses as well as environmental factors as the population (or regional) sex ratio. All these factors impact each of the spouses opportunities outside the marriage and are therefore argued to affect each of the partners ‘power’ within the marriage. For the empirical specification of the model, we model  $\mu$  in the following way (re-calling that  $w$  represents the relative wage):

$$\mu = \exp(\alpha_0 + \alpha' \mathbf{z}_d + \delta_w \ln(w) + \varepsilon_\mu) \quad (26)$$

where  $\mathbf{z}_d$  is a  $D$ -vector of non-wage distribution factors.<sup>9</sup> The unitary effect outweighs the collective effect in equation (23) if  $\delta_w < 1$ . The zero-mean variable  $\varepsilon_\mu$  is an error term which captures other factors affecting  $\mu$  which we have not been able to account for explicitly with our data.

Turning to the preference parameters, we model  $A$ ’s relative taste for consumption and leisure,  $\theta$  and  $\tau$  respectively, as a function of a set of household attributes such as age and the presence of children,  $\mathbf{z}_a$ , and unobservable components:

$$\theta = \exp(\gamma_{\theta 0} + \gamma'_\theta \mathbf{z}_a + \varepsilon_\theta) \quad (27)$$

$$\tau = \exp(\gamma_{\tau 0} + \gamma'_\tau \mathbf{z}_a + \varepsilon_\tau) \quad (28)$$

We assume that the distribution factors  $(\mathbf{z}_d, \ln(w))$  are disjoint from the preference factors  $\mathbf{z}_a$ .

Before substituting these parameterisations into the equations derived above we have to take account of the fact that we only observe a subset of expenditures by each partner. If we let  $x^*$  denote the ‘true’ relative expenditure and  $x$  be the relative expenditure calculated from the subset of goods we observe then we define implicitly a factor  $\eta$  by:

$$x \equiv e^\eta x^* \quad (29)$$

The factor  $\eta$  varies across households. Our model above relates to  $x^*$  but our empirical modelling uses  $x$ .

Entering (26), (27) and (28) into (15) and (16) (allowing for equation (29)) and taking logs, we have the following pair of structural equations for the shares of observables:

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<sup>9</sup>In our empirical work below we test for whether the two log wage measures enter separately (so that the Pareto weight depends on the level of wages as well as the relative value). We reject this so we discuss the simpler form here.

$$\ln \frac{x_A}{x_B} = \ln x = (\alpha_0 + \gamma_{\theta 0}) + \alpha' \mathbf{z}_d + \gamma'_{\theta} \mathbf{z}_a + \delta_w \ln(w) + (\varepsilon_{\theta} + \varepsilon_{\mu} + \eta) \quad (30)$$

and

$$\begin{aligned} \ln \frac{l_A}{l_B} = \ln l &= \rho(\alpha_0 + \gamma_{\tau 0}) + \rho \alpha' \mathbf{z}_d + \rho \gamma'_{\tau} \mathbf{z}_a \\ &+ \rho(\delta_w - 1) \ln(w) + \rho(\varepsilon_{\tau} + \varepsilon_{\mu}) \end{aligned} \quad (31)$$

Our primary parameters of interest are the Pareto weight parameters  $(\alpha_0, \alpha, \delta_w)$ . This structural system has a system of linear reduced forms:

$$\ln x = \pi_{x0} + \pi'_x \mathbf{z}_d + \pi'_{\theta} \mathbf{z}_a + \pi_{xw} \ln(w) + \varepsilon_x \quad (32)$$

$$\ln l = \pi_{l0} + \pi'_l \mathbf{z}_d + \pi'_{\tau} \mathbf{z}_a + \pi_{lw} \ln(w) + \varepsilon_l \quad (33)$$

Although parameter  $\rho$  is identified if we have estimates of the reduced form parameters, we do not feel confident in the estimate since it is a parameter that governs intertemporal allocation and we have only cross-section data. Consequently we shall present results with *a priori* plausible values for  $\rho$ .

If we fix  $\rho$  then all of the parameters of primary interest are identified from either equation, except for the intercept  $\alpha_0$ . The result that we cannot identify the ‘location’ of the Pareto weight is generic; as Bourguignon et al (2005) we can only identify the Pareto weight if we observe the allocation of all goods to each partner. If we take a particular value for  $\rho$  then this gives the following  $D + 1$  cross-equation restrictions:

$$\pi_l^i = \rho \pi_x^i \text{ for } i = 1, 2 \dots D \quad (34)$$

$$\pi_{lw} = \rho(\pi_{xw} - 1) \quad (35)$$

where  $\pi_l^i$  is the  $i$ th element of  $\pi_l$ . These restrictions are a test of our maintained assumptions. Finally we note that if we assume that  $\varepsilon_{\theta}, \varepsilon_{\tau}$  and  $\eta$  are distributed independently of each other then we expect a positive correlation between the errors in the two reduced form equations, through their dependence on  $\varepsilon_{\mu}$ .

To close this section we consider the identification of our parameters of interest. Since we do not have panel data we necessarily have to make strong assumptions concerning the unobserved heterogeneity. The strongest assumption is that both the composite errors  $\varepsilon_x$  and  $\varepsilon_l$  are uncorrelated

with the right hand side variables in the two equations. For some of the components this is unobjectionable. For example, the assumption that the mismatch between true expenditure shares and observed expenditure shares ( $\eta$ ) is uncorrelated with a preference factor such as age is probably innocuous. The strongest element of our identifying assumption is that wages are uncorrelated with  $\varepsilon_\tau$  which captures relative preferences for work. We might well expect that a high taste for work leads to higher wages, all other observables (such as education) being considered. In the intrahousehold literature we are forced to make this exogeneity assumption for want of a decent instrument for wages. Since we have two equations and cross-equation restrictions, we can test for this in our framework. Suppose that:

$$\varepsilon_l = \kappa \ln(w) + \tilde{\varepsilon}_l \quad (36)$$

where  $\tilde{\varepsilon}_l$  is uncorrelated with  $\ln(w)$ ,  $\mathbf{z}_d$  and  $\mathbf{z}_a$ . Then the log relative wage in equation (33) is exogenous if and only if  $\kappa = 0$ . Substituting (36) into (31) gives:

$$\ln l = \dots + \rho(\delta_w - 1 + \kappa) \ln(w) + \rho(\tilde{\varepsilon}_\tau + \varepsilon_\mu) \quad (37)$$

In this case, the test for the restriction in (35) can be viewed as an exogeneity test. If we reject exogeneity then we only impose estimate (34) to derive our estimates of the structural parameters. Note, however, that the test depends on the value of  $\rho$  we assume and we can always choose a value for the latter that makes the estimate of  $\kappa$  exactly zero.

## 4 Results

### 4.1 Parameter estimates and tests

We first present the estimates for a completely unrestricted model, see Table 4. A number of features of these estimates deserve attention. First, the children variables are insignificant in both equations. It is important to emphasise that the latter finding for the leisure equation does *not* imply that mothers and fathers do the same amount of child care (here classified as housework); for example the estimates are consistent with mothers doing more child care and fathers doing more market work (a common finding in the literature for young children) or more other types of housework. Second, the parameter estimates for log wages in the expenditure equation are of



| Variable                             | Relative expenditures |        | Relative leisures |        |
|--------------------------------------|-----------------------|--------|-------------------|--------|
| Constant                             | −.735                 | [1.20] | −.243             | [1.34] |
| log gross hhold inc.                 | .183                  | [1.04] | .096              | [1.83] |
| log wife’s wage                      | .195                  | [1.95] | −.098             | [3.28] |
| log husband’s wage                   | −.192                 | [1.62] | −.012             | [0.35] |
| wife’s age                           | −.019                 | [3.24] | .000              | [0.01] |
| husband’s age                        | .015                  | [2.59] | −.000             | [0.17] |
| wife’s education                     | −.012                 | [1.07] | .006              | [1.90] |
| husband’s education                  | −.004                 | [0.34] | .007              | [2.15] |
| # young children                     | −.059                 | [1.09] | −.003             | [0.19] |
| # older children                     | −.015                 | [0.30] | −.011             | [0.76] |
| $R^2$                                | .027                  |        | .039              |        |
| Correlation ( $\chi^2(1)$ )          | 0.11 (6.92)           |        |                   |        |
| Values in [.] are absolute t-values. |                       |        |                   |        |

Table 4: Estimates of unrestricted model

very similar absolute magnitude but opposite sign (see the footnote following equation (26)). Third, the age variables in the two equations sum to close to zero and are significant in the expenditure equation. Fourth, the education variables enter with the same sign within each equation.

Before moving on to the structural estimation it is worth testing for some restrictions on the reduced form; specifically, whether we can replace the levels of his and her variables by their difference. More specifically, we test whether the coefficient to the wife's wage is equal to the negative of the coefficient to the husband's wage etc., as our first look at the estimates suggests. We test these restrictions on both equations jointly. The  $\chi^2(2)$  statistics for these within-equation restrictions on the log wages, age and education are 4.69, 2.33 and 19.94 respectively (with probabilities of 9.6%, 31% and 0 respectively).<sup>10</sup>

Consequently we impose the first two restrictions on the reduced form; parameter estimates are given in Table 5. As can be seen, the coefficients on other variables do not change significantly and the differenced variables are more 'significant'. Thus the reduced form estimates point toward relative wage having a positive effect on the relative expenditures and a negative effect

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<sup>10</sup>In all cases the difference is her value minus his.

| Variable                           | Relative expenditures |        | Relative leisures |        |
|------------------------------------|-----------------------|--------|-------------------|--------|
| Constant                           | −.706                 | [1.16] | −.227             | [1.24] |
| Log gross hhold inc.               | .146                  | [1.40] | .003              | [0.09] |
| Log relative wage                  | .191                  | [2.83] | −.051             | [2.52] |
| Relative age                       | −.016                 | [2.93] | .001              | [0.36] |
| Female education                   | −.011                 | [0.96] | .006              | [1.82] |
| Male education                     | −.003                 | [0.26] | .007              | [2.12] |
| Young children                     | −.021                 | [0.44] | −.002             | [0.16] |
| Older children                     | −.023                 | [0.46] | −.010             | [0.73] |
| $R^2$                              | .027                  |        | .039              |        |
| Correlation ( $\chi^2(1)$ )        | 0.11 (6.97)           |        |                   |        |
| Values in [.] are standard errors. |                       |        |                   |        |

Table 5: Estimates of reduced form

on relative leisures. The difference between her age and his age has a negative effect on relative expenditure implying that the oldest of the spouses has a relatively smaller expenditure share. Finally, note that the  $R^2$  is low for both equations and that there is significant positive correlation between the errors in the two equations. We turn now to the interpretation given the structural model derived above.

## 4.2 Structural estimates and implications

When we consider the theoretical restrictions on the reduced form equation estimates we have to decide which right hand side variables are distribution factors and which are preference factors. For the former, relative wages and household gross income are natural candidates since they are not usually taken to be preference factors and hence should only enter the expenditure equation through the Pareto weight. Conversely, the children dummies can reasonably be taken as preference factors since they impact directly on the value of leisure. Following the results in Browning *et al* (1994)) we also choose to take the difference in age as a distribution factor; this does not rule out that preferences depend on age but simply that the dependence is the same for husband and wife. We leave the classification of the education variables to the data. If we do not impose exogeneity of the relative wage in

the leisure equation (see equation (37)) then we have two restrictions (for the difference in age and log household income). To test we take a value for the curvature parameter of  $\rho = 0.1$ , which is in line with  $\rho$ -values found in other empirical studies.<sup>11</sup> The value of the  $\chi^2(2)$  test statistic for the restriction given in equation (34) is 1.81 (probability = 40%). We impose these two restrictions and then test for (35). Given that we assume that relative wage is a distribution factor, this is a test for the exogeneity of log relative wages in the relative leisure equation. The  $\chi^2(1)$  statistic for exogeneity is 2.69 (probability = 10%). Given that this is marginally significant we shall present results with and without exogeneity. The first and second set of columns in Table 6 present the estimates for the structural model without and with (35) imposed respectively.<sup>12</sup>

Our main parameter of interest is the coefficient for the log relative wage. As we would expect the effect is stronger when we impose exogeneity (compare the estimates of 0.189 and 0.213 in the expenditure equation) but for both cases it is positive in the consumption equation and negative in the relative leisure share equation. As we recall from (22), the relative wage only affects relative expenditure through its positive effect on the Pareto weight, see equations (25) and (31). This is evidence in favour of the collective model. The fact that the relative wage is negative in the relative leisure equation is not contradictory to the collective framework, but on the other hand a positive effect would have given extra evidence in its support. However, a negative effect means that the unitary effect outweighs the collective effect for leisures, see (23). The difference in age has a negative effect on the Pareto weight so that wives who are older than their husbands have less power. Finally, the level of gross household income has a positive effect suggesting that wives do better in high income households but note that this effect is statistically weak. We interpret our results as being consistent with a non-unitary, collective framework as a suitable description of household decision making for expenditures and time use.

Figure 4 shows the implications of our estimates in graphical form, with exogeneity of relative wages imposed. Since the intercept for the Pareto

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<sup>11</sup>In our estimation the optimal value of  $\sigma$  was 0.06. Using this value rather than the value of 0.1 gives very similar results.

<sup>12</sup>The parameter estimates for the education variables suggest that we cannot treat them (or their difference) as distribution factors; a formal test of (34) confirms this. We also note that excluding the ‘insignificant’ preference factors makes only a small difference for the coefficients on the distribution factors.

|                                      | Relative wage |        | Relative wage |         |
|--------------------------------------|---------------|--------|---------------|---------|
|                                      | endogenous    |        | exogenous     |         |
| Relative expenditure equation        |               |        |               |         |
| Constant                             | −.657         | [1.10] | −.652         | [1.09]  |
| Log hhold gross inc.                 | .138          | [1.35] | .138          | [1.35]  |
| Log relative wage                    | .189          | [2.81] | .213          | [3.24]  |
| Difference in age                    | −.015         | [2.71] | −.015         | [2.71]  |
| Female education                     | −.010         | [0.94] | −.011         | [1.01]  |
| Male education                       | −.003         | [0.23] | −.002         | [0.16]  |
| Young children                       | −.021         | [0.44] | −.020         | [0.41]  |
| Older children                       | −.022         | [0.44] | −.021         | [0.42]  |
| Relative leisure equation            |               |        |               |         |
| Constant                             | −.289         | [4.01] | −.295         | [4.09]  |
| Log hhold gross inc.                 | .014          | [1.35] | .014          | [1.35]  |
| Log relative wage                    | −.048         | [2.47] | −.079         | [11.96] |
| Difference in age                    | −.001         | [2.71] | −.001         | [2.71]  |
| Female education                     | .006          | [1.74] | .007          | [2.08]  |
| Male education                       | .007          | [2.05] | .006          | [1.77]  |
| Young children                       | −.002         | [0.15] | −.004         | [0.29]  |
| Older children                       | −.012         | [0.81] | −.013         | [0.90]  |
| Correlation of errors                | 0.11          |        | 0.11          |         |
| Values in [.] are absolute t-values. |               |        |               |         |

Table 6: Structural form estimates

weight is not identified (see the discussion preceding (34)) we take the relative expenditures to be unity when the wages and the ages are the same and household income is at the mean of the data. The variation in relative wages on the x-axis is from her wage being half of his ( $\ln w = -0.65$ ) to her wage being 60% higher than his ( $\ln w = 0.5$ ). The variation in relative expenditures over this range for medium income households is from around 0.86 to 1.11 so that changes in relative wages lead to substantial changes in expenditure shares: an elasticity of 0.22. The upper and lower lines show the responses for changes in household income of one half of the mean to twice the mean; these are also substantial (about 0.89 to 1.09) but recall that these are imprecisely estimated. The results for the effect of relative wages on relative leisures are a compound of a unitary effect (here fixed to be 0.1) and a collective effect. For the latter the coefficients are the same as for relative expenditures except that the coefficient is multiplied by  $\rho = 0.1$  (see (30) and (31)). The unitary effect elasticity is  $-0.1$  (by assumption) and the collective effect elasticity is  $+0.02$  so that the net elasticity is 0.08.

As we have seen the fits of our reduced form equations are rather poor (2.7% and 3.9% for expenditures and leisures respectively) and most of the variation in relative expenditures and leisures is unexplained. If we are willing to make strong assumptions concerning the error terms in (30) and (31) then we can decompose this latent variation into that part which is due to the unobserved variation in Pareto weights and the part due to measurement error and unobserved preference factors. To do this we assume:

$$E((\varepsilon_\theta + \eta)\varepsilon_\mu) = E(\varepsilon_\tau\varepsilon_\mu) = E((\varepsilon_\theta + \eta)\varepsilon_\tau) = 0 \quad (38)$$

Under these assumptions the variances of  $(\varepsilon_\theta + \eta)$ ,  $\varepsilon_\tau$  and  $\varepsilon_\mu$  are identified from the error variances  $\sigma_x^2$ , and  $\sigma_l^2$  and the covariance,  $cov(\varepsilon_x, \varepsilon_l)$ . The estimated values of the latter are 0.329, 0.0296 and 0.01 respectively. Under our assumptions we have:

$$cov(\varepsilon_x, \varepsilon_l) = \rho\sigma_\mu^2 \quad (39)$$

so that the variance of  $\varepsilon_\mu$ ,  $\sigma_\mu^2$ , is 0.1. The proportions of the latent variation that are explained by the Pareto weight are given by:

$$\frac{\sigma_\mu^2}{\sigma_x^2} = \frac{0.1}{0.329} = 0.304 \quad (40)$$

$$\frac{\rho^2\sigma_\mu^2}{\sigma_l^2} = \frac{0.01 * 0.1}{0.0296} = 0.003 \quad (41)$$

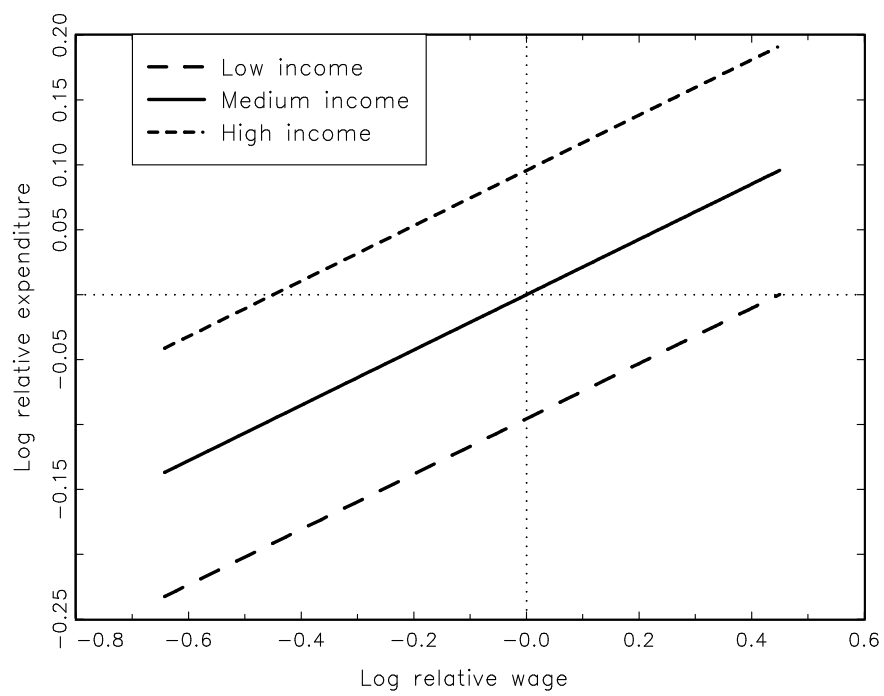


Figure 4: The variation in relative expenditures

for expenditures and leisures respectively. Thus about 30% of the unexplained variation in relative expenditures can be attributed to variations in power but only a fraction (0.3%) can be attributed thus for the leisure relatives.

## 5 Conclusions

This paper treats the interactions between the allocation of time and the allocation of expenditure within the household. We develop a simple collective model with household production which allows us to bring out the main theoretical issues and also to discuss explicitly issues of accounting for heterogeneity, measurement error and exogeneity in our empirical work. We show that if there is no wage variation across households and there is heterogeneity in power and uncorrelated heterogeneity in preferences over work and private goods then relative expenditures and relative leisure will be positively correlated. Conversely, if there is no variation in power and preferences for work and private consumption are negatively correlated then the relative expenditures and leisures will be negatively correlated. We show how variations in wages across couples modify these predictions. For our parametrisation, the effects of changes in relative wages can be decomposed additively into a unitary effect and a collective effect. In the relative expenditure equation, the unitary effect is zero, so only the collective effect is in play. In the relative leisure equations, both effects are operating, see (23). These two effects have opposite signs so that the net effect is ambiguous. Finally, we provide a general proportionality test for a collective model in which all outcomes are efficient.

Although we present theoretical results, the main contribution of our paper is to provide an empirical analysis of the intra-household allocation of time and money, making use of a unique data set with information on both time use, assignable private expenditures and individual wages for more than 600 households. Even though we have a relatively small sample and noisy data some strong signals come through loud and clear in the empirical analysis. In the raw data, leisure and assignable expenditures are relatively equal for husbands and wives in the mean, but there is a great deal of heterogeneity across couples. We find that wives who have more leisure also have higher expenditures, without controlling for any observable covariates. In a reduced form analysis we find that relative wages have a significant and positive ef-

fect on relative expenditures and a significant and negative effect on relative leisures.

Turning to our structural model, we find that tests for a collective model do not reject. We also find that age differences and gross household income can be treated as distribution factors. The evidence on the exogeneity of relative wages in the relative leisure equation is marginal but the conclusions are much the same whether or not we treat relative wages as exogenous in that equation. In terms of observables, distribution factors have a large impact on relative expenditures but only a small (albeit, statistically significant) impact on relative leisures. Thus moving from the wife having a wage that is half her husband's to having a wage that is double increases her share of assignable expenditures by about 25%. The same variation decreases her relative share of leisure by about 8%, most of which can be attributed to the unitary effect. Most of the variation in observed relative expenditures and observed relative leisures is unexplained. Under strong assumptions we conclude that about 30% of the unexplained variation in relative expenditures is due to variations in unobserved power but almost none of the unexplained variation in leisures can be accounted for by variations in power.

## A Appendix

### A.1 Derivation of theoretical results

Given the household utility function:

$$\begin{aligned}\Psi &= \mu u^A(x_A, Q, l_A) + u^B(x_B, Q, l_B) = \\ &= \mu u^A(x_A, F\left(T - l_A - m_A, T - l_B - \frac{(x_H + x_A + x_B - y - w_A m_A)}{w_B}, x_H\right), l_A) + \\ &+ u^B(x_B, F\left(T - l_A - m_A, T - l_B - \frac{(x_H + x_A + x_B - y - w_A m_A)}{w_B}, x_H\right), l_B)\end{aligned}\tag{42}$$

which is maximised with respect to the six control variables  $(x_A, x_B, l_A, l_B, m_A, x_H)$ . Assuming interior solutions<sup>13</sup> we have the following first order conditions:

$$\mu u_x^A = (\mu u_Q^A + u_Q^B) \frac{F_B}{w_B}$$

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<sup>13</sup>In our sample below, all partners are in market work and all report positive levels of leisure.



$$\begin{aligned}
u_x^B &= (\mu u_Q^A + u_Q^B) \frac{F_B}{w_B} \\
F_A &= \frac{\mu u_l^A}{\mu u_Q^A + u_Q^B} \\
F_B &= \frac{u_l^B}{\mu u_Q^A + u_Q^B} \\
F_A &= F_B \frac{w_A}{w_B} \\
F_x &= F_B \frac{1}{w_B}
\end{aligned}$$

In our data, we do not observe anything about the output of the public good produced, so we cannot hope to use the conditions on the marginal productivities  $F_A$ ,  $F_B$  and  $F_x$ . Rearranging the first-order conditions, we end up with the four equations (9)-(12) in the text.

## A.2 Derived preferences over total expenditure and market work

We here show that if preferences over consumption, leisure and the home produced good are additive then derived preferences over total expenditure and market work have ‘consumption’ non-separable from market work. Suppose we have a single person with the utility function  $u(x, Q, l)$  and access to home production  $Q = F(h, y)$  where  $h$  is housework and  $y$  is expenditure on home production. Time use satisfies the constraint:  $m + l + h = T$ . We define a derived utility function over total expenditure,  $c = x + y$ , and market work,  $m$ , by:

$$V(c, m) = \max_{y, h} \{u(c - y, F(h, y), T - h - m)\} \quad (43)$$

That is, the total expenditure,  $c$ , is divided optimally between direct consumption ( $c - y$ ) and home production ( $y$ ) and housework is chosen optimally, given the market work level,  $m$ . By the envelope theorem we have:

$$V_c(c, m) = u_x(c - \hat{y}, F(\hat{h}, \hat{y}), T - \hat{h} - m) \quad (44)$$

where subscripts denote partial derivatives. Taking derivatives with respect to  $m$  we have:

$$V_{cm}(c, m) = -u_{xx} \frac{\partial \hat{y}}{\partial m} + u_{xQ} \left[ F_h \frac{\partial \hat{h}}{\partial m} + F_y \frac{\partial \hat{y}}{\partial m} \right] - u_{xl} \frac{\partial \hat{h}}{\partial m} \quad (45)$$

If we impose additivity on  $u(\cdot)$  this gives:

$$V_{cm}(c, m) = -u_{xx} \frac{\partial \hat{y}}{\partial m} \quad (46)$$

which is positive if housework and market inputs to home production are substitutes ( $\frac{\partial \hat{y}}{\partial m} < 0$ ). Thus consumption ( $c$ ) and market work ( $m$ ) are complements in the derived utility function.

### A.3 The interpretation of the leisure curvature parameter

Once again we consider a single agent and we ignore home production. Our parameterisation (13) has:

$$u(c, l) = \ln c + \left( \frac{\rho}{\rho - 1} \right) (l)^{\left( \frac{\rho - 1}{\rho} \right)} \quad (47)$$

Denoting wage by  $w$  the first order condition is:

$$u_l = w u_c = \lambda w \quad (48)$$

where  $\lambda$  is the marginal utility of consumption. Using the parameterisation and normalising the total time available to unity ( $l + h = 1$ ), we have the following closed form for the Frisch (or  $\lambda$ -constant) labour supply function:

$$\hat{h} = 1 - (\lambda w)^{-\rho} \quad (49)$$

The Frisch elasticity is then given by:

$$\frac{\partial \hat{h}}{\partial w} \frac{w}{\hat{h}} = \rho \left( \frac{1 - h}{h} \right) \simeq 2\rho \quad (50)$$

if we assume that full-time work is about  $h = 1/3$ . Generally the left hand side elasticity is thought to be small with values of 0.1 – 0.2 thought to be plausible, so that values of around 0.05 – 0.1 are probably reasonable for  $\rho$ .

## A.4 Data selection

The initial data set consists of 1767 couples. Of these couples, we have information on hours spent in the labour market, in household production and in leisure for 1522 couples. In our analysis we confine ourselves to looking at couples where both work full time, that is 813 couples. For a little more than 100 of these, we have no information on wage rates for both spouses in the household. We also have to have information on assignable consumption on clothing, recreation and other personal consumption for both partners in the household. For a good 50 of the couples, this information has not been given in the questionnaire. Finally, we drop a small number of outliers and end up with the data set used for this analysis of 615 couples.

## A.5 Summary statistics

In the table below are shown the summary statistics for the 615 couples used in the estimations.

|  | Mean  | Std. | Min. | Max. |
|--|-------|------|------|------|
| Female relative consumption              | 1.20  | 0.72 | 0.09 | 4.70 |
| Female relative leisure                  | 0.99  | 0.18 | 0.48 | 1.98 |
| Female relative age                      | 0.96  | 0.10 | 0.64 | 1.53 |
| Relative wage                            | 0.93  | 0.25 | 0.06 | 1.93 |
| Household gross income                   | 0.61  | 0.20 | 0.15 | 2.72 |
| Female age                               | 40.47 | 9.53 | 19   | 61   |
| Female education, # of years             | 13.37 | 2.55 | 10   | 18   |
| Dummy for young children (up to 6 years) | 0.39  | 0.49 | 0    | 1    |
| Dummy for older children (7-17 years)    | 0.31  | 0.46 | 0    | 1    |

## A.6 Diary and survey time use

Figure 5 below compares the distributions of women's housework share (her housework relative to total housework) from the question on usual time use for housework and the information from the time diaries. As we would expect, the diary information is much more dispersed. This reflects infrequency in the diary information and rounding in the survey response data. This can be seen most clearly in the spikes at zero and unity. The means and medians of the two sources are (0.61, 0.60) for the diary and (0.59, 0.57) for the usual time response.

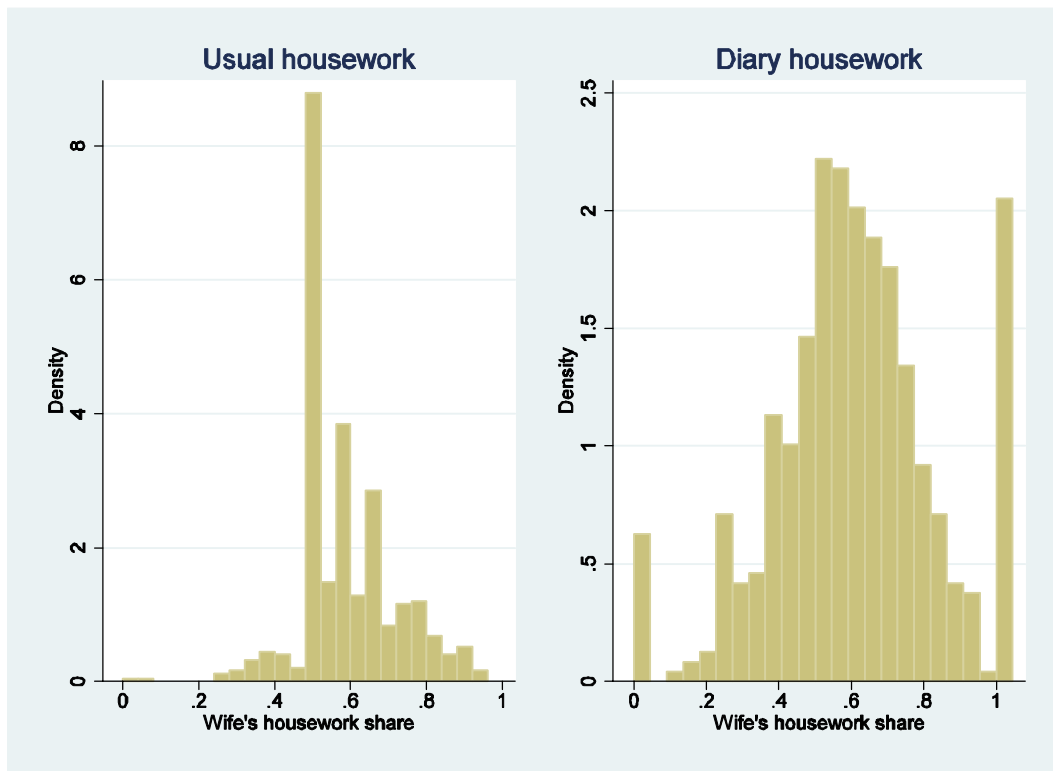


Figure 5:

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## **Chapter 3**

### **Ageing and Well-being: Consumption and Time Use of Elderly Americans**



# Ageing and Well-being: Consumption and Time Use of Elderly Americans

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## Abstract

This paper studies patterns of consumption, household production and leisure for the elderly American population. The main objective of the paper is to study how incorporating the value of time spent in household production and leisure affects economic well-being. Based on the 2003 Consumption and Mail Activities Survey (CAMS) from the Health and Retirement Study (HRS), we find that the level of expenditure is lower for non-retired people, while levels of housework and leisure are higher. We also see that expenditure are decreasing with age, while leisure is increasing with age for both groups. Inequality in expenditure is higher for the group of retired households as compared to the group of non-retired households. However, while the elderly and retired seem to be less well off in terms of consumption goods bought in the market, they are generally “richer” in terms of time for household production or leisure. Broadening our concept of economic well-being to include first the value of household production and secondly the value of leisure reduces our measure of economic inequality among the elderly.

Keywords: Ageing, inequality, household production, well-being

JEL classifications: D3, J1

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# 1 Introduction

The economic well-being of the elderly population has been followed closely over the last couple of decades as the population share of the elderly as well as the mean age have increased, cf. Hurd (1990), Lumsdaine and Mitchell (1999), Rendall and Speare (1993). Much of the interest has focused on comparing income or expenditure of the working and the retired population. However, the debate usually underlines that economic well-being should be analyzed in a broader context incorporating other sources of welfare as e.g. household production and leisure, cf. Hamermesh and Pfann (2004), Becker (1965), Gronau (1986), Bonke (1992), Dow and Juster (1985).

This paper looks into consumption, household production and leisure for the elderly population. We use data from a survey from the US Health and Retirement Study (HRS), the Consumption and Activities Mail Survey (CAMS) from 2003, to study consumption, household production and leisure for elderly people. In general, for people at the same age, we find significant differences in levels of expenditure and time-use depending on whether people have retired or not. Based on cross-sectional evidence, we see that expenditure is decreasing with age, while leisure is increasing with age. Housework is slightly decreasing with age. These trends are characteristic of both the retired group and people still at work.

The main purpose of this paper is to analyze distributional issues related to ageing and retirement.<sup>1</sup> More specifically, we explore the consumption distribution among the elderly and the differences between people who have retired and people still working in terms of different concepts of consumption. The average level of expenditure is around 10-20 percent higher for the non-retired population as compared to the retired population and inequality is higher for the group of retired households as compared to the group of non-retired households. Our analysis confirms that while the elderly seem to be less well off in terms of consumption goods bought in the market, they are generally “richer” in terms of time which can be allocated to either household production or leisure. We broaden our concept of economic well-being to include first the value of household production, and secondly the value of leisure. This has consequences for our assessment of inequality among the elderly.

The paper is organized as follows. Section 2 describes the data applied in the analyses. Section 3 presents trends in consumption of the elderly. Section 4 shows the

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<sup>1</sup> In studies of inequality, current income may not reflect the long run consumption possibilities of the household. Due to possibilities of borrowing and saving through the capital markets, intergenerational transfers etc., current income is usually more fluctuating (volatile) than consumption. This makes measured inequality based on income data, particularly income data from one year, higher than if the analysis was based on consumption, cf. Blundell and Preston (1998), and Attanasio et al. (2004). Problems of large differences between income and consumption might even be more serious for the group of elderly people since this group will often have a lower income from market activities supplemented with consumption out of savings etc.

distribution of expenditure among the elderly and discusses the distributional aspects within and across the subgroups retired and non-retired people. Section 5 presents trends in time use for the elderly. In section 6, we discuss the value of time spent in household production and leisure, and we look at the consequences of including the value of time for the level of distribution of economic well-being in a broader sense. Section 7 concludes.

## 2 Data

Data used for this paper is from the US Health and Retirement Study (HRS). In particular, we use the Consumption and Activities Mail Survey (CAMS) which has information about time use and consumption for the elderly population in 2001 and 2003. We use data from the 2003 survey to study inequality in consumption and time use.<sup>2</sup> CAMS is described in Hurd and Rohwedder (2003, 2005). Further documentation on the CAMS and HRS data can be found at the Health and Retirement Study webpage (<http://hrsonline.isr.umich.edu>).

The consumption part of the survey asks about recalled consumption of a long list of consumption items. The respondent could choose to report consumption per week, per month or per year and indicate the chosen reporting period for each consumption item. Total consumption and consumption in the main consumption groups in CAMS is comparable to consumption of the same age group in the CEX, cf. Hurd and Rohwedder (2005).

CAMS' time use information is based on respondents' recalled time use over the last week or month, depending on the character of the activity. Previous analyses of time use data observe that information based on respondents' recalled time use has a lower variance than time use information based on a diary. On the other hand, time use diaries generally give better estimates of average time use, cf. Juster and Stafford (1991). The questions in the time use survey allow for double activities. The respondents were asked to assess their time spent on different activities, irrespective of whether these activities were carried out as the single activity at the time or the respondent performed several activities at the same time. For example, if the respondent spent one hour ironing while at the same time watching the television, the time use at both activities would be counted as one hour. Therefore, it is not given that the sum of all activities adds up to 24 hours a day. We have made the simplifying assumption that one hour spent on  $M$  activities is equal to  $1/M$  effective hours devoted to each activity. We argue that this is justified based on the observation that the productivity in work done when "multi-tasking" is lower than in the case where the person is only doing one thing at the time. Moreover, if

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<sup>2</sup> We performed the analysis with 2001 data, too. The results from using 2001 and 2003 data, respectively, give similar results. We concentrate on 2003 data in this paper.

the person enjoys leisure (e.g. watches television) while at the same time ironing, the individual value of this leisure is lower than if the person had simply concentrated on watching television. In praxis, this means that we have rescaled all detailed activities to ensure that the sum of time use per person equates 24 hours a day.

Due to missing information and outliers in many consumption and time-use variables, it has been necessary to perform a thorough data cleaning. The result of the data cleaning process is a dataset of a little more than 1000 individuals. Retirement status is generally based on people's own reporting. The average retirement age for the whole sample in our dataset is around 62 years.

### **3 Expenditure and ageing**

In the following, we use information on consumption from the CAMS data on 8 main consumption groups: housing (mortgage plus rent), utilities (energy, water and telephone), car use (petrol plus repairs/services), health related expenditure (excluding health insurance), expenditure on equipment for home and garden (not repairs/maintenance etc.), food at home, dining out, clothing and equipment for leisure activities (including travel expenditure) and other expenditure (gifts, contributions etc.). We define our measure of total consumption as the sum of these 8 main consumption groups. We define basic consumption as food at home, food out, clothing and expenditure for leisure activities.

Data on expenditure is generally collected at the household level. The level of consumption is likely to vary depending on whether the household consists of a single person, is a married household or a household with children still living at home. As it is custom in these types of analyses, we adjust total expenditure for the number of household members. As there are obviously economies of scale related to sharing the same house and other types of consumption, it is customary to take this into account using so-called "equivalence scales", meaning that the correction factor takes economies of scale into account. We use the most simple equivalence scale, the square-root of the number of household members, to adjust for different household sizes. However, this definition of equivalence scale is problematic, cf. Atkinson and Bourguignon (2000). One of the problems with this simple adjustment is that it does not treat additional household members differently depending on whether they are adults or children.

Figure 1 shows cross-sectional evidence for total consumption and for aggregated basic consumption. For both consumption aggregates, we find that consumption is lower for the older respondents in the survey than for the younger respondents. Moreover, for almost all age categories, respondents not having retired have a higher level of consumption than retired people.

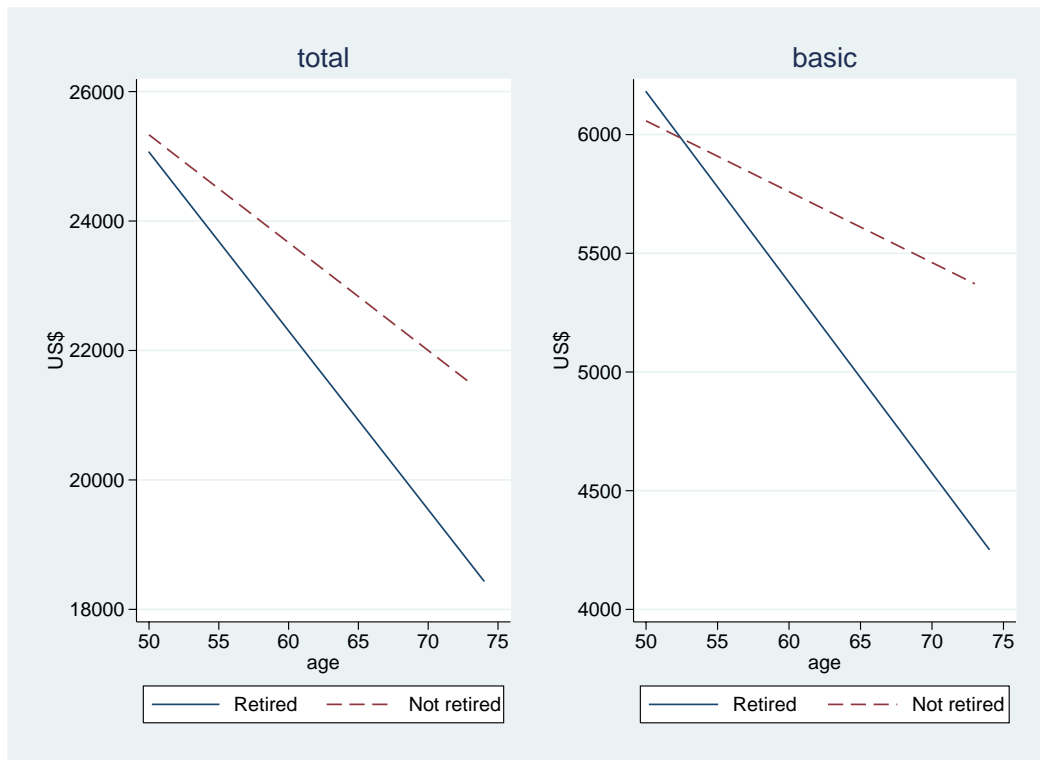


Figure 1: Expenditure through age

The development in consumption for the detailed categories over age shows the same pattern as for total expenditure, see figures 2-6. Except for health expenditure, consumption is decreasing monotonically with age, and the level of consumption is higher for non-retired than for retired persons. The difference in consumption across the two groups of retired and non-retired is significantly different from 0 according to a simple t-test. For non-retired respondents approaching the usual retirement age, consumption is getting closer to the consumption level for retired people. It should also be underlined that the group of non-retired gets very thin in the high-age groups.

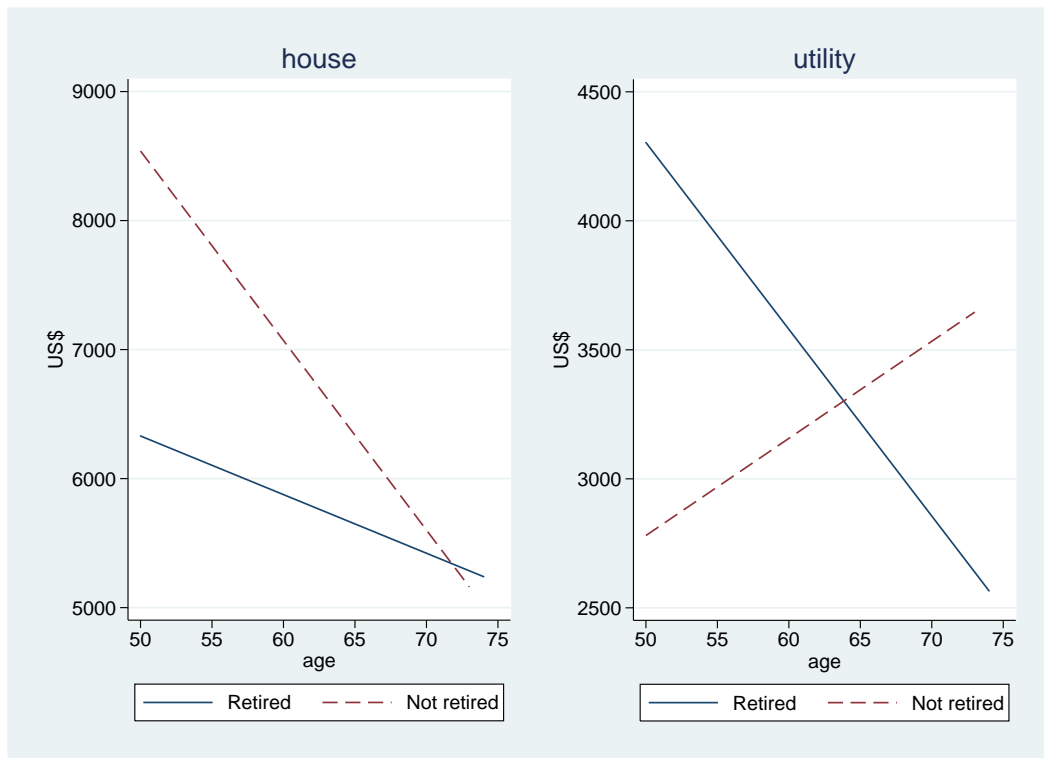


Figure 2: Expenditure on housing and utilities over age

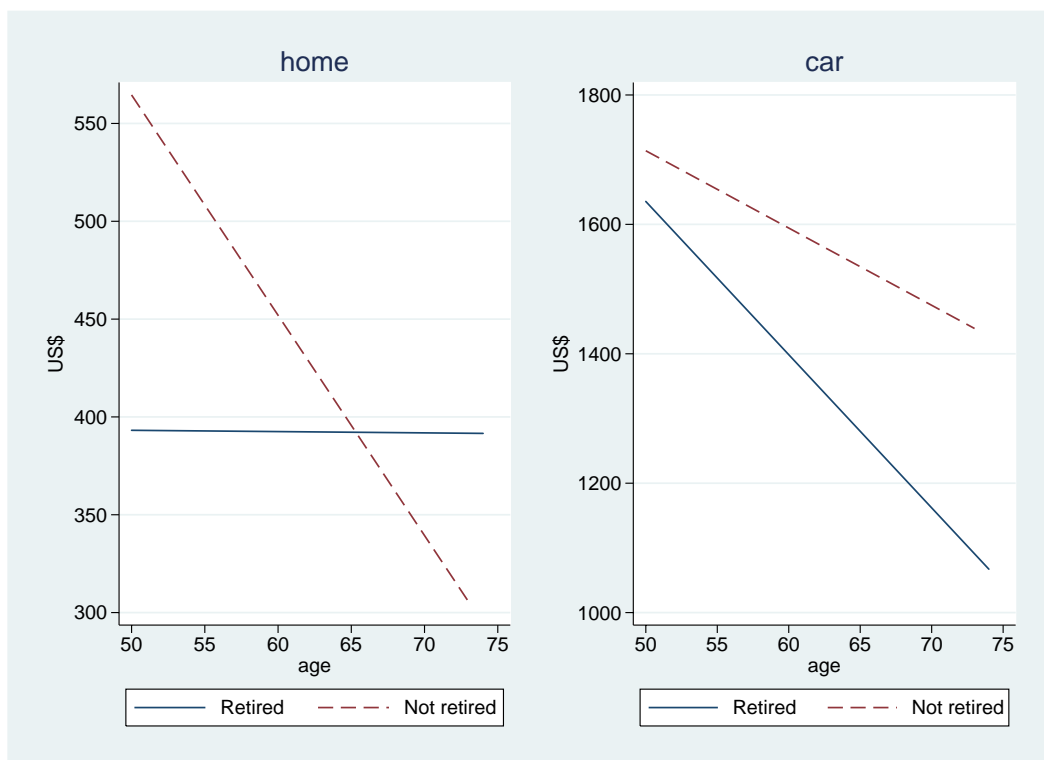


Figure 3: Expenditure on home&garden supplies and car use

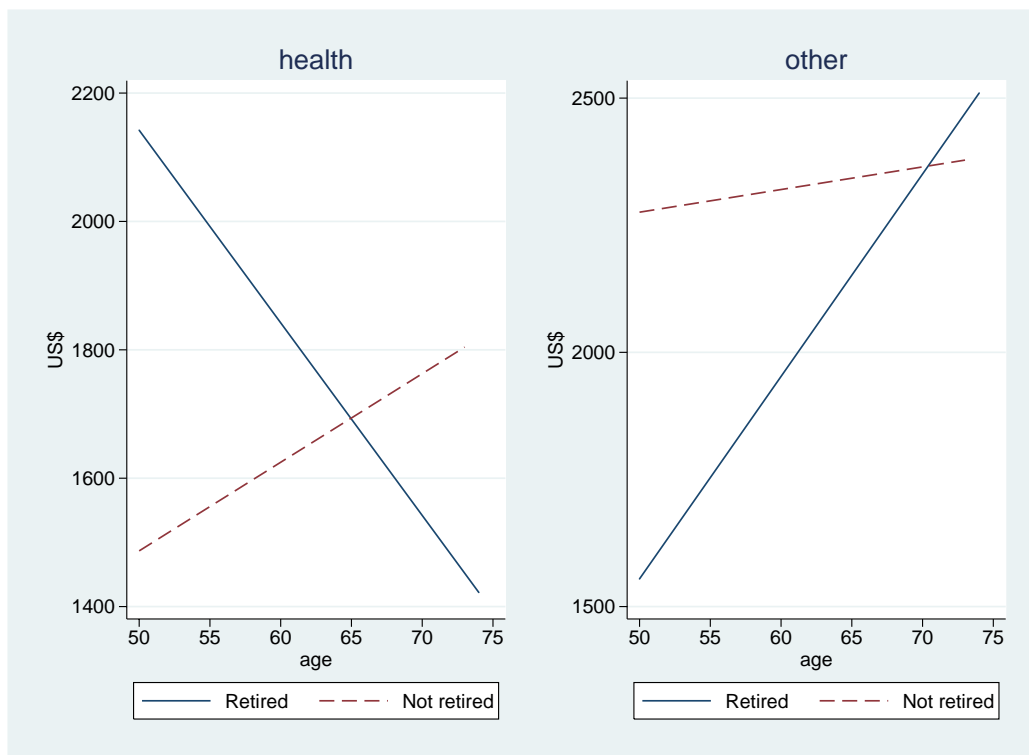


Figure 4: Expenditure on health and other expenditures

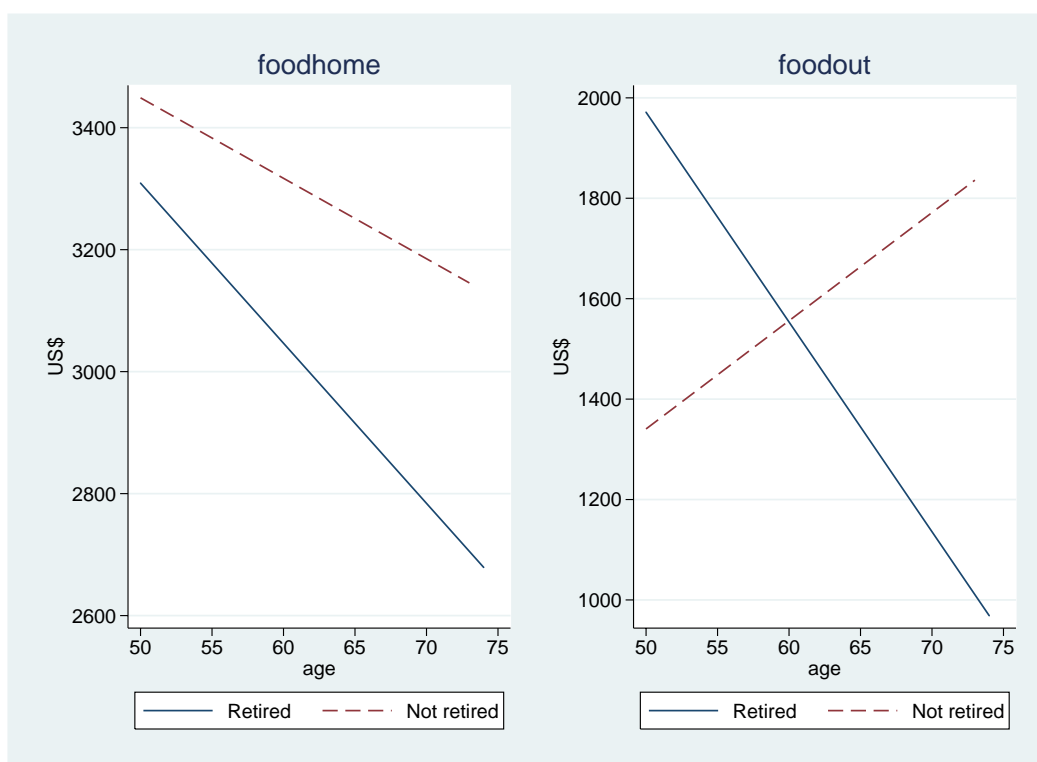


Figure 5: Expenditure on food at home and food out

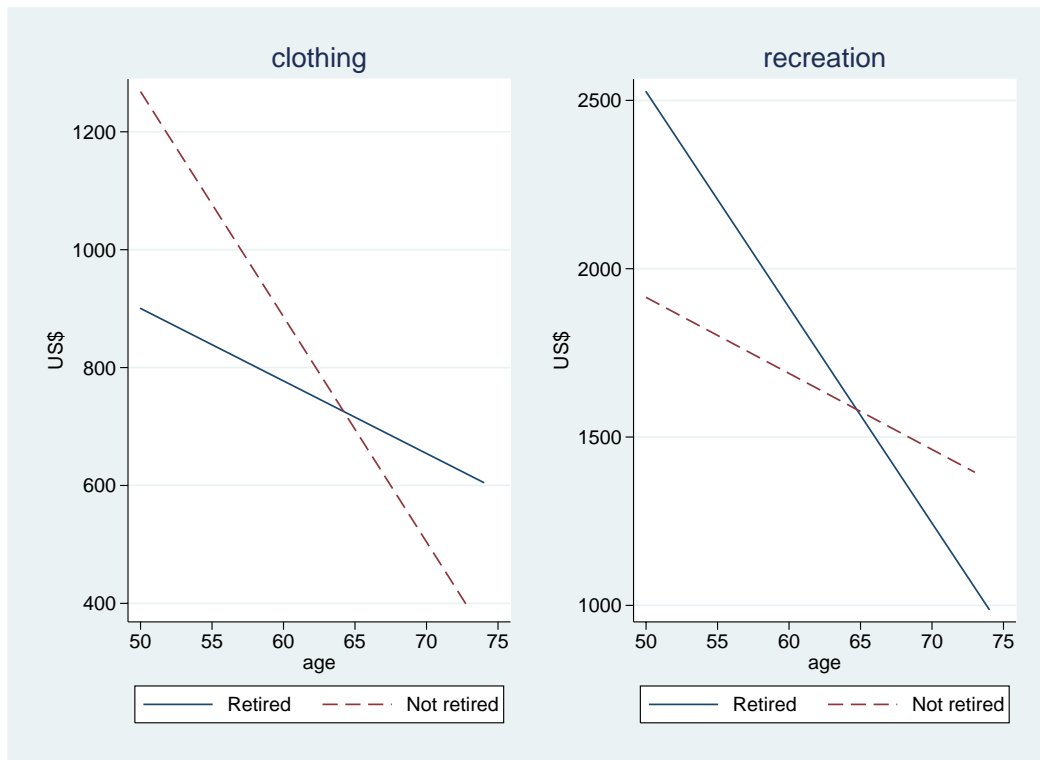


Figure 6: Expenditure on clothing and recreation

When looking at consumption for the retired and the non-retired groups separately, it appears that there is a negative correlation between consumption and age for both groups. Thus, consumption is declining with age for both retired and non-retired people, but at different levels. Moreover, the consumption level for the non-retired converges to the consumption level for the retired population at the same age as people approach the normal retirement age.

However, it should be emphasized that this is cross-sectional evidence. Thus, when comparing consumption across age, we are in fact comparing consumption for different cohorts in the population. The CAMS-cohort around the age of 70, who was born in the beginning of the 1930's, has faced other possibilities and living conditions than the CAMS-cohort now around the age of 50 who were born in the 1950's. Furthermore, different cohorts have faced different options for inter-temporal substitution due to long-term shifts in capital markets, interest rates etc. which might have induced them to choose different paths of consumption.



## 4 Distribution of expenditure

We now turn to look at the distribution of consumption in the elderly population. In general, insight into the distribution of *consumption* is preferable to information on the distribution of *income* if we want to compare welfare distribution in the population, especially for the group of elderly where savings, capital income etc. serve as a significant source of consumption.

The literature on inequality contains a vast discussion on appropriate measures of distribution and inequality, cf. Atkinson and Bourguignon (2000). Graphical presentations include simple histograms and the Lorenz curve. A number of indices summarize characteristics of the whole income distribution in one “inequality measure”. The Gini coefficient is one of the most well known and popular indices. Graphically, it is related to the Lorenz curve as the area between the Lorenz curve and the diagonal and as such straightforward in its interpretation. However, the Gini coefficient is not decomposable, neither by population subgroups, e.g. through a decomposition in retired and non-retired people, nor by consumption/welfare subgroups. Another group of measures which fulfils the decomposition property is the “generalized entropy” measures including Theil’s index (1967). Simple variance measures are also decomposable into within-group and between-group effects.<sup>3</sup>

In the following, we use a number of different measures of inequality to ensure that our assessment of distributional issues is not a consequence of the chosen inequality measures. For graphical presentations, we draw the Lorenz curve. For numeric presentation, we calculate the coefficient of variation (standard deviation divided by mean), the standard deviation of log consumption (which is often preferred as it puts relatively less weight on observations in the tails of the distribution), and the Gini and Theil indices. The Theil and Gini indices in their general form are (Cowell, 2000):

$$\begin{aligned} I_{Theil}(F) &\equiv \int \frac{x}{\mu(F)} \log\left(\frac{x}{\mu(F)}\right) dF(x) \\ I_{Gini}(F) &\equiv \frac{1}{2\mu(F)} \iint |x - x'| dF(x) dF(x') \end{aligned} \tag{1}$$

Thus, the Gini index measures the mean difference between any observation  $x$  and another observation  $x'$  in the distribution.

Since our data is probably most noisy in the tails of the expenditure distribution due to missing information or misunderstandings in questionnaire, measurement error etc.,

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<sup>3</sup> One could be concerned that the choice of inequality measure to compare distributions might lead to contradictory conclusions. For distributions with the same mean and total population, it can be shown that the use of different indices lead to the same conclusion if the Lorenz curve for one distribution is above the Lorenz curve for another distribution at all points in the distribution. This condition is known as “Lorenz dominance”.

we also report the easily interpretable decile ratio (D9/D1), which is expenditure for the household at the 90<sup>th</sup> percentile over expenditure for the household at the 10<sup>th</sup> percentile.

|                                  | <b>Total</b> | <b>Retired</b> | <b>Non-retired</b> |
|----------------------------------|--------------|----------------|--------------------|
| Decile ratio (D9/D1)             | 4.15         | 4.38           | 3.38               |
| Coefficient of variation         | 0.59         | 0.63           | 0.54               |
| Standard deviation of log(xtot1) | 0.55         | 0.57           | 0.50               |
| Theil index                      | 0.15         | 0.17           | 0.13               |
| Gini index                       | 0.31         | 0.32           | 0.28               |
| Mean expenditure per year, US\$  | 21,900       | 20,700         | 23,800             |
| # of individuals in group        | 1030         | 633            | 397                |

Table 1: Distribution of total expenditure

Based on the inequality measures above, we first note that inequality is higher in the group of retired than in the group of non-retired. The variance of consumption (here defined without correcting for degrees of freedom) is easily decomposed into “within” and “between” groups effects:

$$\begin{aligned}
\text{var}(x) &= \frac{1}{N} \sum_{i=1}^N (x_i - \bar{x}_N)^2 = \frac{1}{N} \sum_{i=1}^N x_i^2 - \bar{x}_N^2 = \\
&= \frac{1}{N} \left( \sum_{i=1}^R x_i^2 - \sum_{i=R+1}^N x_i^2 \right) - \left( \frac{1}{N} (R\bar{x}_R^2 - L\bar{x}_L^2) \right)^2 = \\
&= \frac{R}{N} \text{var}(x_R) + \frac{L}{N} \text{var}(x_L) + \frac{RL}{N^2} (\bar{x}_L - \bar{x}_R)^2
\end{aligned} \tag{2}$$

where R is the group of retired people, L is the group of people who are still in the labor market, and N is the whole group of elderly, implying R+L=N. x is expenditure per equivalence scaled household.  $\bar{x}$  is mean within relevant group.

Thus, the variance in expenditure x for the whole group of elderly is equal to a weighted sum of the variances of each sub-group – the “within effects” - plus the square of the difference in mean expenditure weighted by  $RL/N^2$  – the “between effect”.

Using the variance decomposition approach outlined above, we find that within-group effects of the two groups, retired and non-retired, contribute to the major part of the total inequality in the group of elderly. Less than 1 percent of total inequality can be attributed to between-group effects. This is consistent with the finding that mean expenditure does not vary much between the two groups.

One of the important advantages of the Theil index is that it is decomposable for subgroups of the population and that the decomposition is simple to interpret. The Theil

index can be decomposed into a weighted sum of Theil indices for the population subgroups plus a Theil index for the inequality between the means of the subgroups:

$$I_{Theil} = \sum_{j=1}^J \left[ \frac{X_j}{X} I_{Theil,j}(x_1, \dots, x_{Nj}) \right] + I_{Theil}(\bar{x}_1, \dots, \bar{x}_J) \quad (3)$$

$$X = \sum_{j=1}^J X_j = \sum_{j=1}^J \sum_{i=1}^{Nj} x_{ij}$$

For example, in the case where we want to decompose the total population of elderly people into the two groups of retired and non-retired people, we find that the Theil index for the total population is the sum of the Theil indices for each subgroup, each weighted by the consumption share of this subgroup (the “within” effects), plus the Theil index found when comparing the consumption means across subgroup (the “between” groups effect). Based on the calculations above, the Theil index value of 0.15 for the total population of elderly constitutes of a contribution of 0.10 from the group of retired and 0.05 for the group of non-retired. Therefore, the “within” effects contribute to the main part of inequality among the elderly, while the “between” effect is negligible. This is consistent with the conclusion for the variance decomposition.

## 5 Time use and ageing

The respondents in the CAMS survey were asked to state their time use on 31 activities, cf. table A3 in the appendix. These activities are aggregated into 6 major activity groups: leisure, housework, marketwork, personal care, transport & communications (including computer time) and other activities (including volunteer work, helping out friends and family etc.).

Comparing time use for retired people and non-retired people, it appears that the time spent on the 6 main activities is very different between these two groups. Not surprisingly, the level of market work is significantly higher for people still in the labor market (some retired people still have a low number of working hours), whereas people who have retired spend a significant number of extra hours in leisure or with housework. We also find that the time spent on personal care is somewhat higher for people who have retired, and the same is true for time spent in other activities (which is a small number of hours). On the other hand, people who have not retired spend more time traveling/commuting or communicating (using computer).

|                           | All  | Retired | Non-retired |
|---------------------------|------|---------|-------------|
| Leisure                   | 8.3  | 9.4     | 6.4         |
| Personal care incl. sleep | 8.0  | 8.3     | 7.4         |
| Housework                 | 3.0  | 3.3     | 2.4         |
| Travel and communication  | 1.8  | 1.5     | 2.4         |
| Marketwork                | 2.1  | 0.6     | 4.6         |
| Other activities          | 0.8  | 0.9     | 0.7         |
| No. of households         | 1030 | 633     | 397         |

Table 2: Time use in hours per day

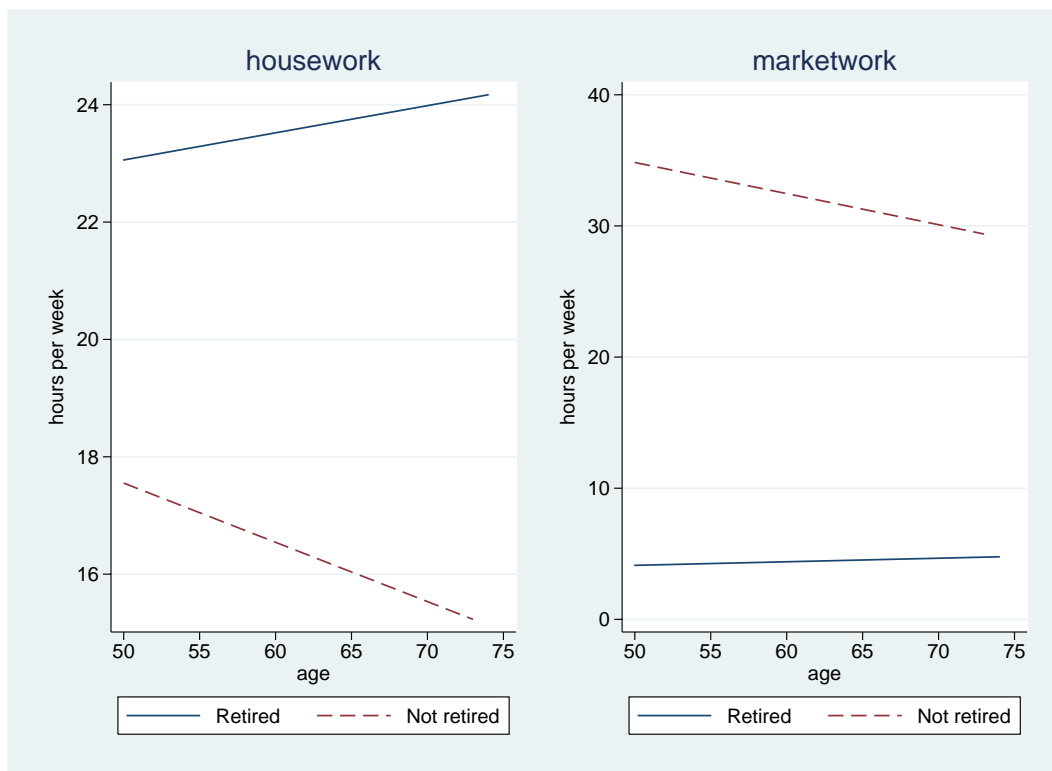


Figure 7: Time in housework and marketwork over age

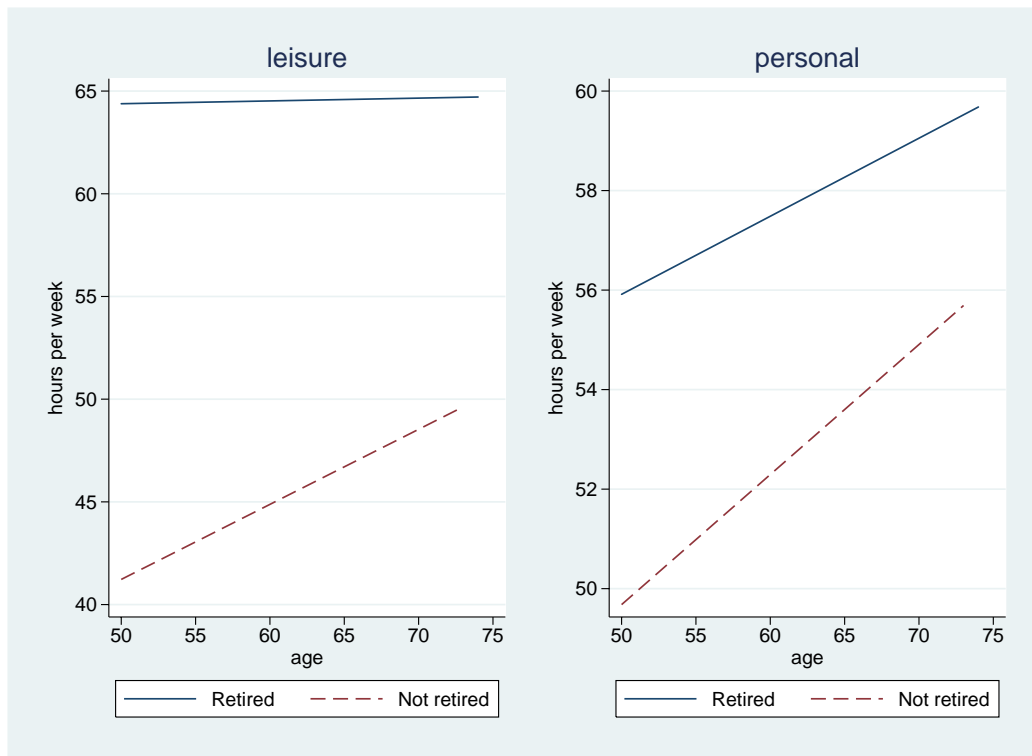


Figure 8: Time spent in leisure and personal care & sleep

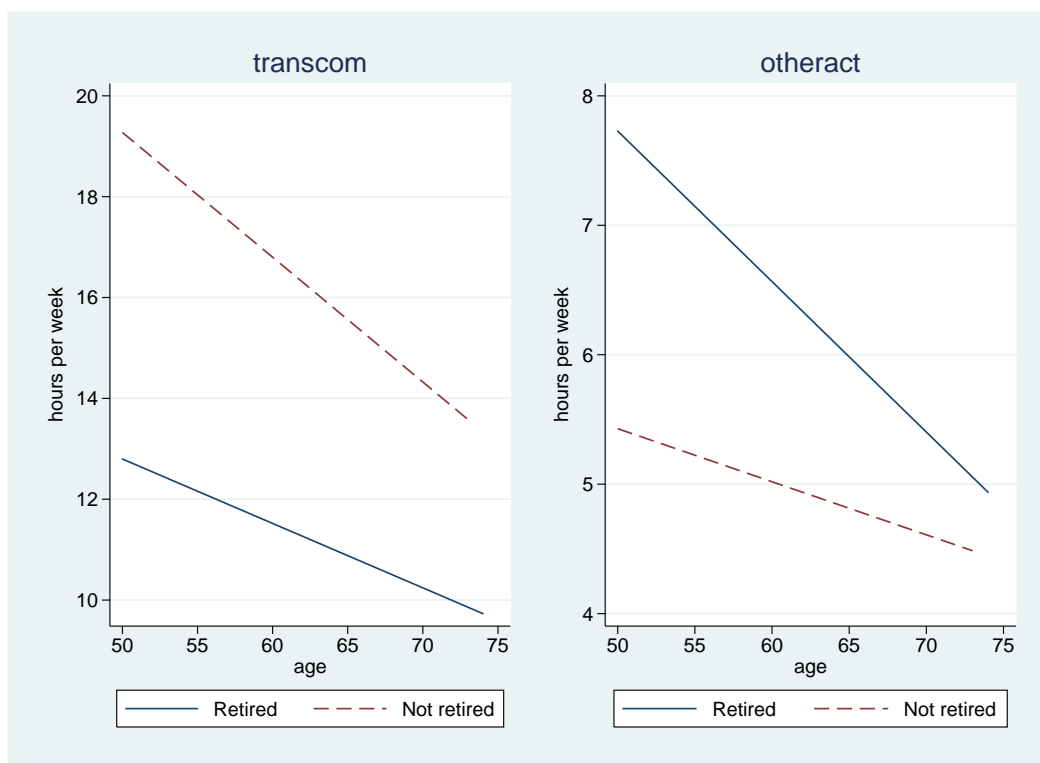


Figure 9: Time spent in transport & communications and other activities

The variation in time use over different age groups shows the same pattern for the retired and the non-retired group. The level of market work slowly declines over the age groups. Housework, which is at a relatively high level for the retired people, slowly increases with age. The level of housework is decreasing across age groups for the group of non-retired. Time spent on leisure activities decreases with age for non-retired people and is fairly constant for retired people.

Time spent on personal care including sleeping increases with age, whereas time spent on transport & communications and other activities decreases with age for both retired and non-retired. Again, it should be noted that we are looking at cross-section data where cohort effects are present. Thus, time spent on computer use is probably affected by the fact that people in their 50's are much more likely to have learned to use a computer than people in the 70's.

Our results on trends in time use over ages confirm prior analyses, cf. Hill (1985) and Bureau of Labor Statistics (2004).

## **6 Economic well-being**

### **6.1 The value of time**

The above analysis illustrates that consumption is decreasing with age, while household production and leisure is increasing with age. This tendency might be interpreted as evidence of the observation that households substitute expenditure with time – in household production and leisure – when they age. Thus, households substitute from goods bought in the market to goods produced at home and to leisure. To fully measure the welfare effect of these substitution effects, we have to measure the value of time spent in household production and leisure.

Generally, there are two main methods for assessing the value of housework. By the first method, housework is valued through its opportunity-cost where the shadow price of household production equals the individual wage rate. An alternative approach is to price household production by a market alternative. For example, the value of time spent on cleaning equals the price of cleaning bought in the market. For a discussion of the value of a housewife's time, see Chiswick (1982).

Both valuation methods are problematic. Valuation by market alternative is far from ideal. Differences in productivity between household production performed by one-self and house services could lead to a biased estimate of household production. On the one hand, this estimate might be upward biased because productivity in household production by the husband or wife is lower than the productivity of a hired professional carrying out work in the household. This productivity difference is probably most prevalent when comparing the work of a trained craftsman with do-it-yourself work. On

the other hand, it might be argued that the estimate of the value of do-it-yourself work might be downward biased since people might put more energy, effort and concentration into work done for themselves than a professional would have done. Furthermore, valuation by this method requires detailed knowledge of the type and quality of the activity performed at home in order to find a relevant market substitute.

The valuation by opportunity cost is based on the perception that individuals allocate their time between market work and housework in such a way that the marginal products of their time in both uses are equal to their wage rate. One obvious objection to this approach is that it does not provide a valuation of alternative time uses for corner solutions, i.e. in cases where people do not spend any time at housework, but only in market work. Or, vice versa, when people spend no time in market work, but only work in the house, for example because they have retired.

A pragmatic approach to the last problem could be to use individual wage rates observed shortly before retirement. However, we would then implicitly assume that productivity in various activities is constant over the years after retirement. Thus, we would not account for declining productivity in housework as people get older; e.g. as a consequence of health problems, reduced physical mobility, cognitive ability etc. In general, evaluating the value of time by its alternative cost seems less relevant for people who are retired. Retirement is a more or less “irrevocable” decision as it can be difficult to return to the labor market after some years in retirement. On the other hand, returning to the labour market from retirement is not uncommon. In the CAMS data, a few individuals who reported that they were retired in 2001, had returned to the labour market in 2003. Maestas (2004) analyzed “unretirement” transitions based on HRS data. She found that nearly one-half of retirees follow a non-traditional retirement path that involves partial retirement and/or retirement. Moreover, the unretirement rate observed at least five years after their first retirement is around  $\frac{1}{4}$ . Dygalo and Abowd (2005) study trends in productivity over the labor market career and find that in general, productivity increases with age. It is difficult to find studies that analyze what happens to productivity close to and after retirement. Gronau and Hamermesh (2001) show that there is a positive correlation between the level of education and demand for variety in time-use activities. They interpret this result as evidence that people with higher levels of education have a higher productivity, not only in market work, but also in housework.

Another common objection to the use of the wage as an indicator for the value of household production is that certain types of housework provide individual satisfaction to the person performing the activity. Following this line of thought, these so-called “process benefits” should partly be considered as a form of leisure activity. Prominent examples are time devoted to child care, gardening, some do-it-yourself activities etc. This problem is discussed in Gronau (1986), Graham and Greene (1984), and Kerkhofs and Kooreman (2003) and will not be discussed further here. Previous studies of process benefits indicate that people rate time with children and friends highest, closely followed

by market work, while most housework activities are rated considerably lower, cf. Hallberg and Klevmarken (2003) and Juster (1985).

The HRS Core Data provides information on hourly wages for a large part of our CAMS sample. The mean hourly wage in our sample is US\$ 25 which is higher than the mean wage for the private sector reported by the Bureau of Labor Statistics (BLS) which is US\$ 18. The wage information in HRS is noisy. As a pragmatic solution, we base our valuation of time on the mean wage from BLS (corrected for an average marginal tax rate of 30 percent). Obviously, this is problematic, as there are productivity differences across the population in both market work and housework. Furthermore, these productivity differences probably affect the allocation of time between market work and housework. We use half the after tax mean wage to value time spent in household production or leisure. This correction is arbitrarily chosen to take account of the possible decline in productivity after retirement. The correction is in accordance with Aguiar and Hurst (2004) who also arbitrarily choose to use one-half the previous wage rate to value household production. Thus, we operate with a value of one hour spent in household production or leisure of approximately \$6 which probably represents a lower bound on the value of time in leisure and household production.

## 6.2 Redistribution of well-being

In the following, we try to take the value of time into account. We define extended consumption as total expenditure plus the value of household production. And we define total welfare as total expenditure, the value of household production and the value of leisure.

It is not always obvious whether the result of housework, household production, is a private good or a public good. In the following we assume that household production is shared within in the household. For example, the result of the time spent cooking a meal by one spouse will usually be enjoyed by both spouses. Likewise, a newly cleaned house will benefit both spouses, although preferences for a clean house might differ within the household. We do not take scale effects in household production into account. Therefore, parallel to the consumption data above, we apply an equivalence scale correction to adjust for number of household members consuming household production. On the other hand, we do not have any knowledge of the housework by the spouse. Also, one could argue that household production is a public good where consumption is non-rival. On the other hand, the level of household production is somewhat higher in couples than for singles.

Figure 10 below depicts Lorenz curves for total expenditure (left panel, above), for extended consumption (right panel, above), and for total welfare (left panel, below).





Figure 10: Lorenz curves for total consumption, extended consumption (including housework) and welfare (including value of leisure)

The inequality indices and measures for expenditure, extended consumption and welfare in table 3 confirm that inequality shrinks, the more broadly defined our consumption/welfare concept is. Thus, when allowing for the value of household production in our extended consumption concept, the Gini coefficient reduces from 0.31 to 0.26. When we include the value of leisure in the extended welfare figure, inequality is even further reduced to 0.17. These trends hold when we treat the groups of retired and non-retired separately.

|                      | <b>Expen-<br/>diture</b> | <b>Household<br/>production</b> | <b>Extended<br/>consumption</b> | <b>Leisure</b> | <b>Welfare</b> |
|----------------------|--------------------------|---------------------------------|---------------------------------|----------------|----------------|
| <b>Total sample</b>  |                          |                                 |                                 |                |                |
| Decile ratio (D9/D1) | 4,15                     | 6,30                            | 3,20                            | 2,79           | 2,09           |
| Coeff. of variation  | 0,59                     | 0,70                            | 0,49                            | 0,36           | 0,31           |
| Std. dev. log x      | 0,55                     | 1,12                            | 0,46                            | 0,40           | 0,29           |
| Theil index          | 0,15                     | 0,23                            | 0,11                            | 0,07           | 0,05           |
| Gini index           | 0,31                     | 0,37                            | 0,26                            | 0,21           | 0,17           |
| Mean per year, US\$  | 21,900                   | 5,100                           | 26,900                          | 19,000         | 45,900         |
| <b>Retired</b>       |                          |                                 |                                 |                |                |
| Decile ratio (D9/D1) | 4,38                     | 6,34                            | 3,33                            | 2,16           | 2,00           |
| Coeff. of variation  | 0,63                     | 0,66                            | 0,51                            | 0,29           | 0,29           |
| Std. dev. log x      | 0,57                     | 1,19                            | 0,48                            | 0,33           | 0,28           |
| Theil index          | 0,17                     | 0,21                            | 0,12                            | 0,04           | 0,04           |
| Gini index           | 0,32                     | 0,35                            | 0,27                            | 0,16           | 0,16           |
| Mean per year, US\$  | 20,700                   | 5,600                           | 26,500                          | 21,600         | 48,100         |
| <b>Non-retired</b>   |                          |                                 |                                 |                |                |
| Decile ratio (D9/D1) | 3,38                     | 6,22                            | 2,85                            | 2,69           | 2,18           |
| Coeff. of variation  | 0,54                     | 0,70                            | 0,46                            | 0,37           | 0,33           |
| Std. dev. log x      | 0,50                     | 0,97                            | 0,42                            | 0,39           | 0,31           |
| Theil index          | 0,13                     | 0,22                            | 0,09                            | 0,07           | 0,05           |
| Gini index           | 0,28                     | 0,37                            | 0,24                            | 0,21           | 0,17           |
| Mean per year, US\$  | 23,800                   | 3,900                           | 27,700                          | 14,800         | 42,500         |

Table 3: Distribution of expenditure, extended consumption and welfare

Household production is about as unevenly distributed as expenditure, as reported by table 3. Thus, the significant reduction in inequality when moving from expenditure to extended consumption is due to the fact that household production is negatively correlated with expenditure. In popular terms, people who are relatively poor in terms of money compensate by enjoying the results of a relatively higher household production. This is illustrated by the following decomposition of the variance of extended consumption (extx) into the sum of the variance in expenditure (x), the variance in household production (hhp) multiplied by hourly wage (w) squared and the covariance between extended consumption and hhp multiplied by 2\*w:

$$\begin{aligned}\text{var}(\text{extx}) &= \text{var}(x + w * \text{hhp}) = \\ &= \text{var}(x) + w^2 * \text{var}(\text{hhp}) + 2w * \text{cov}(x, \text{hhp})\end{aligned}\tag{4}$$

The correlation between expenditure and household production is around -0.07. Using the results in table 3, we find that more than 90 percent of the variance in extended consumption can be attributed to the variance in expenditure. In the same manner, we decompose total variance in welfare into the contributions of the sources of total welfare, i.e. expenditure, value of household production and value of leisure and the effects of the correlations among the three sources of welfare:

$$\begin{aligned}\text{var}(\text{welf}) &= \text{var}(x) + w^2 * \text{var}(\text{hhp}) + w^2 * \text{var}(\text{lei}) + \\ &+ 2w * \text{cov}(x, \text{hhp}) + 2w * \text{cov}(x, \text{lei}) + 2w^2 * \text{cov}(\text{hhp}, \text{lei})\end{aligned}\tag{5}$$

The correlation between expenditure and leisure is -0.11, and the correlation between household production and leisure is -0.01. More than ¾ of the variance in welfare consists of the contribution from expenditure, while household production and leisure contribute with, respectively, around 1/20 and 1/5. The negative correlation works in the opposite direction with a total contribution of around -12 percent.

The simple decomposition of extended consumption and welfare in (5) underlines that “redistribution” through the inclusion of time in our welfare concept is sensitive to our valuation of time spent in household production and leisure.

### 6.3 Mobility in well-being

The inequality indices and measures above all share the common feature that inequality is summarized in one figure. However, these measures do not describe the effects at the *individual level* when we broaden our concept of consumption. Thus, a reduction in one of the inequality measures above might reflect that the inclusion of the value of time benefits more in the bottom of the welfare distribution than in the top, still preserving more or less the same ranking of the individuals, but it might also be the case that the ranking has been completely reversed. One way to get a picture of this is to calculate the difference in each individual’s percentile position in the expenditure, the extended consumption and the welfare distributions, respectively. The distributions of these changes are shown in figure 11 below. The peaks of the distributions in all four panels are around zero, indicating that most individuals more or less keep their position in the ranking. However, a considerable amount of people jump several deciles when the consumption concept is broadened from expenditure to extended consumption including household production. And the change in ranking is even higher when the welfare concept is extended to incorporate the value of leisure.

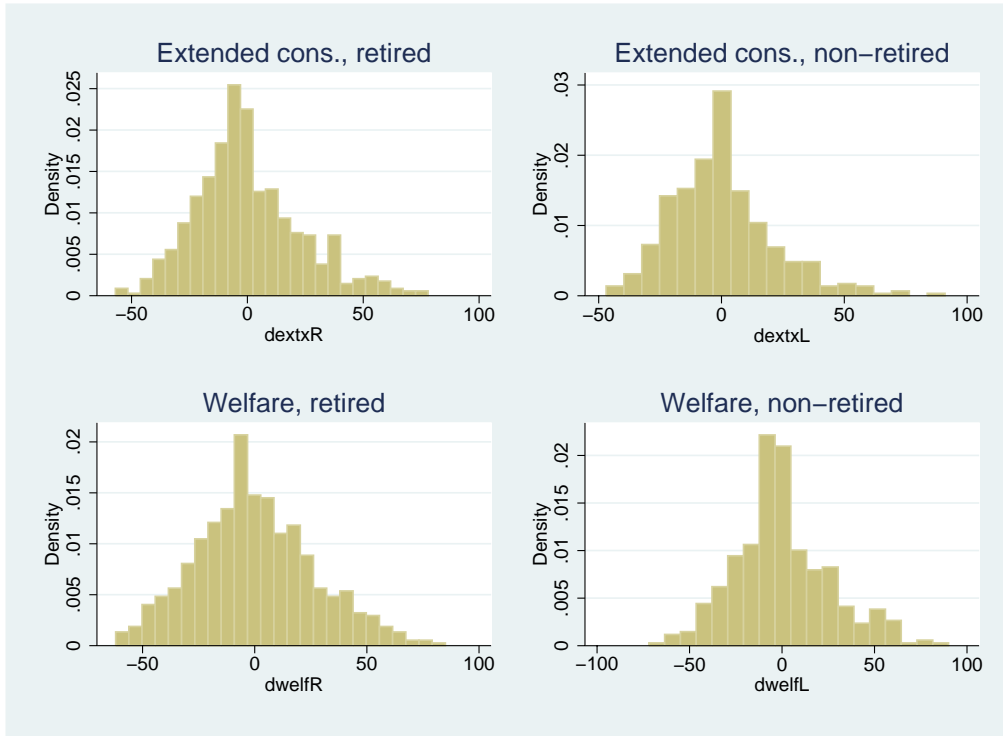


Figure 11: Histograms of changes in percentile position of individuals when moving from expenditure to extended consumption (top) and welfare (bottom)

## 7 Conclusion

The analyses presented in this paper illustrate that inequality is higher among the retired than among the non-retired group. However, people with low levels of expenditure are often less constrained for time for housework and/or leisure. By broadening our concept of economic well-being by taking the value of time in housework and leisure into account, we find that inequality among the elderly in general shrinks. Moreover, we find that the pattern is reversed in the sense that inequality in well-being is lower among the retired than among the non-retired. The results should be interpreted with care as the value of time spent in leisure and household production is difficult to measure, especially for the group of retired where the alternative pricing method makes less sense than for people with a more tight bond to the labor market. Future research in this area is needed to tackle the problems of the valuation of time and the substitutability between expenditure, household production and leisure. Moreover, it would be useful to develop tools to better analyze the “mobility” of individuals/households in the welfare distribution when we move from measures of well-being solely based on expenditure to a measure of well-being which incorporates the value of time.

Appendix



Figure A1: Time spent in housework and marketwork by gender over age

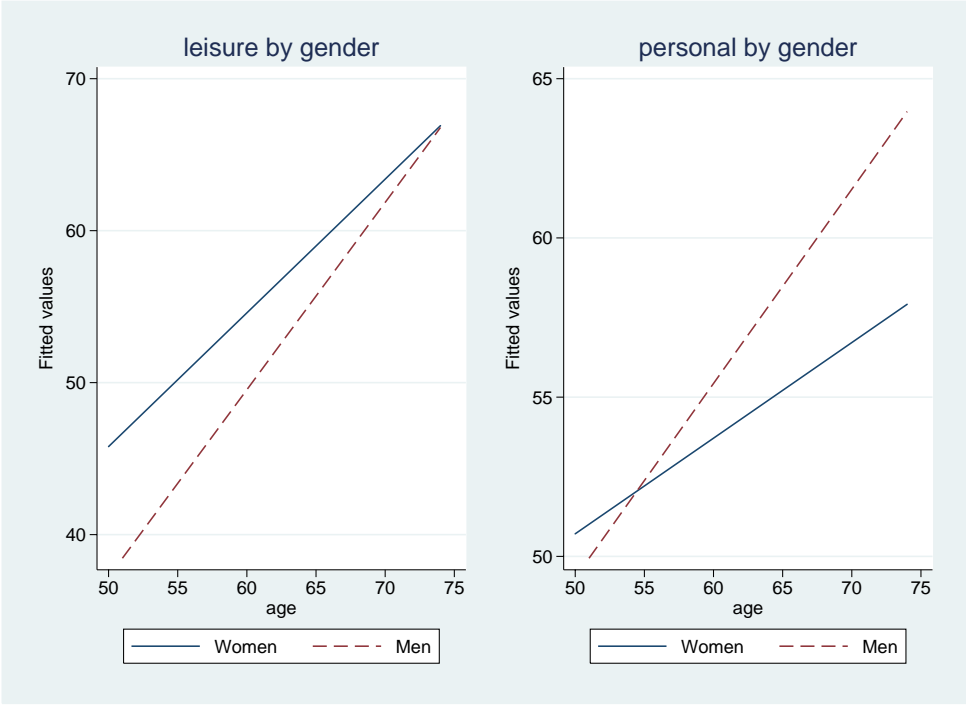


Figure A2: Time spent in leisure and personal care (including sleep)



Figure A3: Time spent in transport & communications and other activities

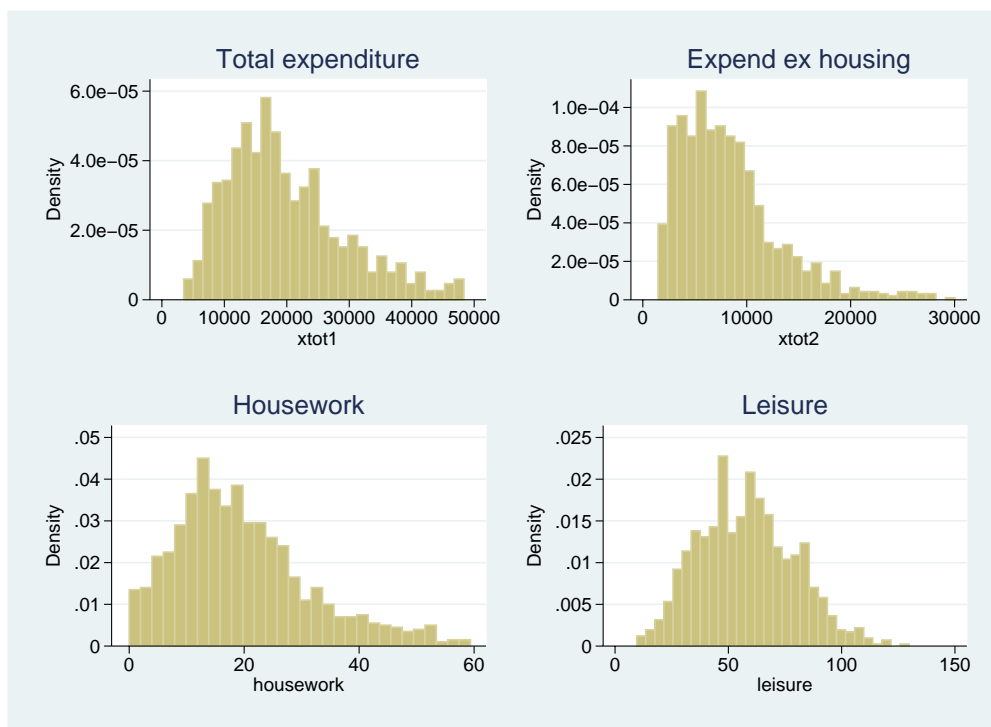


Figure A4: Histograms of expenditure, housework and leisure



Figure A5: Retirement age

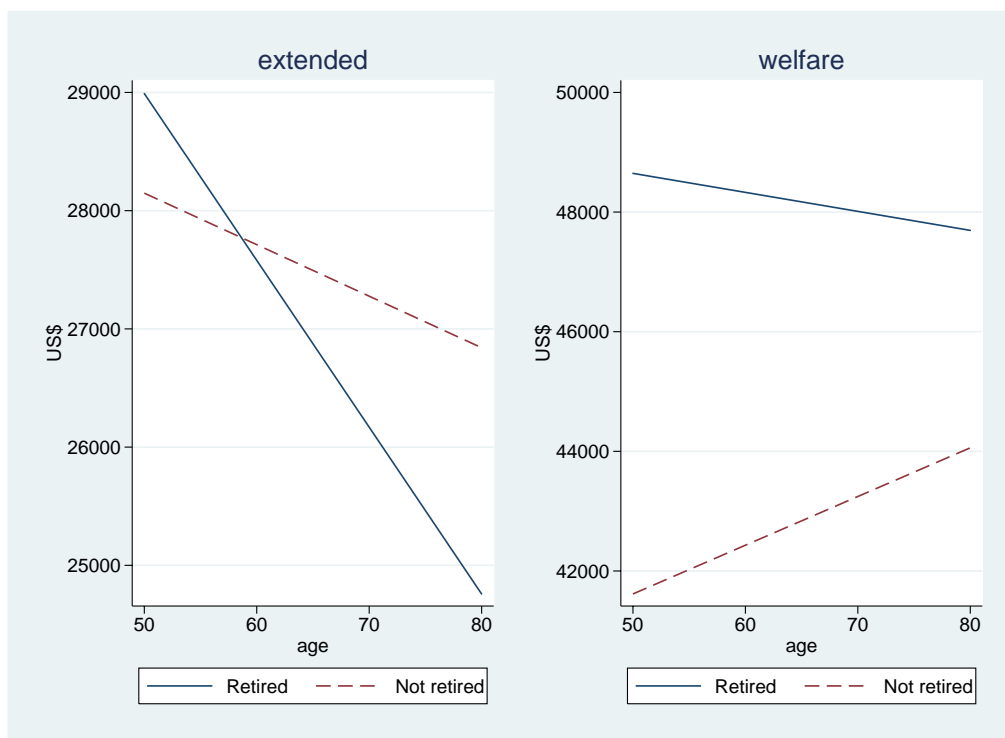


Figure A6: Extended consumption (including household production) and welfare (extended consumption and leisure) through age

|                                       | Var. name in<br>panel | Var. name in<br>CAMS 2001 | Var. name in<br>CAMS 2003 |
|---------------------------------------|-----------------------|---------------------------|---------------------------|
| Mortgage                              | XB7                   | B7                        | B13                       |
| Home/rent insurance                   | XB8                   | B8                        | B7                        |
| Property tax                          | XB9                   | B9                        | B8                        |
| Rent                                  | XB10                  | B10                       | B14                       |
| Electricity                           | XB11                  | B11                       | B15                       |
| Water                                 | XB12                  | B12                       | B16                       |
| Heat                                  | XB13                  | B13                       | B17                       |
| Phone/cable                           | XB14                  | B14                       | B18                       |
| Auto finance charges                  | XB15                  | B15                       | B19                       |
| Auto insurance                        | XB16                  | B16                       | B9                        |
| Health insurance                      | XB17                  | B17                       | B11                       |
| House/yard supplies                   | XB18                  | B18                       | B20, B22                  |
| Home maintenance                      | XB19                  | B19                       | B24, B25                  |
| Food/drink groceries                  | XB20                  | B20                       | B36                       |
| Dining out                            | XB21                  | B21                       | B37                       |
| Clothing                              | XB22                  | B22                       | B26                       |
| Gasoline                              | XB23                  | B23                       | B38                       |
| Vehicle service                       | XB24                  | B24                       | B10                       |
| Drugs                                 | XB25                  | B25                       | B28                       |
| Health services                       | XB26                  | B26                       | B29                       |
| Medical supplies                      | XB27                  | B27                       | B30                       |
| Vacations                             | XB28                  | B28                       | B12                       |
| Tickets to movies, sports events etc. | XB29                  | B29                       | B31                       |
| Hobbies/leisure equipment             | XB30                  | B30                       | B32, B33                  |
| Contributions                         | XB31                  | B31                       | B34                       |
| Gifts                                 | XB32                  | B32                       | B35                       |

Table A2: List of consumption groups in CAMS consumption survey



| Code | Description              | Observed | Activity type* |
|------|--------------------------|----------|----------------|
| A1   | WATCH TV                 | weekly   | L              |
| A2   | READ PAPERS/MAGS         | weekly   | L              |
| A3   | READ BOOKS               | weekly   | L              |
| A4   | LISTEN MUSIC             | weekly   | L              |
| A5   | SLEEP/NAP                | weekly   | P              |
| A6   | WALK                     | weekly   | T              |
| A7   | SPORTS/EXERCISE          | weekly   | L              |
| A8   | VISIT IN PERSON          | weekly   | L              |
| A9   | PHONE/LETTERS/EMAIL      | weekly   | L              |
| A10  | WORK FOR PAY             | weekly   | M              |
| A11  | USE COMPUTER             | weekly   | T              |
| A12  | PRAY/MEDITATE            | weekly   | L              |
| A13  | HOUSE CLEANING           | weekly   | H              |
| A14  | WASH/IRON/MEND           | weekly   | H              |
| A15  | YARD WORK/GARDEN         | weekly   | H              |
| A16  | SHOP/RUN ERRANDS         | weekly   | H              |
| A17  | MEALS PREP/CLEAN-UP      | weekly   | H              |
| A18  | PERSONAL GROOMING        | weekly   | P              |
| A19  | PET CARE                 | weekly   | L              |
| A20  | SHOW AFFECTION           | weekly   | O              |
| A21  | HELP OTHERS              | monthly  | O              |
| A22  | VOLUNTEER WORK           | monthly  | O              |
| A23  | RELIGIOUS ATTENDANCE     | monthly  | L              |
| A24  | ATTEND MEETINGS          | monthly  | T              |
| A25  | MONEY MANAGEMENT         | monthly  | H              |
| A26  | SELF CARE                | monthly  | P              |
| A27  | PLAY CARDS/GAMES/PUZZLES | monthly  | L              |
| A28  | CONCERTS/MOVIES/LECTURES | monthly  | L              |
| A29  | SING/PLAY MUSIC          | monthly  | L              |
| A30  | ARTS AND CRAFTS          | monthly  | L              |
| A31  | HOME IMPROVEMENTS        | monthly  | H              |

\*) H: Housework, L: Leisure, M: Marketwork, P: Personal care including sleep,  
T: Transport and communication (computer time), O: Other activities.

Table A3: List of activities in CAMS time use survey

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## **Chapter 4**

# **Heterogeneity in Preferences and Productivity – Implications for Retirement**

# Heterogeneity in Preferences and Productivity – Implications for Retirement

Mette Gørtz

## Abstract

This paper discusses the determinants of the retirement decision and the implications of retirement on economic well-being. The main contribution of the paper is to formulate the role of individual heterogeneity explicitly. We argue that individual heterogeneity in 1) productivity of market work versus housework, 2) preferences for leisure compared to consumption, and 3) marginal utility of wealth, is correlated with the retirement decision. Based on US consumption and time use data for 2001 and 2003 from the Consumptions and Activities Mail Survey (CAMS), we study the patterns of individual choices of expenditure, household production and leisure for people in and around retirement. The unobserved individual heterogeneity factor is isolated by comparing cross-sectional evidence and panel data estimates of the effects of retirement on consumption and time allocation. Based on cross-section data, we can identify a difference in consumption due to retirement status, but when the panel nature of the data is exploited, the effect of retirement on consumption is small and insignificant. Moreover, the analyses point at a large positive effect of retirement on household production. Our results therefore contribute to the discussion of the so-called retirement-consumption puzzle. Many analyses of the retirement-consumption drop assume that the retirement decision is exogenous. However, the individual decision on when to retire may depend on expected changes in consumption and time allocation. This suggests that the retirement decision is endogenous. To test this, we apply an instrumental variables method in the treatment effects tradition.

**Keywords:** Retirement, consumption, household production, heterogeneity

**JEL classification:** C2, D1, D9, J1

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# 1 Introduction

Trends in consumption and well-being for the elderly have attracted a great deal of attention in recent years. A vast empirical literature has identified a fall in expenditure around retirement which may seem difficult to explain in the context of the standard lifecycle model which – in its simplest form – implies consumption smoothing. This phenomenon is often referred to as the so-called “retirement-consumption puzzle”. However, while simple life cycle models may predict that *consumption* should be smoothed across periods of predictably high and low income, it is in fact the *marginal utility of consumption* that is smoothed across time periods.

Previous studies of the consumption drop offer various explanations. First, it is argued that retirement leads to a substitution from consumption bought in the market to consumption with a higher content of household production, thus retaining the same level of consumption in a broader sense. A second argument is that retirement is followed by a substitution of consumption for leisure, thereby retaining the same level of well-being. A third explanation attributes the reduction in expenditure to a reduction in consumption items related to working life, i.e. transport, eating out (e.g. lunch), work clothing etc. A fourth interpretation is that preferences change over the life cycle. And a fifth explanation focuses on the idea that if retirement is caused by an unexpected event such as job loss or disability, the observed consumption fall is not in conflict with the life-cycle model of consumption. In the following, we refer the main points of the existing literature which is centered around these five arguments.

Hamermesh (1984) tries to identify what he refers to as the “missing link” in the life cycle model. He concludes that the drop in consumption can be rationalized by a combination of a bequest motive, uncertainty about length of lifetime, coupled with a rate of time preference which exceeds the real rate of interest. Hamermesh (1984) argues that individuals may simply have preferences for consumption earlier in life, partly due to expectations about health.

This idea is also discussed in Banks, Blundell and Tanner (1998) who use a “pseudo-panel” based on 25 successive years of data from the British Family Expenditure Survey. After controlling for changes in mortality risk and labor-market-related costs there is still an unexplained gap left between actual and predicted consumption growth around the age of retirement. This leads them to conclude that there may be unanticipated shocks occurring around the time of retirement. Banks, Blundell and Tanner argue that the systematic arrival of unexpected adverse information is the only way to fully reconcile the fall in consumption.

Haider and Stevens (2004) use subjective retirement expectations (the expected year of retirement prior to actual retirement) as an instrument for retirement and thereby



isolate the element of “surprise” in retirement.<sup>1</sup> By instrumenting retirement, the estimated consumption drop is reduced substantially.

Ameriks, Caplan and Leahy (2002) find that many working households do expect a considerable fall in consumption when they retire. After retirement, some households experience that the fall in consumption is smaller than their *ex ante* expectations. Ameriks, Caplan and Leahy attribute part of this divergence to unexpected stock market appreciation that may create surprises in a positive or negative direction to retiring households.

A number of contributions focus on the possibility of substituting household production for consumption at retirement, cf. Aguiar and Hurst (2004), Hurd and Rohwedder (2003), and Browning and Kolodziejczyk (2005). Aguiar and Hurst (2004) compare cross-sectional information from detailed food diaries with data on food expenditure for US households. They show that even though food expenditure declines at retirement, neither the quantity nor the quality of food consumption is lower for retired people. They underline that it is not clear whether this measure of food intake captures the utility of food consumption.

Hurd and Rohwedder (2003) use the Consumption and Activities Mail Survey (CAMS) 2001, which is part of the Health and Retirement Study (HRS) to show that a substantial proportion of households expect their expenditures to decrease upon retirement. Based on the difference between people’s anticipated changes in consumption prior to retirement and their realized changes in consumption, they conclude that in general people expect a consumption drop after retirement which is larger than their realized consumption drop. In a follow-up study by Hurd and Rohwedder (2005), they use two waves of CAMS, 2001 and 2003, to examine the changes in consumption and time use over the period. They find no evidence of a consumption drop.

Browning and Kolodziejczyk (2005) consider a model where consumption and leisure are non-separable and retirement is endogenous. They argue that non-separabilities are due to 1) fixed costs of going to work, and 2) household production. They show that unobserved heterogeneity related to these non-separabilities lead to biases in the OLS estimates of the structural parameters.

Miniaci, Monfardini and Weber (2003) use synthetic cohorts in Italy and find a decline in spending at retirement. They show that Italian households who retired in the sample period had reasonable information about their pension income and argue that forward looking consumers would only choose to reduce expenditure because of their increased leisure after retirement. They find evidence that taking leisure into account markedly reduces the drop in consumption at retirement.

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<sup>1</sup> Haider and Stevens (2004) quote Leon Trotsky (1879-1940) saying: “Old age is the most unexpected of all things that happen to a man”.

Bernheim, Skinner and Weinberg (2001) find a discontinuity in consumption at retirement which is negatively correlated with retirement savings and income replacement rates. However, they find no evidence for explanations suggesting that this discontinuity should be related to differences in relative tastes for leisure, home production or work-related expenses. Bernheim, Skinner and Weinberg (2001) conclude that their results are difficult to interpret in the context of the life-cycle model and that people tend to use simple rules of thumb instead of rationally planning their retirement saving as the life-cycle model implies.

Smith (2004) uses the British Household Panel Study (BHPS) to investigate the drop in consumption of food at home and well-being.<sup>2</sup> She distinguishes between different groups of retired people wrt. their retirement being voluntary or involuntary (due to health or employment shocks). The idea is that when retirement is voluntary, people are assumed not to experience a negative wealth shock at retirement, while people who retire involuntarily will be more likely to experience negative wealth shocks.

Christensen (2005) uses Spanish panel data to study the effects of retirement. She finds no income fall for retiring households in the Spanish data and finds no significant effect of retirement on any commodity groups except medicines.

The main contribution of this paper is to explicitly formulate the role of individual heterogeneity in 1) preferences for the output of home production versus market products, 2) productivity in household production versus in the market, and 3) the marginal utility of wealth. We argue that unobserved heterogeneity in preferences, productivity and marginal utility of wealth may be correlated with the retirement decision. Thus, individuals with a relatively high taste for goods produced at home or with a relatively high productivity in home production may be more inclined to retire earlier than individuals with relatively higher taste for and productivity in market production. And individuals with a relatively low marginal utility of wealth will be expected to retire early, *ceteris paribus*. If the unobserved individual heterogeneity is correlated with the retirement status, then OLS-estimates of the effect of retirement will be biased and inconsistent.

Most previous studies of the consumption drop have been based on cross-section data or data from pseudo panels. Smith (2004) and Christensen (2005) both used panel data, but none of these studies explicitly discussed the role of unobserved heterogeneity. Pseudo panels are constructed on the basis of observables and can not take account of unobserved heterogeneity. We use the 2001 and 2003 panel from the Consumption and Activities Mail Survey (CAMS) which has information on consumption and time use. We isolate the individual heterogeneity factor by comparing cross-sectional evidence and panel data estimates of the effects of retirement on consumption and time allocation.

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<sup>2</sup> Well-being is measured by an index which weighs together different types of self-reported factors contributing to physical, psychological and emotional well-being.

Comparing OLS-estimates with panel data estimates, we see that the fixed effects panel data estimates are numerically smaller and significantly different than the OLS estimates, and we also find that the fixed effects estimates differ significantly from the random effects estimates. We interpret this as evidence that unobserved heterogeneity in preferences, productivity and the marginal utility of wealth is correlated with the retirement decision.

In most studies of the retirement-consumption drop, the retirement index has been viewed as an exogenous variable. Thus, it is usually assumed that the retirement decision is unaffected by the level of or anticipated changes in consumption or housework, respectively. However, we can think of several examples where people's retirement decision is linked to anticipated changes in consumption or housework. Previous studies have investigated the timing of the retirement decision, cf. Gustman and Steinmeier (1986), Rust and Pheelan (1997). In this paper, we allow for endogeneity in the retirement decision by applying a treatment effects methodology. When using predicted probabilities as an instrument in our panel data analysis of the consumption and housework model, we find somewhat larger but still insignificant effects of retirement

The paper is organized as follows. In section 2, we review the theoretical background of the dynamic life-cycle model. In section 3, we present the data. Section 4 shows some empirical evidence on consumption and time use over ages. In section 5, we develop the empirical model. Section 6 presents the results from the panel data estimations. Section 7 presents an analysis of the possible endogeneity problem in the retirement decision, and section 8 concludes.

## 2 Theoretical background

According to the life-cycle model of consumption and labor supply, an individual/household chooses a path of consumption and leisure where the marginal utility of consumption and leisure is constant over the lifetime, cf. Browning et al. (1985). Most empirical analyses of the life-cycle model formulate utility as a function of consumption of market-produced goods and leisure. Leisure is usually defined as time spent not doing market work. This definition does not take other uses of time explicitly into account. The importance of including the value of household production in the utility function has been emphasized by Gronau (1977, 1980, 1986) in his important extension of Becker's seminal work on the allocation of time, cf. Becker (1965).

The standard life-cycle model can be extended to explicitly include home production, cf. Rupert et al. (2000). We allow for three uses of time each time period,  $t$ : market work ( $h_{mt}$ ), household production ( $h_{nt}$ ), and leisure ( $l_t$ ). The individual/household derives utility from consuming market goods ( $c_{mt}$ ), home-produced goods ( $c_{nt}$ ) and leisure ( $l_t$ ).

Home-produced goods are produced with the input of time spent in housework ( $h_{nt}$ ).<sup>3</sup> Wages are assumed exogenous over the life cycle. We use a marginal-utility-of-wealth-constant labor supply function, also known as a Frisch function, cf. Blundell and MaCurdy (1999). A critical assumption in this framework is that preferences show intertemporal strong separability. The marginal utility of wealth,  $\lambda_t$ , serves as the sufficient statistic to capture all information from other periods necessary to solve the maximization problem of each current period. For simplicity, we assume a non-stochastic interest rate. The household optimization problem can be formulated into a dynamic programming problem. The individual/household chooses consumption of market goods, household goods and leisure according to the following value function:

$$\begin{aligned}
V(A_t, t) &= \max\{U(c_{mt}, c_{nt}, l_t) + (1 + \rho)^{-1} E_t[V(A_{t+1}, t+1)]\} \\
s.t. \\
A_{t+1} &= (1 + r_{t+1})(A_t + B_t + w_t h_{mt} - c_{mt}) \\
c_{nt} &= g_t(h_{nt}) \\
h_{mt} + h_{nt} + l_t &\equiv H
\end{aligned} \tag{1}$$

$A_t$  is the real value of assets at the beginning of period  $t$ ,  $\rho$  the household's subjective discount rate,  $r$  the real rate of return earned on assets between  $t$  and  $t+1$ ,  $w_t$  the after-tax wage rate,  $B_t$  is unearned non-asset income, and  $H$  the total available time per period (e.g. year/week etc.). As usual, we assume that  $U$  is convex and monotonous in its elements.

It should be emphasized that we are here looking at individuals who have a positive supply of working hours in the labour market. This implies that we focus on finding an interior solution for the choice of market work, as well as for consumption and housework. We shall relax this assumption in section 5 to treat the situation where people are retired (which implies a corner solution). Solving the consumer's problem by standard dynamic programming techniques leads to the following first-order conditions:

$$\begin{aligned}
\frac{dU}{dc_{mt}} &= \lambda_t \\
\frac{dU}{dh_{mt}} &= -\lambda_t w_t \\
\frac{dU}{dh_{nt}} &= \lambda_t w_t \\
\text{where } \lambda_t &= (1 + \rho)^{-1} E_t[(1 + r_{t+1})\lambda_{t+1}]
\end{aligned} \tag{2}$$

$\lambda_t = \partial V / \partial A_t$  is the marginal utility of wealth.  $\lambda_{t+1}$  is a random variable which is realized by the beginning of period  $t+1$ . We therefore end up with the familiar result that

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<sup>3</sup> Unlike the model derived in Rupert et al. (2000), we abstain from the - in this context unnecessary - complication of introducing home capital in the household production function.

the individual/household chooses a level of consumption of market goods where the discounted marginal utility (discounted by the subjective discount rate) equals the marginal utility of wealth (discounted by the interest rate). Furthermore, we find that the marginal utility of time devoted to market work and housework should be numerically equal across activities. And finally, we conclude that the discounted marginal utility of housework depends on the wage rate and the marginal utility of wealth, discounted by the interest rate. The first-order conditions imply that consumption demand and the supply of market work and housework can be formulated as functions of the individual's current characteristics (including wages) and the marginal utility of wealth at  $t$ , which captures all relevant information and expectations about the other periods. The Euler equation implies a time path for  $\lambda_t$  of the form:

$$\begin{aligned} \ln \lambda_t &= b_t + \ln \lambda_{t-1} \\ \text{where } b_t &= -\ln \left( \frac{1+r_t}{1+\rho} \right) \end{aligned} \quad (3)$$

By repeated substitution, the marginal utility of wealth,  $\lambda_t$ , can be expressed by an individual fixed effect,  $\lambda_0$ , plus the sum of the  $b_j$  terms. The  $b_j$ 's are a function of the consumer's individual discount rate,  $\rho$ , and the market interest rate,  $r$ .

$$\ln \lambda_t = \sum_{j=1}^t b_j + \ln \lambda_0 \quad (4)$$

If we assume that  $\rho$  and  $r_t$  are constant across consumers, the first term in  $\lambda_t$  will vary depending on the age of the individual or household head. In cases where the rate of time preference,  $\rho$ , equals the rate of interest, then  $b_j=0$  in all time periods, and  $\lambda$  is constant over time and equal to  $\lambda_0$ . In praxis,  $\rho$  will vary across individuals and across time and will often deviate from the rate of interest.

### 3 Data

Data used for this paper is from Consumption and Activities Mail Survey (CAMS) which is part of the US Health and Retirement Study (HRS). CAMS has information about time use and consumption for the elderly population in 2001 and 2003. The CAMS 2001 and 2003 data form a panel of about 3000 individuals, and information from the CAMS panel has been linked to background information from the HRS survey. The CAMS data is described in Hurd and Rohwedder (2003, 2005). Further documentation on the CAMS and HRS data can be found at the Health and Retirement Study webpage (<http://hrsonline.isr.umich.edu>).

The consumption part of the survey asks about recalled consumption of an extensive list of consumption items. The respondent could choose to report consumption per week, per month or per year and indicate the chosen reporting period for each consumption item. Total consumption and consumption in the main consumption groups in CAMS is comparable to consumption of the same age group in the US Consumer Expenditure Survey (CEX), cf. Hurd and Rohwedder (2005). One of the problems with expenditure information based on recall questions is that it seems to be very noisy; see Browning, Crossley and Weber (2003) for a discussion.

CAMS's time use information is based on respondents' recalled time use over the last week or month, depending on the character of the activity. Previous analyses of time use observe that so-called "stylized" time use surveys where respondents are asked about their "normal" or recalled time use have a lower variance than time use information based on a diary. On the other hand, time use diaries generally give better estimates of the means of time use. See Juster and Stafford (1991) for a discussion. The questions in the time use survey have been asked to allow for double activities. Thus, the respondents were asked to assess their time spent on different activities, irrespective of whether these activities were carried out as the single activity at the time or if the respondent performed several activities. For example, if the respondent spent one hour ironing while at the same time watching the television, the time use at both activities would be counted as one hour. The consequence of this survey method is that it is not given that the sum of all activities adds up to 24 hours a day. This is a well known picture in "stylized" time-use surveys. As the theoretical model outlined above builds on a time constraint saying that the sum of market work, housework and leisure should equate 24 hours a day, we have made the simplifying assumption that one hour spent on  $M$  activities is equal to  $1/M$  *effective* hours devoted to each activity. In praxis, this means that we have rescaled all detailed activities to ensure that the sum of time use per person equates 24 hours a day.

Due to missing information and outliers in many consumption and time-use variables, it has been necessary to perform a thorough data cleaning. We started out with a balanced panel dataset of around 4300 observations (2179 per year) between 50 and 75 years of age. Observations with missing information or extreme outliers in both the time use part and the consumption part, and observations where the change from 2001 to 2003 seemed unrealistic (e.g. increases in consumption of more than 200 pct.), were dropped. Furthermore, we dropped observations with missing information on one of the explanatory variables. Moreover, as a panel data analysis demands information for each individual in both years, we had to drop panel observations for an individual/household if they were missing or "odd" in one of the years. The result of the data cleaning process is a somewhat smaller dataset than the original CAMS data. Consequently, we end up with a balanced panel of 1372 observations per year. A little more than half (753) of the individuals in this panel had already retired in 2001. A good 600 were not retired in

2001, and of these 158 individuals retired between 2001 and 2003, while 461 remained not retired in both years. There is a small group of people who “unretire”, i.e. who were retired in 2001 but not in 2003. This is not unrealistic. Retirement is often seen as an absorbing state since it can be difficult to return to the labour market after retiring, but returning to the labour market from retirement is not uncommon.<sup>4</sup> But this observation could also be due to misreporting in either 2001 or 2003. In this paper, we choose to disregard individuals who “unretire”.

Retirement status is generally based on people’s own reporting. In the CAMS survey as well as the HRS, people were asked if they were retired or otherwise.<sup>5</sup> The average retirement age for the whole sample in our panel dataset is around 62 years, and the people who retired in the period 2001-2003 were around the same age on average. Figures in the appendix show the distribution of retirement ages for the whole sample and for the subset of people who retired in the period 2001-2003. The distributions appear to show similar characteristics.

## 4 Expenditure, time use and ageing

In the following, we document the general trends of consumption and time use in our panel dataset from 2001 and 2003. For comparison with other studies of the retirement-consumption drop, we focus on food at home and an aggregate of basic consumption items which consists of food-at-home, food-out, clothing and leisure expenditures.<sup>6</sup>

Data on expenditure is generally collected on a household level. The level of consumption is likely to vary depending on whether the household consists of a single person, is a married household or a household with children still living at home. As it is custom in these types of analyses, we adjust total expenditure for the number of household members. As there are obviously economies of scale related to sharing the same house and other types of consumption, it is customary to take this into account using so-called “equivalence scales”, i.e. correcting consumption by a factor that takes

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<sup>4</sup> Maestas (2004) analyzed “unretirement” transitions based on HRS data. She found that nearly one-half of retirees follow a non-traditional retirement path that involves partial retirement and/or retirement. Moreover, the unretirement rate observed at least five years after their first retirement was around ¼.

<sup>5</sup> It is not quite clear how homemakers and others not having participated in the labor force throughout the working ages have responded to this. Thus, there is a risk that some homemakers report themselves as not having retired although they have the age for being retired, while others report themselves of being retired, maybe because their husband is retired.

<sup>6</sup> Consumption in the CAMS data consists of 8 main consumption groups: housing (mortgage plus rent), utilities (energy, water and telephone), car use (petrol plus repairs/services), health related expenditure (excluding health insurance), expenditure on equipment for home and garden (but not for repairs/maintenance etc.), food at home, dining out, clothing and equipment for leisure activities (including travel expenditure) and other expenditure (gifts, contributions etc.).

economies of scale into account. We use the most simple equivalence scale, the square-root of the number of household members, to adjust for different household sizes.<sup>7</sup>

Figure 1 shows cross-sectional evidence from the 2001 and 2003 surveys for food at home and basic consumption. In general, we find that basic consumption is lower for the older respondents in the survey than for the younger respondents. Moreover, for almost all age categories, respondents not being retired have a higher level of basic consumption than retired people. The consumption of food at home is higher for the non-retired than for the retired, and there is a downward trend in food consumption as people age.

When looking at consumption for the retired and the non-retired groups separately, it appears that there is a negative correlation between consumption and age. However, it should be emphasized that this is cross-sectional evidence. Thus, when comparing consumption across age, we are in fact comparing consumption for different cohorts in the population. The CAMS-cohort around the age of 70, who was born in the beginning of the 1930's, has faced other possibilities and living conditions than the CAMS-cohort now around the age of 50 who was born in the 1950's. Moreover, different cohorts might have faced different options for intertemporal substitution due to long-term shifts in capital markets, interest rates etc. which might have induced them to choose different paths of consumption. Figures on total consumption and main consumption groups are shown in the appendix.

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<sup>7</sup> Choosing the appropriate equivalence scale is a highly debated issue, cf. Atkinson and Bourguignon (2000). One of the problems with the simple equivalence scale adjustment described above is that it does not distinguish between extra household members being children or adults.



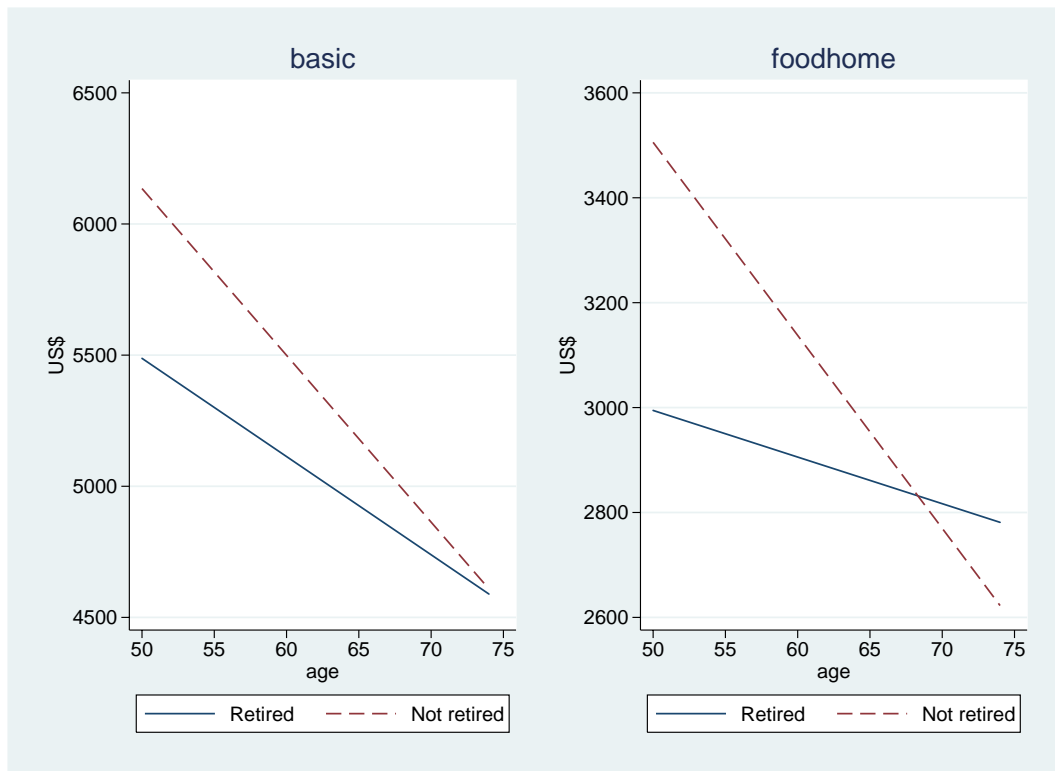


Figure 1: Expenditure through age

The respondents in the CAMS survey were also asked to state their time use on 31 activities, cf. the list of activities in the appendix. These 31 activities have been aggregated into 6 major activity groups: leisure, housework, market work, personal care, transport & communications (including computer time) and other activities (including volunteer work, helping out friends and family etc.).

Comparing time use for retired people and non-retired people, it appears that the time spent on the 6 main activities is very different between these two groups, cf. table 1. Not surprisingly, the level of market work is significantly higher for people still in the labor market (some retired people still have a low number of working hours), whereas people who have retired spend a significant number of extra hours in leisure or with housework. We also find that the time spent on personal care is somewhat higher for people who have retired, and the same is true for time spent in other activities (which is a small number of hours). On the other hand, people who have not retired spend more time traveling/commuting or communicating (using computer).

|                           | All  | Non-retired | Retired |
|---------------------------|------|-------------|---------|
| Leisure                   | 8.2  | 7.0         | 9.2     |
| Personal care incl. sleep | 8.1  | 7.4         | 8.6     |
| Housework                 | 3.1  | 2.5         | 3.5     |
| Travel and communication  | 1.7  | 2.0         | 1.3     |
| Marketwork                | 2.2  | 4.4         | 0.5     |
| Other activities          | 0.8  | 0.7         | 0.8     |
| No. of households         | 1372 | 619         | 753     |

Table 1: Time use in hours per day in 2001

Figure 2 shows time use over age for the retired and the non-retired group. The level of market work is at a fairly constant level over the age groups. Housework, which is at a relatively high level for the retired people, is constant for the group of retired, but slowly declines with age for the non-retired. Tables of time use over time for the other time use categories can be found in the appendix. Time spent on personal care including sleep increases with age, whereas time spent on transport & communications and other activities decreases over time for both retired and non-retired. Again, it should be noted that we are looking at cross-section data where cohort effects are present. Thus, time spent on computer use is probably affected by the fact that people in their 50's are much more likely to have learned to use a computer than people in the 70's. In general, these trends in time use over age confirm prior analyses, cf. Hill (1985) and Bureau of Labor Statistics (2004).

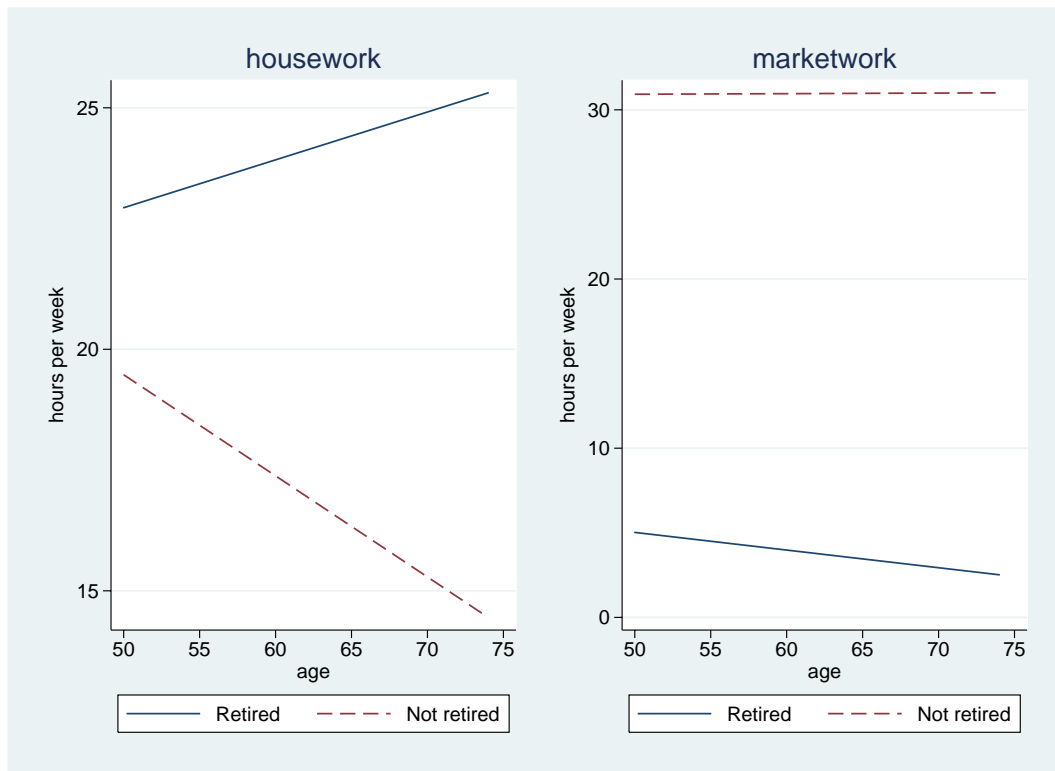


Figure 2: Time-use through age

All in all, we find that expenditure gradually decreases as people age, and that the level of consumption is lower for retired than for non-retired across all ages. Furthermore, we see that retired people have more time for household production and leisure. Thus, it seems obvious to conclude that retired people compensate for the loss of consumption of market products with a higher level of consumption of household production and a higher level of leisure.

## Individual heterogeneity in preferences and productivity

The different allocations across individuals may reflect differences in productivity in the labor market and in household production, different preferences for expenditure versus leisure, different constraints in the labor and product markets, and different marginal utilities of wealth. People with a relatively high preference for market goods compared to leisure or goods produced in household production will tend to postpone retirement. Along the same lines, individuals with a relatively high productivity in household production compared to their productivity in the market may retire relatively early. Thus, people who are productive at home, good at do-it-yourself work, cooking

etc. may be more interested in early retirement, giving up consumption of market goods for household production goods. On the other hand, people who are not productive in household production might hold on to their jobs in the labor market for a longer period, thereby reducing a possible consumption drop at retirement. These individual specific differences affect people's decision on when to retire, their willingness to accept a decline in consumption in order to achieve an increase in leisure, and their desire to swap hours worked in the labor market with hours worked at home.

In general, preferences are often assumed to be constant over time for the individual. This is a convenient generalization. However, the individual utility function may change over the life time as priorities and needs may change with age.<sup>8</sup> Moreover, productivity in market work versus in household production may change over the life. Most wage regression studies find a positive relationship between age/experience and wages/productivity, but it is not yet clear what happens to productivity when people approach and cross their retirement age. Due to depreciation of human capital, changes in work processes from technological change and gradual detriments in individual health one might expect that productivity is declining from a certain age. This hypothesis is substantiated by the fact that the unemployment risk is usually higher for people above 55 than for middle aged people. Thus, it is likely that the relative productivity of market work versus housework may change over time. For example, people may find that their market productivity degrades faster than their productivity in household production, or vice versa. This in turn might affect their retirement decision and their preferences for market goods versus household production goods.

Our theoretical model allows for individual differences in the marginal utility of wealth. We expect that people who are well off (high wealth) will have a relatively lower marginal utility of wealth than people who have less wealth. Data shows a small negative correlation between retirement age and total wealth. This implies that people who retire early have a relatively higher wealth than people who retire later in life.

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<sup>8</sup> For example, while more than 90 percent of the respondents interviewed in HRS 2002 answered that they enjoyed going to work, it was also the case that 60 percent of the respondents who had (recently) retired reported that they were very satisfied with retirement, while another 33 percent report that they were moderately satisfied, and more than 45 percent told that their retirement years have been better than pre-retirement. Among the most important reasons for why people retire, almost 30 percent reported that they found it very important to have time to do other things; more than 35 percent wanted to spend more time with their family. Around one third of the respondents mention poor health as a very or moderately important reason for retiring, while only 6 percent said that not liking their work was a very important reason for them to retire. Moreover, people mention that the advantages to retirement is "being one's own boss", "taking it easy" and the opportunity to travel. Moreover, not being productive does not seem to worry the majority of the respondents at all, while the risk of illness/disability and not having enough income concerns around half of the respondents. A natural interpretation of these observations is that people's work life and retirement life are seen as two independent phases in life. The fact that people seem to enjoy working and later enjoy not working might reflect that preferences for consumption versus leisure change gradually as people age. Whether this change over life is truly "exogenous" or reflects that preferences are shaped by circumstances/constraints is hard to tell. One could interpret preferences as being endogenous, i.e. "you learn to love what you can get instead of getting what you love". See Hill and Juster (1985) for a discussion.

## 5 Empirical model

Above, we argued that there may be individual differences in preferences for consumption of market goods versus household produced goods or leisure. In order to derive an empirical model for our analysis of the joint decision of the allocation of time and consumption, we add some more structure to the general lifecycle model introduced earlier by assuming that utility is separable in its arguments, market consumption ( $c_{mt}$ ), output from household production ( $c_{nt}$ ), and (pure) leisure ( $l_t$ ). For simplicity, we assume that utility can be expressed in the form of an add-log utility function for each individual/household, i:

$$\begin{aligned} U_{it} &= \theta_{mit} \ln c_{mit} + \theta_{nit} \ln c_{nit} + \theta_{lit} \ln l_{it} \\ \theta_{mit} + \theta_{nit} + \theta_{lit} &\equiv 1 \end{aligned} \quad (5)$$

where  $\theta_{jit}$ ,  $j=m,n,l$  denote individual/household i's preference/taste parameters for market goods, household produced goods and leisure, respectively, at time t. Furthermore, we assume that the productivity in household production is constant, thus ruling out economies of scale in household production. Exploiting the first-order conditions derived previously, and using the time-constraint  $h_{imt} + h_{int} + l_{it} \equiv H$ , we can derive two equations for the demand for consumption and household production:

$$\begin{aligned} \ln c_{mit} &= \ln \theta_{mit} - \ln \lambda_{it} \\ \ln h_{nit} &= \ln \theta_{nit} - \ln \lambda_{it} - \ln w_{it} \end{aligned} \quad (6)$$

Thus, individual i's demand for market products at time t is positively correlated with individual i's preference for market products and/or productivity in market production, and negatively correlated with i's marginal utility of wealth at t. These preferences may change over time/age. For example, people who approach the "usual" retirement age are usually well settled in their homes, costs on mortgages are decreasing or have stopped altogether etc., and this may induce them to focus more on other sources of well-being, as discussed above. In addition, preferences may depend on the composition of the household. As people age, they often cease to have financial responsibilities for supporting children. Moreover, they might have got grandchildren etc. with whom they want to spend more time. Another important source of individual heterogeneity is individual differences in productivity in the market versus productivity in the household. These individual productivities may also vary over the life cycle.

The preference factors for consumption of market goods and household production,  $\ln \theta_{mit}$  and  $\ln \theta_{nit}$ , are specified by a set of individual specific observables as age, gender, marital status, household size, educational status etc., all captured by  $X_{it}$ . As in Zeldes (1989), we further assume that preferences depend on unobserved individual/household characteristics, time effects, and residual effects (a random term).

$$\begin{aligned}\ln \theta_{mit} &= \gamma_0 + \gamma_1 X_{it} + \phi_{mt} + \xi_{mi} + v_{mit} \\ \ln \theta_{nit} &= \alpha_0 + \alpha_1 X_{it} + \phi_{nt} + \xi_{ni} + v_{nit}\end{aligned}\tag{7}$$

The marginal utility of wealth,  $\lambda_{it}$ , can be expressed by a stochastic process, cf. Blundell and MaCurdy (1999):

$$\ln \lambda_t = b_t^* + \ln \lambda_{t-1} + \varepsilon_t^* = \sum_{j=1}^t b_j^* + \ln \lambda_0 + \sum_{j=1}^t \varepsilon_j^* \tag{8}$$

With this specification, the marginal utility of wealth can be captured by an individual fixed effect  $\lambda_0$  plus a function of age plus a random error reflecting expectational error up to the current period.

As noted in section 2, the standard life cycle model applies to an individual with a positive labour supply, i.e. an interior solution. In the following we suggest a small adaptation to this formulation. Since an individual who is retired has zero market wage, we are in a corner solution. A convenient way to incorporate this is to drop the wage measure in the housework equation and put in dummies for retirement status,  $R$ , in both equations. We then end up with the following empirical specification of the model:

$$\begin{aligned}\ln c_{mit} &= \alpha_0 + \alpha_1 X_{it} + \alpha_2 R_{it} + \phi_{mt} + \eta_{mi} + u_{mit} \\ \ln h_{nit} &= \beta_0 + \beta_1 X_{it} + \beta_2 R_{it} + \phi_{nt} + \eta_{ni} + u_{nit}\end{aligned}\tag{9}$$

The idiosyncratic error terms,  $u_{mit}$  and  $u_{nit}$ , reflect the sum of the effects of 1) the random error from the stochastic process for  $\lambda_{it}$  2) random error in the preference specification, and 3) random error in the optimization of consumption and household production, respectively. We assume that the idiosyncratic error terms are uncorrelated with retirement status  $R$  as well as with the other explanatory variables captured by  $X$ . The individual specific unobserved heterogeneity factors,  $\eta_{mi}$  and  $\eta_{ni}$ , capture 1) unobserved heterogeneity in the marginal utility of wealth,  $\lambda_{i0}$ , and 2) unobserved heterogeneity in preferences for market production versus household production. We control for age through  $X_{it}$ . The age parameter captures effects of age working through two channels: 1) preferences, and 2) the marginal utility of wealth.

A comparison between the estimates found by using cross-sectional data with the estimates found by exploiting the panel dimension of the data gives us an indication of the extent of unmeasured individual heterogeneity. In a cross-section estimation by e.g. OLS, the empirical model does not take explicit account of the unobserved individual factors,  $\eta_i$ , which are instead treated as part of a combined error term. We assume that  $\eta_i$  captures individual specific unobserved factors like preferences for consumption of market goods versus home produced goods, productivity in market work versus productivity in household production, and marginal utility of wealth. These characteristics may vary across otherwise comparable households. If  $\eta_i$  is uncorrelated with the explanatory variables in  $X$  and  $R$ , then OLS produces consistent estimates.

However, if  $\eta_i$  is correlated with e.g. the retirement status,  $R_i$ , the OLS-estimates of  $\alpha_2$  and  $\beta_2$  are biased and inconsistent. This could be the case if the unobserved individual characteristics reflected by  $\eta_i$  tend to enhance the chance of choosing retirement at an early age. Performing OLS-regression in the equations above would then result in a biased and inconsistent estimate of the effect of  $R$ . The different sources of unobserved heterogeneity  $\eta_i$  result in correlation between  $\eta_i$  and  $R_i$  of different signs.

*On the one hand*, we might ex ante expect that  $\eta_i$  is *negatively* correlated with  $R_i$  through the following two channels:

- Relatively higher preferences for consumption of market goods rather than other sources of utility tend to keep people in labor market (low  $R_i$ ).
- Higher productivity in market work rather than housework tends to postpone retirement (low  $R_i$ ).

*On the other hand*, we may ex ante expect that  $\eta_i$  is *positively* correlated with  $R_i$  because:

- A person with relatively low  $\lambda_{i0}$  (high  $\eta_i$ , high wealth), will retire earlier than otherwise (high  $R_i$ ).

If the correlation between  $\eta_i$  and  $R_i$  is negative, the OLS-estimates of the effect of retirement status  $R$  in both equations will be numerically larger than the “true” effect of retirement,  $\alpha_2$  and  $\beta_2$ . On the other hand, if the correlation between  $\eta_i$  and  $R_i$  is positive, then the OLS-estimates will be numerically smaller than “true” effects of retirement,  $\alpha_2$  and  $\beta_2$ . Whichever effects dominate is an empirical question.

## 6 Panel data estimation

Below, we compare cross-sectional evidence with longitudinal evidence from the CAMS 2001-2003 panel on consumption and time use. We perform our analysis on food-at-home and on our aggregate of basic consumption (food-at-home, food-out and clothing). In cases where we do not expect any correlation between the unobserved effect and the explanatory variables, the random effects approach is the natural choice of panel data estimator. However, as argued above, we expect the unobserved heterogeneity  $\eta_i$  to be correlated with retirement  $R_i$ . Moreover, unobserved heterogeneity in relative preferences and relative productivity is likely to be correlated with other individual and household characteristics, captured in  $X_i$ . This speaks in favour of using a fixed effects approach which allows correlation between the unobserved effect and the explanatory variables. The fixed effects approach does not allow the inclusion of time-constant explanatory variables in  $X_{it}$ . The problem is that time-demeaning in the

context of the fixed effects approach generates collinearity between the time-constant explanatory variables and the unobserved heterogeneity effect. The time-constant explanatory variables are not identified as they are perfectly correlated with the unobserved heterogeneity. In our study, the parameter of primary interest is the coefficient to R, which changes over time. The fixed effects approach allows us to interpret the coefficient to R.<sup>9</sup>

|                  | OLS    |         | Random effects<br>panel data estimator |         | Fixed effects<br>panel data estimator |         |
|------------------|--------|---------|--|---------|---------------------------------------|---------|
| Retired          | -0.062 | (-2.42) | -0.037                                 | (-1.34) | 0.054                                 | (1.14)  |
| Age              | -0.006 | (-3.01) | -0.007                                 | (-2.93) | -0.034                                | (-4.37) |
| D partner        | 0.158  | (6.94)  | 0.136                                  | (5.07)  | -0.215                                | (-2.76) |
| Education, years | 0.038  | (9.51)  | 0.042                                  | (8.5)   | -                                     |         |
| Wealth           | 0.124  | (7.87)  | 0.086                                  | (5.13)  | -0.028                                | (-1.06) |
| Dummy d2003      | -0.041 | (-1.96) | -0.042                                 | (-2.73) |                                       |         |
| Constant         | 8.187  | (59.45) | 8.223                                  | (49.6)  | 10.663                                | (21.8)  |
| R <sup>2</sup>   | 0.12   |         | 0.12                                   |         | 0.00                                  |         |
| N                | 2604   |         | 2604                                   |         | 2604                                  |         |

Note: t-values in parentheses.

Table 2: Estimation results, log consumption of basic commodities

The OLS regressions indicate that retirement status has a significant effect on log basic expenditure in the first column. Obviously, retirement status and age are strongly correlated, but both show up significant in the OLS regression. Having a partner also has a positive effect on basic consumption. Since consumption has been corrected for equivalent household size, a positive effect from having a partner might indicate either that this correction is not adequate or that married households can exploit economies of

<sup>9</sup> In cases where the interest lies in the coefficients of the time-constant explanatory variables and where there is concern that the unobserved effect is correlated with some explanatory variables, it may be a problem to find an appropriate panel data estimator. Random effects will produce inconsistent estimates of all parameters. And fixed effects (or first differencing which produces equal results in a two period context) eliminates the time-constant variables. In cases when all time-constant variables are assumed to be uncorrelated with the unobserved effect while the time-varying variables are possibly correlated with the unobserved effect, a Hausman and Taylor type model may be an alternative, cf. Wooldridge (2001). The Hausman and Taylor (1981) estimator fits random-effects models in which some of the covariates are correlated with the unobserved individual-level random effect. The idea is that there is a subset of the time-invariant and time-varying explanatory variables that can be assumed a priori to be uncorrelated with the unobserved heterogeneity effects. This subset of explanatory variables can be used as instruments in defining a number of moment conditions that can be solved using a GMM approach. Applying the Hausman and Taylor estimator on our data resulted in a parameter estimate for retirement very close to the fixed effects estimate.



scale through e.g. fixed costs as housing, cars etc. and therefore have more money left for expenditure on variable consumption items. An alternative interpretation might be that having a partner may be correlated with a higher employment probability, higher income etc. because these characteristics are considered attractive elements in the marriage market. Finally, having a partner is negatively correlated with age in the age group above 50.

Moving from cross-sectional analysis to panel analysis makes the effect of retirement somewhat smaller and the effect of age larger. The random effects estimation results are shown in column 2 and the fixed effects results in column 3. In particular, in the fixed effects approach, the effect of retirement is small and insignificant. The Hausman test verified that the fixed effects estimates are significantly different from the random effects estimates and the OLS estimates, respectively. This is interpreted as evidence in favour of the fixed effects assumption that the unobserved individual specific effects are correlated with the explanatory variables.<sup>10</sup>

The same regressions were performed for the consumption of food-at-home, cf. table 3. The estimates and test results for the food-at-home equation are in line with the results for basic commodities above. The smaller effect of retirement in the panel data setting is in accordance with the idea that unobserved heterogeneity in preferences/productivity in market production versus household production will lead to a (numerically) upward bias in the OLS estimates. A number of explanations could be offered for this. One obvious explanation is that the OLS-analysis only catches the cross-sectional variance in expenditure. Expenditure differences between retired and non-retired are due to the fact that different types of individuals choose different timing of retirement due to different preferences for leisure versus consumption or different productivities in housework versus market work.

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<sup>10</sup> We should however be aware of the usual caveats when using the Hausman test. First, that strict exogeneity is maintained under the null and the alternative. Consequently, correlation between the explanatory variables and the idiosyncratic errors within and across time periods causes both fixed effects and random effects to be inconsistent. Secondly, the Hausman test is implemented assuming that the conditional variances are constant and the conditional covariances are zero when using the random effects estimator. If this is not the case, the standard Hausman test may fail.

|                    | OLS            | Random effects<br>panel estimator | Fixed effects<br>panel estimator |
|--------------------|----------------|-----------------------------------|----------------------------------|
| Retired            | -0.065 (-2.11) | -0.048 (-1.44)                    | 0.073 (1.09)                     |
| Age                | -0.003 (-1.24) | -0.004 (-1.36)                    | -0.056 (-5.22)                   |
| D partner          | 0.158 (5.76)   | 0.151 (4.85)                      | -0.057 (-0.53)                   |
| Education in years | 0.020 (4.03)   | 0.021 (3.66)                      | -                                |
| Wealth             | 0.047 (2.48)   | 0.039 (1.92)                      | -0.009 (-0.25)                   |
| Dummy for 2003     | -0.091 (-3.58) | -0.092 (-4.35)                    | -                                |
| Constant           | 7.736 (46.44)  | 7.771 (40.82)                     | 11.431 (16.71)                   |
| R <sup>2</sup>     | 0.04           | 0.04                              | 0.04                             |
| N                  | 2604           | 2604                              | 2604                             |

Note: t-values in parentheses.

Table 3: Estimation results, log consumption of food at home

An alternative explanation could be that people having retired in the time span 2001-2003 might not have adjusted their consumption levels, yet. Thus, the fact that we do not observe as large an effect of changes in retirement status in the panel data estimations might simply reflect that the consumption drop is not reflected in the 2003 data. It is difficult to reject this argument since we do not have more recent data. It would undoubtedly have been nice to have a longer panel. However, other analyses of the consumption drop seem to point to the fact that the drop is experienced very close to the retirement date and that people adjust their consumption upwards later, cf. Hurd and Rohwedder (2003) and Banks, Blundell and Tanner (1998). Banks, Blundell and Tanner (1998) find that consumption *growth* drops around retirement but returns to a somewhat higher level a couple of years after retirement. Hurd and Rohwedder (2003) compare survey information on people's expected consumption drop around retirement with their information on actual consumption change around retirement and conclude that people are more pessimistic about retirement's effects on their consumption levels than what appears to be necessary.

It could also be argued that the people who chose to retire between 2001 and 2003 did not retire following a planned retirement decision, but rather retired following an unemployment period and unsuccessful job search. This would probably imply that they had already adjusted their consumption to a lower level of income prior to retirement. Other studies find evidence of such an effect, cf. Christensen (2005) or Smith (2005). Due to the relatively small group (around 160 people) changing retirement status between 2001 and 2003 in our data set, we have not tried to subdivide this group further.

|                    | OLS            | Random effects<br>panel estimator | Fixed effects<br>panel estimator |
|--------------------|----------------|-----------------------------------|----------------------------------|
| Retired            | 0.430 (11.92)  | 0.413 (10.60)                     | 0.300 (3.84)                     |
| Age                | -0.002 (-0.68) | -0.001 (-0.39)                    | -0.037 (-2.89)                   |
| Dummy woman        | 0.512 (16.44)  | 0.510 (14.19)                     | -                                |
| Dummy partner      | -0.004 (-0.11) | -0.011 (-0.31)                    | -0.244 (-1.91)                   |
| Education in years | -0.032 (-5.67) | -0.032 (-4.87)                    | -                                |
| Wealth             | 0.014 (0.64)   | 0.007 (0.30)                      | -0.035 (-0.81)                   |
| Dummy 2003         | -0.082 (-2.77) | -0.082 (-3.33)                    | -                                |
| Constant           | 2.863 (14.35)  | 2.831 (12.43)                     | 5.198 (6.47)                     |
| R <sup>2</sup>     | 0.17           | 0.17                              | 0.01                             |
| N                  | 2604           | 2604                              | 2604                             |

Note: t-values in parentheses.

Table 4: Estimation results, log household production

From the estimates in table 4, columns 1-3, we find that the housework increases by around 40 pct. when retirement status changes from 0 to 1. Being a woman has a large positive and significant effect on the amount of housework, and the level of education affects housework negatively. Age as well as having a partner has a negative and significant effect on the demand for housework in the fixed effects estimates. Comparing the OLS estimates in column 1 with the panel data estimates in columns 2-3, we see that the effect of retirement status is larger for the cross-section estimates than for the panel estimates. Again, we interpret this as evidence in favour of the idea that unobserved heterogeneity in preferences for consuming the output from household production and in individual productivity in household production are correlated with the decision to retire. Therefore, the OLS estimates are upward biased and inconsistent. The Hausman test rejects the null that the fixed effects estimates are the same as the random effects and the OLS estimates. This is evidence in favour of the fixed effects assumptions that the unobserved heterogeneity is correlated with the explanatory variables. We find a correlation between the error terms in the consumption equations and the housework equation of around 0.06. This may suggest estimating the consumption and the household production equations simultaneously. We leave this challenge for future analysis.

In the following discussion of panel data versus cross-sectional evidence (OLS) we shall assume that the functional form above is correct. It is important to note that panel estimates produce precise estimates of the effect of retirement only if:

- a) “Enough” people change retirement (R) status over the period.
- b) The unobserved individual specific effects ( $\eta_i$ ) really are fixed over time.
- c) The change in retirement status is exogenous.

Assumption (a) is a crucial assumption as it is not possible to identify any effects of R in the panel data context if R does not change. 8 percent of the sample - around 160 people – changed status between 2001 and 2003. In a statistical context, this is not a large number of observations and may be an explanation of why the effects of changes in retirement status were insignificant in at some of the panel regressions. The CAMS survey will be updated with a 2005 wave some time in 2006. Adding a new wave will probably enhance the panel data quality and improve the reliability and statistical significance of the effects analyzed.

Assumption (b) also deserves some attention. It is highly probable that people’s preferences for consumption versus leisure change as they age. On the productivity side, people’s productivity is likely to decline with age, and this might affect their market productivity more than their productivity in household production. This is explicitly reflected in our modeling of individual preferences as a function of observables including age.

Assumption (c) – that the change in R is exogenous – can obviously be challenged. Previous studies on the retirement decision, cf. Gustman and Steinmeier (1986), Rust and Pheelan (1997) etc., suggest that people’s timing of retirement depends on a number of factors, including the level of income compensation upon retirement. Consequently, it is highly likely that people postpone retirement depending on their anticipated consumption change. The decision to retire is taken under numerous uncertainties, i.e. changes in professional and marital status, risk of illness, changes in tastes, retirement systems etc. We will investigate this issue further below.

Unobserved heterogeneity is only one type of problem. Another problem which is probably also relevant in the context of the CAMS dataset is measurement error. The CAMS data is subject to measurement error in consumption and time use, as discussed in the data section. Consumption and time use are left-hand side variables in our analysis, and under the classical errors-in-variables assumption that the measurement error is uncorrelated with the independent variables, measurement error has no effect on the statistical properties of OLS but may lead to larger standard errors, cf. Wooldridge (2002). More importantly, the indicator for retirement status may be subject to measurement error. In the data, retirement status is determined by respondents’ own information about whether they are retired. Previous analyses show that people’s perception of whether and when they have retired can vary. For example, some people who have been outside the labor force for most of their careers as homemakers will

report that they are retired, others may not, perhaps depending on the retirement status of their spouse. People who are unemployed might report to have retired, and others might report that they are unemployed while they effectively are not active in job seeking anymore. And others again have effectively withdrawn from the labor force, but do not consider themselves retired and do not claim social security pensions or other pensioners benefit.

In the case of a classic measurement error of a *continuous* right-hand side variable where the error is uncorrelated with the true indicator (but correlated with the observed), we know that the estimated parameter will always underestimate the true parameter, and that the attenuation bias depends on the variance of the measurement error and the variance of the unobserved “true” indicator. In general, the attenuation bias is worse in the panel setting. In a model where the right-hand side variable in question is *binary* as it is the case with retirement, the standard assumption about the classical measurement error being uncorrelated with the true value of  $R$  no longer holds. For example, if the true value of  $R$  is 1 and the observed value is 0, the measurement error is always -1, and vice-versa, and the measurement error is then correlated with the true value of  $R$ . To conclude, there are two types of bias – selection (unobserved heterogeneity) and measurement error – which affect the parameter estimates in opposite directions. The direction of the net effect is unknown.

## 7 Endogeneity in the retirement decision

In the previous analysis, retirement was treated as an exogenous variable. Thus, we assumed that the retirement decision is unaffected by the level of or anticipated changes in consumption or housework, respectively. However, we can think of several examples where people’s retirement decision is linked to anticipated changes in consumption or housework. For example, consider two otherwise identical people who have different expectations about their consumption drop at retirement due to e.g. unobserved differences in pension schemes. If the person who anticipates the highest drop decides to postpone retirement in order to smooth consumption, then we may underestimate the costs of retirement in the form of a consumption drop. Another example is two people with the same individual and household characteristics, but with different costs (in terms of expenses or time) of going to work. We may see that the person with the higher costs of going to work will choose to retire sooner than the person with the lower costs. Moreover, the drop in expenditures will be higher for the person with the higher costs of going to work even though this extra drop does not result in a drop in well-being.

Previous studies on the retirement decision, cf. Gustman and Steinmeier (1986) or Rust and Pheelan (1997), suggest that people’s timing of retirement depends on a number of factors, including the level of income compensation upon retirement. Thus, it

is very likely that people postpone retirement depending on their anticipated consumption decrease.<sup>11</sup> Now, the decision to retire is taken under numerous uncertainties, i.e. changes in professional and married life, risk of illness, changes in taste, retirement systems etc. We will investigate this issue further below.

With retirement status  $R$  being a binary and possibly endogenous explanatory variable, we can profit from the methodology of estimating Average Treatment Effects (ATE), cf. Wooldridge (2001). The central problem faced in the treatment effects literature is that for each individual we observe either the outcome with treatment ( $y_1$ ) or the outcome without treatment, the so-called “counter-factual” ( $y_0$ ), but since an individual cannot simultaneously be in both stages, we cannot observe both outcomes. If the treatment, retirement, was randomly assigned, estimation of the average treatment effect would simply be the difference between the average outcome of the treated and the average outcome of the untreated. However, for retirement (as for many other treatments) randomization is infeasible. Instead, individuals determine themselves whether they want to retire. And this decision is often related to the benefits/costs of treatment. Consequently, there is self-selection into retirement.

The parameter of interest is the difference in outcomes with and without treatment,  $y_1 - y_0$ . In many contexts, the main measure of interest is the average treatment effect (ATE), i.e. the expected effect of treatment on a randomly drawn person from the population:

$$ATE \equiv E(y_1 - y_0) \quad (10)$$

The treatment effects literature offers some suggestions to solve the problem of finding the counterfactual effect. The idea is that by conditioning on observables,  $X$ , we can eliminate the bias that arises from self-selection into retirement. Broadly speaking, there are two main types of treatment effects estimators. One group of estimators is based on the assumption of ignorability-of-the-treatment conditional on the covariates. In our context, this assumption implies that, conditional on observables  $X$ , retirement  $R$  and  $(y_0, y_1)$  are independent:<sup>12</sup>

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<sup>11</sup> As an illustration, we performed a simple probit of non-retired citizens choice to retire. If not retired in 2001, CAMS asked what their expected change in consumption would be if they retired right now. In CAMS 2001, non-retired respondents were asked if they expected that their consumption would increase, decrease or stay the same if they should choose to retire, and by how much their consumption would change in percent. Controlling for age, gender, partner and health change, we find that people’s expectations about their consumption change upon retirement is significantly correlated with their probability to retire. One possible explanation could be that people use the timing of retirement to smooth consumption over time, thus postponing retirement until the decline in consumption is not too large.

<sup>12</sup> The interpretation of the conditional independence assumption is that two people with the same observables  $X$ , one being retired and the other not being retired, the outcome of the retired person, had he/she not retired, is the same as the outcome for the non-retired person. Likewise, again holding  $X$  fixed, the outcome of the non-retired person, had he/she retired, is the same as the outcome for the retired person. Thus, conditional on  $X$ , we can eliminate the selection bias. The conditional independence assumption always holds if retirement is a deterministic function of  $X$ , in which case we have so-called “selection on observables”.

$$(y_1, y_0) \perp R \mid X \quad (11)$$

However, people's timing of retirement may be linked to anticipated changes in consumption or housework upon retirement. Thus, people select into the treatment (retirement) based on expectations about the benefits and costs of the treatment. The instrumental variable approach is useful when we suspect failure of the ignorability-of-treatment assumption. The idea is that the instrument should predict treatment after partialing out controls. Furthermore, the instrument should be unrelated to unobserved heterogeneity.

We can predict retirement by performing an estimation of the retirement choice based on predetermined individual or household observables. In order to predict each person's retirement status in 2001 and 2003, we performed a probit with retirement status as the dependent variable and a number of characteristics known prior to these years as age in the form of age dummies, gender, years of education etc. captured in the matrix  $X$ . The probability of a person being retired takes the following form:

$$p(X) \equiv P(R = 1 \mid X) = \Phi(X\beta) \quad (12)$$

The results are presented in table 5 below. The estimation is based on pooled observations from 2001 and 2003. The pseudo- $R^2$  of the estimation is 0.24. On average, the probit model seems to fit the data quite well: the observed average propensity to retire and the predicted probability of retirement are both around 0.61. The dummies for age 62 and 65 confirm the peaks in retirement found in other studies. These are due to specific institutional settings in the US, especially connected to the social security system. The probit estimation verifies that non-linearities related to age are important in the identification of the timing of retirement.

The IV approach has been used in previous analyses to reduce the impact of unexpected events such as job loss or disability in the retirement decision. Some of these studies have also used non-linearities in age as instrument for retirement, recognizing that the probability of retirement is higher at certain ages when workers become eligible for government retirement benefits. Haider and Stevens (2004) point to two potential problems when choosing non-linearities in age as an instrument for retirement. First, older households generally reduce their consumption as they age, as we show in section 4. The rapid change in retirement status by age may be correlated with changes in the marginal utility of consumption at these ages. If these changes are not captured by the control variables but are correlated with the non-linearity in age, then the exclusion restriction is violated and age is an inappropriate instrument. Second, when using age as an instrument, it is implicitly assumed that the relationship between age and actual retirement is the same as the relationship between age and expected retirement. However, the fraction of workers who retire unexpectedly may vary systematically by age. Haider and Stevens (2004) show that this is not the case and conclude that age is not

a valid instrument for expected retirement. Instead, they use anticipated retirement time as an instrument, as discussed in the introduction to this paper.

On the other hand, we argue that consumption is correlated with age measured as a continuous variable, while age dummies do not contribute to the identification of consumption. Including age dummies in our consumption equations and household production equations above instead of age as a continuous variable resulted in insignificant age dummies.

|                       | Coefficient | t-statistic |
|-----------------------|-------------|-------------|
| Dummy for woman       | 0.029       | 0.49        |
| Education in years    | -0.026      | -2.49       |
| Dummy for 2003        | 0.115       | 1.99        |
| Dummy for age 51      | -0.175      | -0.31       |
| Dummy for age 52      | -0.179      | -0.33       |
| Dummy for age 53      | -0.278      | -0.55       |
| Dummy for age 54      | 0.029       | 0.06        |
| Dummy for age 55      | -0.189      | -0.39       |
| Dummy for age 56      | 0.163       | 0.35        |
| Dummy for age 57      | -0.009      | -0.02       |
| Dummy for age 58      | 0.181       | 0.38        |
| Dummy for age 59      | 0.141       | 0.3         |
| Dummy for age 60      | 0.590       | 1.26        |
| Dummy for age 61      | 0.514       | 1.1         |
| Dummy for age 62      | 1.081       | 2.32        |
| Dummy for age 63      | 1.151       | 2.48        |
| Dummy for age 64      | 1.256       | 2.68        |
| Dummy for age 65      | 1.510       | 3.23        |
| Dummy for age 66      | 1.479       | 3.15        |
| Dummy for age 67      | 1.561       | 3.33        |
| Dummy for age 68      | 1.694       | 3.6         |
| Dummy for age 69      | 1.822       | 3.84        |
| Dummy for age over 70 | 2.297       | 4.97        |
| Constant              | -0.528      | -1.11       |

Note: t-values in parentheses.

Table 5: Probit estimation for retirement status



The predicted probabilities from the probit estimation are therefore used as instruments in the following. The estimations are performed using the fixed effects panel data estimator with instruments (xtivreg in Stata), cf. Wooldridge (2001). We estimate the usual equations by IV with retirement status instrumented. Instruments are 1,  $X_i$  and predicted probabilities,  $\hat{p}_i$ . A couple of alternative panel IV estimations were also implemented, see Wooldridge (2001) for a discussion of different procedures. One of these was to extend the above procedure to include the explanatory variables for retirement interacted with the deviation between the other explanatory variables and their respective means, i.e.  $R_i * (X_i - \bar{X})$ . Thus, the equations were estimated by IV with retirement status instrumented and instruments 1,  $X_i$ ,  $\hat{p}_i$ , and  $\hat{p}_i * (X_i - \bar{X})$  (predicted retirement probabilities interacted with deviations from the means of  $X_i$ ). The IV procedure was also extended with normal densities  $\hat{\phi}_i = \phi_i(X_i \hat{b})$  of the index function (latent variable function) in the estimation equation (and as an instrument). Finally, we ran a fixed effects regression on 1,  $R_i$ ,  $X_i$ ,  $R_i * (X_i - \bar{X})$ ,  $R_i * \hat{\phi}_i / \hat{\Phi}_i$ ,  $(1 - R_i) * \hat{\phi}_i / (1 - \hat{\Phi}_i)$ . This is a fixed effects version of “switching regressions” due to Heckman, see Vella and Verbeek (1999). The results for consumption of food-at-home and household production when using the first of the IV procedures above and the “switching regressions” procedure are shown in tables 6-7 below.

|   | Fixed effects IV |         | FE “Switching regressions” |         |
|---|------------------|---------|----------------------------|---------|
| Retired (R)                                     | -0.526           | (-1.00) | -0.218                     | (-0.85) |
| Age   | -0.025           | (-0.82) | -0.038                     | (-2.23) |
| Dummy for partner                               | -0.015           | (-0.13) | -0.036                     | (-0.28) |
| Years of education                              | -                |         | -                          |         |
| Wealth  | 0.006            | (0.14)  | 0.036                      | (0.76)  |
| R*dev(age)                                      | -                |         | 0.009                      | (0.41)  |
| R*dev(partner)                                  | -                |         | -0.031                     | (-0.26) |
| R*dev(education)                                | -                |         | -0.009                     | (-0.40) |
| R*dev(wealth)                                   | -                |         | -0.093                     | (-1.44) |
| $R_i * \hat{\phi}_i / \hat{\Phi}_i$             | -                |         | 0.365                      | (1.97)  |
| $(1 - R_i) * \hat{\phi}_i / (1 - \hat{\Phi}_i)$ | -                |         | -0.021                     | (-0.13) |
| Dummy 2003                                      | -                |         | -                          |         |
| Constant  | 9.731            | (5.94)  | 10.282                     | (10.39) |
| N   | 2604             |         | 2604                       |         |

Note: t-values in parentheses.

Table 6: Consumption of food-at-home, fixed effects instrumental variable approach

Using predicted retirement as instrument in the consumption equations results in somewhat higher estimates for the effect of retirement status on consumption than the fixed effects estimations in tables 2 and 3. Since the results are insignificant regarding the effect of retirement, one should be cautious when interpreting the results. One careful interpretation could be that a prediction of retirement status solely based on predetermined household and personal characteristics obviously does not take individual or personal characteristics related to different time preference rates, risk aversion etc. into account. Thus, when we “force” people to retire based on their observed characteristics, the decline in consumption is somewhat higher than the observed decline based on realized behaviour. This suggests that people tend to smooth consumption with the timing of their retirement decision. Table 7 shows that the IV estimates for the housework equation are somewhat smaller (and insignificant) than the fixed effects estimates that we presented in table 4.

|   | Fixed effects IV |         | FE “Switching regressions” |         |
|---|------------------|---------|----------------------------|---------|
| Retired (R)                                     | 0.441            | (0.74)  | 0.136                      | (0.45)  |
| Age   | -0.044           | (-1.30) | -0.035                     | (-1.74) |
| Dummy for woman                                 | -                |         | -                          |         |
| Dummy for partner                               | -0.254           | (-1.89) | -0.246                     | (-1.62) |
| Years of education                              | -                |         | -                          |         |
| Wealth  | -0.039           | (-0.84) | -0.056                     | (-0.99) |
| R*dev(age)                                      | -                |         | -0.050                     | (-2.04) |
| R*dev(partner)                                  | -                |         | -0.157                     | (-1.01) |
| R*dev(education)                                | -                |         | -0.006                     | (-0.04) |
| R*dev(woman)                                    | -                |         | 0.012                      | (0.45)  |
| R*dev(wealth)                                   | -                |         | 0.044                      | (0.57)  |
| $R_i * \hat{\phi}_i / \hat{\Phi}_i$             | -                |         | -0.107                     | (-0.49) |
| $(1 - R_i) * \hat{\phi}_i / (1 - \hat{\Phi}_i)$ | -                |         | -0.187                     | (-0.93) |
| Dummy for 2003                                  | -                |         | -                          |         |
| Constant  | 5.600            | (3.00)  | 5.337                      | (4.59)  |
| N   | 2604             |         | 2604                       |         |

Note: t-values in parentheses.

Table 7: Housework equation, fixed effects instrumental variable approach

## 8 Conclusion

The main purpose of this paper is to explore the role of unobserved individual heterogeneity for the effects of retirement on consumption and household production. We argue that there are three major sources of individual heterogeneity: 1) heterogeneity in preferences for consumption versus leisure and household production, 2) heterogeneity in productivity in market work versus housework, and 3) heterogeneity in the marginal utility of wealth. The unobserved individual heterogeneity is likely to be correlated with the retirement decision. Thus, people with relatively high preferences for leisure or the output from household production or with a high productivity in household production will tend to retire earlier. And individuals with a relatively low marginal utility of wealth will retire relatively early. In that case, OLS-estimates of the effects of retirement will tend to be biased and inconsistent. By exploiting the panel dimension of our data, we find that the effects of retirement on consumption and household production

are numerically smaller in a panel data analysis than when analyzed with OLS. Moreover, the fixed effects estimates, which assume some sort of correlation between the unobserved heterogeneity and the explanatory variables, are significantly different from the random effects estimates, which assume no such correlation. We interpret this as evidence in favour of unobserved heterogeneity being an important factor in the retirement decision. Moreover, the direction of the bias points at unobserved heterogeneity in 1) preferences for household production and leisure versus market goods and 2) productivity in household production versus market production as affecting the retirement decision.

Most studies of the retirement-consumption drop assume that the retirement decision is exogenous. However, it seems reasonable that people consider their expected changes in consumption and time for e.g. household production when they decide when to retire. Thus, retirement may be endogenous. We address the endogeneity issue by using a treatment effects approach where predicted probabilities of retirement are used as instruments for retirement. The IV estimates when applying this method are numerically higher than the results under the exogeneity assumption and insignificant.

# Appendix

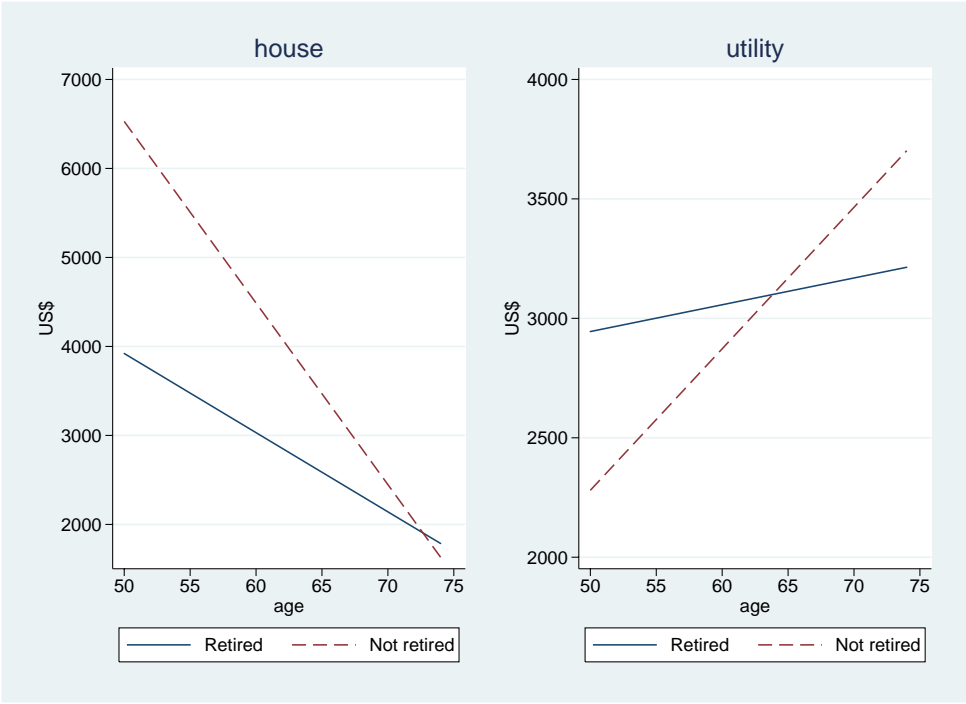


Figure A1: Expenditure on housing and utilities

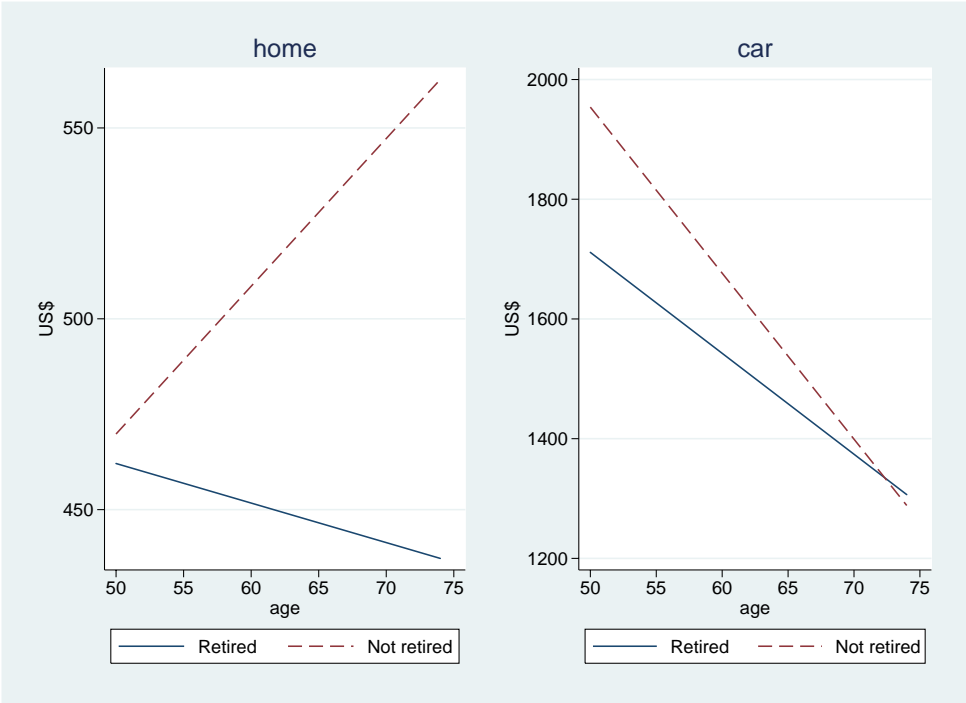


Figure A2: Expenditure on home and garden supplies and car use

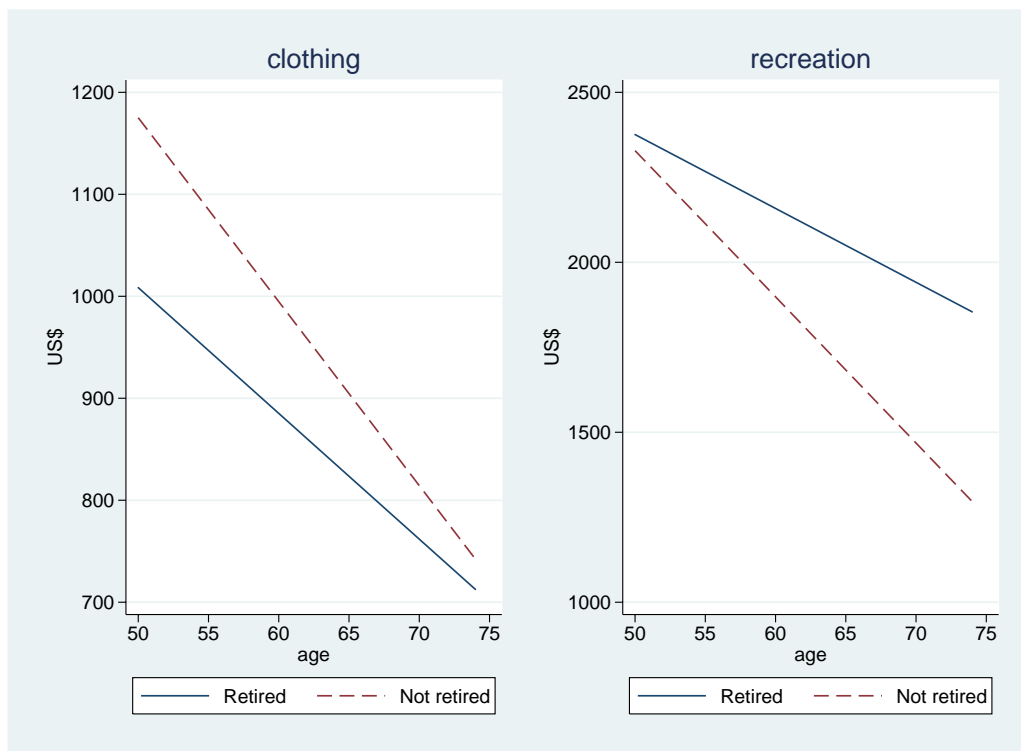


Figure A3: Expenditure on clothing and recreation

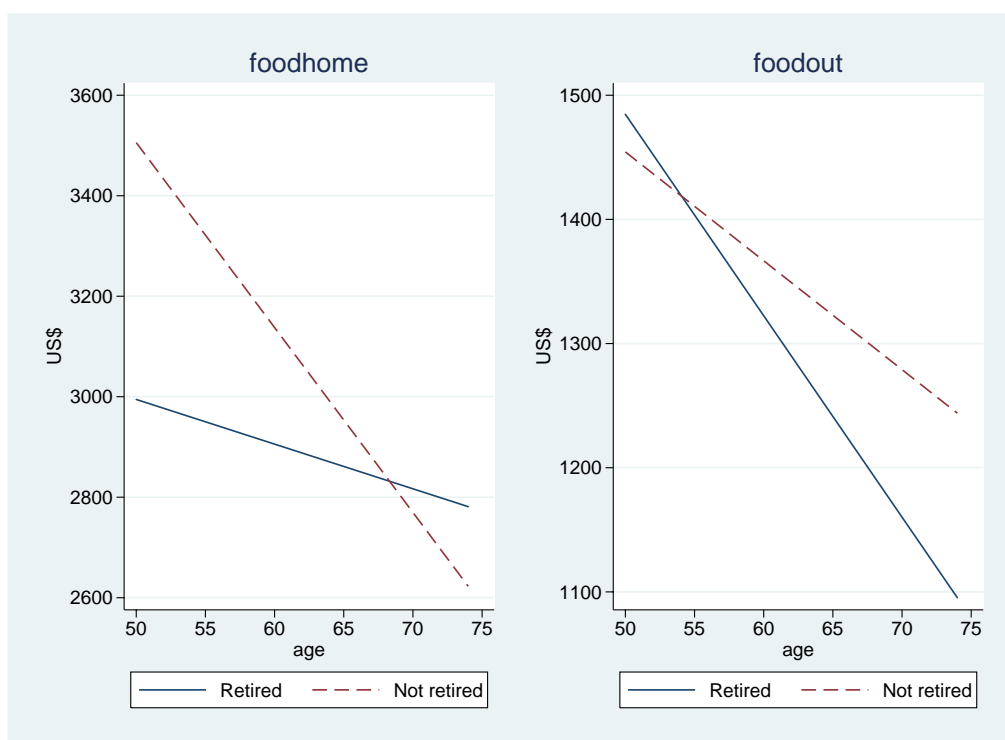


Figure A4: Expenditure on food at home and food out

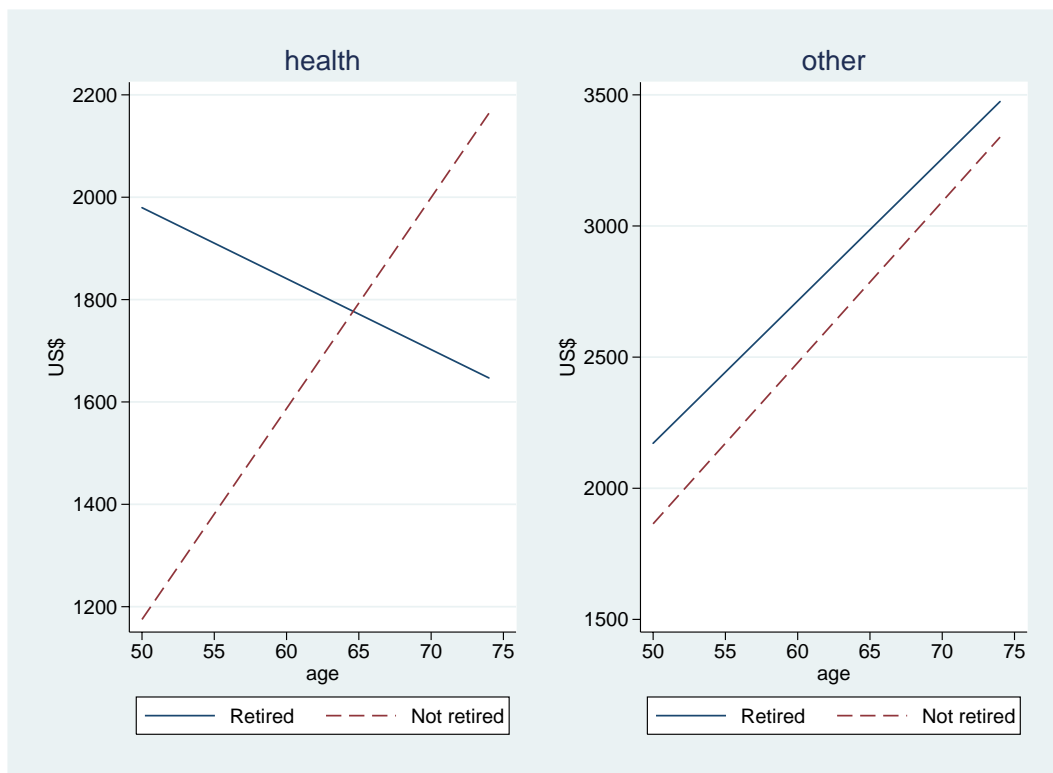


Figure A5: Expenditure on health and other expenditure

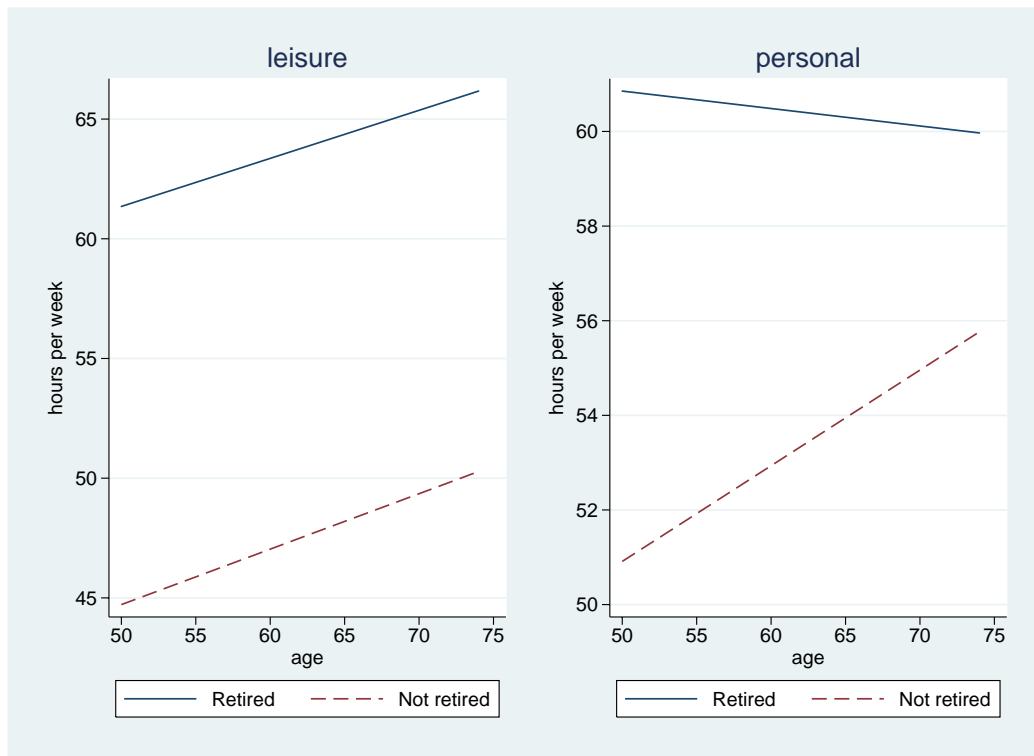


Figure A6: Time use in leisure and personal time (sleep+hygiene etc.)

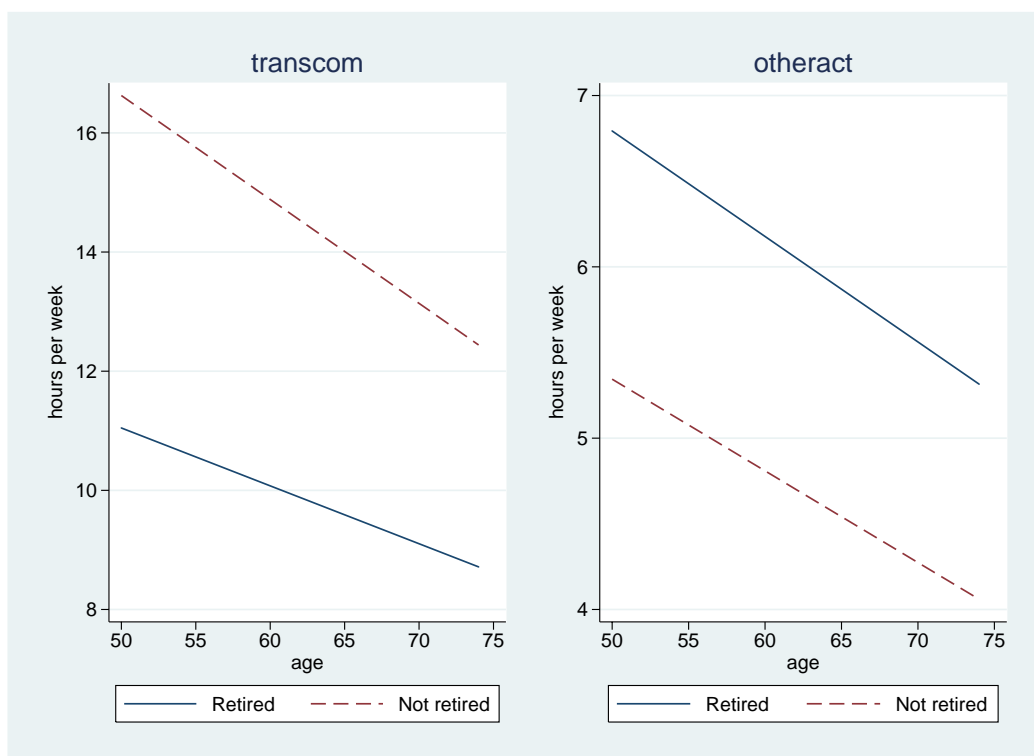


Figure A7: Time use in transport+communication and other activities





Figure A8: Retirement age, pooled sample

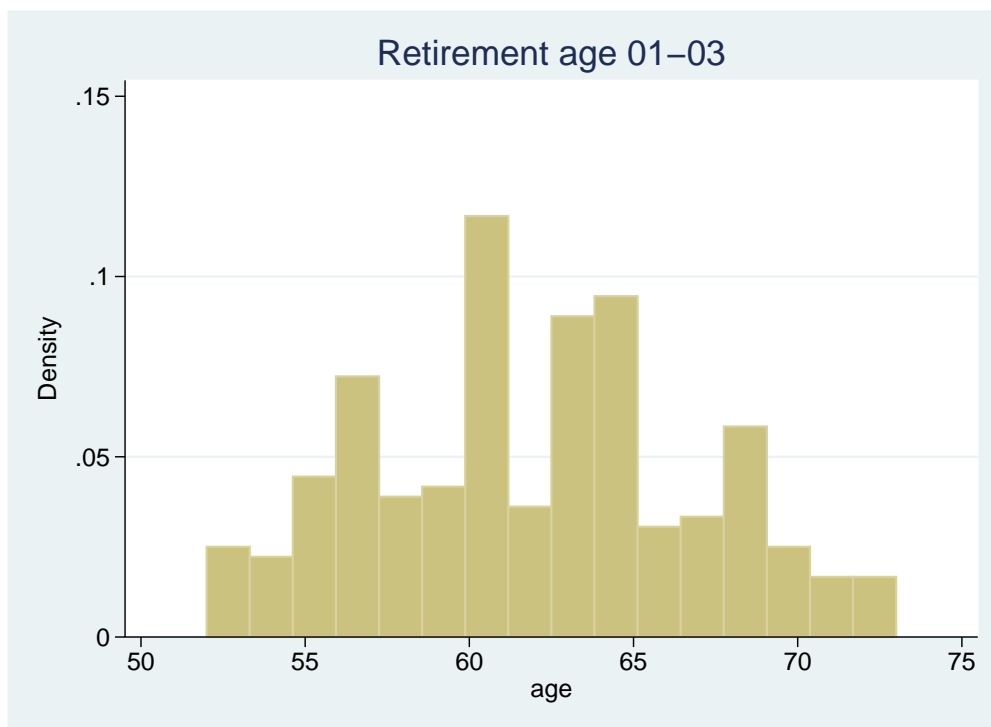


Figure A9: Retirement age, panel

| Variable                      | Mean    | Std.    | Minimum | Maximum  |
|-------------------------------|---------|---------|---------|----------|
| Basic consumption             | 5124.5  | 3139.7  | 1000.0  | 31324.8  |
| Food at home                  | 2960.8  | 1613.2  | 0.0     | 9975.5   |
| Housework                     | 21.8    | 13.4    | 0.0     | 93.4     |
| Age                           | 63.8    | 6.0     | 50.0    | 75.0     |
| Woman                         | 0.6     | 0.5     | 0.0     | 1.0      |
| Partner                       | 0.7     | 0.5     | 0.0     | 1.0      |
| Number of children            | 3.4     | 1.9     | 0.0     | 18.0     |
| No. of residents in household | 2.1     | 1.0     | 1.0     | 8.0      |
| Education in years            | 13.0    | 2.7     | 0.0     | 17.0     |
| Household income, US\$        | 57747.0 | 65632.4 | 0.0     | 744346.1 |

Table A1: Summary statistics for dataset

|                                       | Var. name in<br>panel | Var. name in<br>CAMS 2001 | Var. name in<br>CAMS 2003 |
|---------------------------------------|-----------------------|---------------------------|---------------------------|
| Mortgage                              | XB7                   | B7                        | B13                       |
| Home/rent insurance                   | XB8                   | B8                        | B7                        |
| Property tax                          | XB9                   | B9                        | B8                        |
| Rent                                  | XB10                  | B10                       | B14                       |
| Electricity                           | XB11                  | B11                       | B15                       |
| Water                                 | XB12                  | B12                       | B16                       |
| Heat                                  | XB13                  | B13                       | B17                       |
| Phone/cable                           | XB14                  | B14                       | B18                       |
| Auto finance charges                  | XB15                  | B15                       | B19                       |
| Auto insurance                        | XB16                  | B16                       | B9                        |
| Health insurance                      | XB17                  | B17                       | B11                       |
| House/yard supplies                   | XB18                  | B18                       | B20, B22                  |
| Home maintenance                      | XB19                  | B19                       | B24, B25                  |
| Food/drink groceries                  | XB20                  | B20                       | B36                       |
| Dining out                            | XB21                  | B21                       | B37                       |
| Clothing                              | XB22                  | B22                       | B26                       |
| Gasoline                              | XB23                  | B23                       | B38                       |
| Vehicle service                       | XB24                  | B24                       | B10                       |
| Drugs                                 | XB25                  | B25                       | B28                       |
| Health services                       | XB26                  | B26                       | B29                       |
| Medical supplies                      | XB27                  | B27                       | B30                       |
| Vacations                             | XB28                  | B28                       | B12                       |
| Tickets to movies, sports events etc. | XB29                  | B29                       | B31                       |
| Hobbies/leisure equipment             | XB30                  | B30                       | B32, B33                  |
| Contributions                         | XB31                  | B31                       | B34                       |
| Gifts                                 | XB32                  | B32                       | B35                       |

Table A2: List of consumption groups in CAMS consumption survey

| Code | Description              | Observed | Activity type* |
|------|--------------------------|----------|----------------|
| A1   | WATCH TV                 | weekly   | L              |
| A2   | READ PAPERS/MAGS         | weekly   | L              |
| A3   | READ BOOKS               | weekly   | L              |
| A4   | LISTEN MUSIC             | weekly   | L              |
| A5   | SLEEP/NAP                | weekly   | P              |
| A6   | WALK                     | weekly   | T              |
| A7   | SPORTS/EXERCISE          | weekly   | L              |
| A8   | VISIT IN PERSON          | weekly   | L              |
| A9   | PHONE/LETTERS/EMAIL      | weekly   | L              |
| A10  | WORK FOR PAY             | weekly   | M              |
| A11  | USE COMPUTER             | weekly   | T              |
| A12  | PRAY/MEDITATE            | weekly   | L              |
| A13  | HOUSE CLEANING           | weekly   | H              |
| A14  | WASH/IRON/MEND           | weekly   | H              |
| A15  | YARD WORK/GARDEN         | weekly   | H              |
| A16  | SHOP/RUN ERRANDS         | weekly   | H              |
| A17  | MEALS PREP/CLEAN-UP      | weekly   | H              |
| A18  | PERSONAL GROOMING        | weekly   | P              |
| A19  | PET CARE                 | weekly   | L              |
| A20  | SHOW AFFECTION           | weekly   | O              |
| A21  | HELP OTHERS              | monthly  | O              |
| A22  | VOLUNTEER WORK           | monthly  | O              |
| A23  | RELIGIOUS ATTENDANCE     | monthly  | L              |
| A24  | ATTEND MEETINGS          | monthly  | T              |
| A25  | MONEY MANAGEMENT         | monthly  | H              |
| A26  | SELF CARE                | monthly  | P              |
| A27  | PLAY CARDS/GAMES/PUZZLES | monthly  | L              |
| A28  | CONCERTS/MOVIES/LECTURES | monthly  | L              |
| A29  | SING/PLAY MUSIC          | monthly  | L              |
| A30  | ARTS AND CRAFTS          | monthly  | L              |
| A31  | HOME IMPROVEMENTS        | monthly  | H              |

\*) H: Housework, L: Leisure, M: Marketwork, P: Personal care including sleep,  
T: Transport and communication (computer time), O: Other activities.

Table A3: List of activities in CAMS time use survey

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