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Foreword

This thesis spans two centuries, two continents, two jobs and – three children. When I started my post-graduate studies in 1993, I never thought that the end would be achieved by the year 2004. After six years in non-academic professional life between the years 1997-2002, it was very difficult to believe it would be possible to return to academic life and to conclude a project that had been neglected all that time. Fortunately it turned out to be possible.

This thesis has benefited from the help of a multitude of people. It is, therefore, impossible to thank all those individuals who have encouraged, advised, criticised or blessed this project. Thank you all for being there.

In particular, however, I would like to thank my wife, Johanna, who made the actual writing of this thesis possible. By accepting a job offer in Uganda, she made it possible for me to take a two-year sabbatical and to concentrate on writing in our beautiful home in the hills of Kampala.

I also owe a huge debt to my long standing academic mentors Reija Lilja, Matti Pohjola and Pekka Ilmakunnas. Without their encouragement and confidence in my ability to return to my studies, I might not have had the courage. Reija and Pekka with Hannu Piekkola were also my supervisors, and they all did a tremendous job.

I would also like to thank the Research Institute for Finnish Economy for publishing this thesis in their series. Through the years Pentti Vartia has shown a great interest in the economics of time use and I hope this thesis fills in a modest way the paucity of such studies in Finland.

I wish to thank the Department of Economics of the Helsinki School of Economics for letting me finish my manuscript in their facilities after returning from Uganda with a new and a loudly expressive baby. At home the writing would have been impossible.

This thesis has also benefited from the suggestions received from my pre-examiners Lennart Flood and Kari Hämäläinen. The comments from Iiris Niemi, Hannu Pääkkönen and Paavo Väisänen from Statistics Finland were also very helpful.

The Yrjö Jahnsson Foundation and The Foundation of the Helsinki School of Economics made this thesis possible by financing the research.

Studying time use shows that there are painful trade-offs between different activities. My sons Rainer (6 years), Rurik (4 years) and Joel (10 months) have suffered the most from my involvement in this project. I hope that in the new time-use equilibrium the share of leisure devoted to them and to my wife will increase.

Helsinki, November 2004

Olli-Pekka Ruuskanen

Contents

ESSAY 4.

INTRODUCTION: TIME-USE AND ECONOMICS

Abstract:

This essay surveys the peculiarities of time-use data from the viewpoint of economic research. The most popular approach in modelling economic behaviour with time-use has been the household production model introduced by Becker in the 1960's. However its empirical implication has been difficult. The biggest problem with time-use data is that it has been collected for the needs of societal accounting. Therefore there exists only few observations on a given individual. This creates the problem of zero observations for seldom recurring activities. Econometric estimation is in many cases hampered also by the lack of necessary background variables like income information.

0 INTRODUCTION

This thesis contains four applied econometric essays on time-use in Finnish households. Using Finnish Time-use Survey from year 1999/2000 we will study whether spouses spend time together, the number of activities people engage in during housework and leisure time, how active the leisure time-use is, and what makes people do multiple activities at the same time.

Klevmarken (1999) concluded his survey on the lack of time-use research by noting pessimistically that "…the time-use data are underutilized." Although time-use data have been available from 1960's there has not been as much research utilizing these datasets as would have been expected. He attributed this to the reservation that economists have with the high noise to signal ratio in time-use data and missing economic variables. Indeed, time-use data seem to be a prime example of data that are plagued with endogeneity problems in econometric sense: omitted variables, measurement errors and simultaneity in variables.

However, there are research questions that could and should be analyzed with time-use data. Time allocation, interaction between household

members, human capital formation, determinants of labour supply, gender equality and child care questions are all examples of areas on which time-use data could shed more light. The possible problems with the data should be seen as a challenge - not as a hindrance - to research.

Fortunately, the Finnish time-use data that have been collected by Statistics Finland are of high quality: nonresponse rates are low for household level samples and there exists a lot of background information. Statistics Finland has been active in developing methods for collecting and analysing time-use data since 1979. One indication of the professional high standards is the fact that Statistics Finland has been selected as a coordinator of the European Harmonised Time-use Survey. Thus Finnish Time-use Survey offers a researcher a good opportunity to test the different theories on time allocation.

The economic framework for modelling time-use has also existed since the 1960's. At that time, standard consumer theory was enlarged by Gary Becker to take time into account. In this household production theory, time and market goods are combined within a household to produce more 'basic' commodities like a warm meal. People derive utility from these basic commodities. The problem with this general theory is that the outputs, these 'basic' commodities are unobservable. Subsequently, variants of this framework have been introduced with more easily measured variables. However, the implementation of these models has been scarce.[1]

Two developments are contributing to renewing the interest to study time-use in economics. First, there will be more time-use datasets available that have the information on income, taxation and transfers that is necessary for meaningful economic modelling of household behaviour. There are also attempts to produce comparable cross-country time-use data, so the testing of models with geographically more varied data will be possible in the future.

Secondly, there has been advancement in econometric methods that concern endogeneity problems and limited dependent variables. The advancement in methods makes it possible to draw more accurate inferences from economic models that utilize time-use data.

However, time-use data still offer more problems than solutions. Care should be exercised in dealing with the most common endogeneity

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[1] There are a number of textbooks on household production theory and family economics. For example Bryant (1990), Cigno (1991), Kooreman and Wunderink (1997), and Ermisch (2003). For a definite survey of the field see Rosenzweig and Stark (1997).

problems: omitted variables, measurement errors and simultaneity. These complications can result in widely differing results if they are left unaccounted for. But also careless use of the proposed solutions to complications can result in erroneous interferences.

In this survey we will review the common theoretical models for analyzing time use, the structure of time-use data available, the special econometric problems connected with time-use data, and the state of economic research concerning time-use. This chapter will end with a short review of the essays in this thesis and a discussion of the imputation of certain missing variables used in the studies.

Edward Lazear (2000) has written about economic imperialism, which he interpreted to mean the willingness of economists to study questions that fall clearly outside their traditional subject matter with the refined mathematical methods. Lately it has been the sociologists who have been forced to shout 'The barbarians are coming! The barbarians are coming!" Hamermesh and Lee (2003) warned about the danger that " in many cases our [i.e. economists] research addresses questions that scholars in other disciplines have already addressed, is not linked to economic theory, and/or uses different data but employs methods and approaches used many times before by others."

Economic research has its comparative advantage in the models that explain individual behaviour in a maximizing framework. Our essays will use these models extensively. The outcomes proposed are not random: they are the responses of rational individuals to outside constraints. We propose that this framework will give a more accurate picture of the time allocation process than has been achieved by methods from other, less formal, scientific disciplines.

Time is a scarce commodity. Economics is about the allocation of scarce commodities to competing uses. The road to travel is a natural one, but most of the territory is uncharted.

I HOUSEHOLD PRODUCTION THEORY

1.1 The Beckerian Model of Time Allocation

As Juster and Stafford (1991) noted in their survey of time-use research, "The challenge for economic research [on time] is whether the differ-

ences across countries and over time can be explained by a common model of economic behaviour in which differences in wages, prices, income taxation, or other forces lead to differences in the allocation of time." Indeed the question is whether economic variables are powerful enough to explain time-use or whether cultural or other non-monetary forces are stronger in shaping people's use of time? It could be argued that the proposed answer to this question marks the line between economics and sociology.

Economics uses models to get predictions, which then can be tested with data. Therefore the discussion of time allocation in economic context is a discussion about suitable models to characterize the time allocation process.

In the traditional consumer theory, time has a role in the labour supply decision but does not have a role in the consumption decision. Consumer maximizes utility by consuming the goods that he purchases with the income he gets from working in the market. How long the consumption of different goods and services takes has no effect on the decision. Neither has the composition of leisure or the amount of housework the consumer does. This makes it impossible to study time allocation in the context of traditional consumer theory.

Time was introduced to economic analysis of household behaviour by Gary Becker in a series of seminal articles during the 1960's.[2] Its subsequent variants have become cornerstones for time-use analysis in economics. One of the most popular has been Gronau's (1977) model on the allocation of time in market work, housework and leisure.

In Becker's original model, households combine market goods and time to produce basic commodities. These basic commodities are quite vague, like a warm meal or a happy child. This transformation of time and market goods into basic commodities is described by the use of household production function. Depending on the preferences of the household and the production technology they use, a certain optimal bunch of basic commodities is produced. These are not observable directly, but it is possible to have information on the time inputs and market inputs that have gone into the production process.

In this context, the problem of consumer's choice can be reduced to a time allocation problem: How many hours have to be worked in order to

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[2] For original articles see Becker (1965) and Becker and Michael (1973). For a statement of his approach see Becker (1991). For a survey of the field see Gronau (1986) and Gronau (1997). For critical evaluation of Becker's theories see Pollak (2003).

purchase market goods and how many hours to devote to making basic commodities and consuming them. In the optimum the marginal utility of consumption of a given basic good is equal to its shadow price, which includes marginal inputs of goods and marginal value of time to make the basic commodity. Then each basic commodity is produced to the extent that its marginal rate of substitution between different inputs is equal to the ratio of its input prices, which in this case are wage rate and cost of goods.

There is a widely cited literature starting from Pollak and Wachter (1975) on the weaknesses inherent in the Beckerian framework. Because outputs from the production process, the basic commodities, are not directly observable, it is impossible to separate preferences from the technology in a reduced form demand equations. Families who face the same prices will choose different input mixes and it will be impossible to deduce whether this is caused by their preferences or their household production technology. The only way to make the prices of basic commodities tractable is to assume that the household production process exhibits constant returns to scale and there is no joint production. Joint production means that a person derives direct utility from performing an activity.[3] Pollak and Wachter argued that household production is full of activities that give direct utility. They also argued that constant return to scale is an unrealistic hypothesis in the context of household production.

One way to avoid the criticism advanced by Pollak and Wachter is to narrow the scope of household production to housework and leisure activities. Then the objects of the study will be the time allocation to various activities instead of the more abstract basic commodities. This line was proposed by Gronau (1977) in his paper on the allocation of time to housework, leisure and market work.

When household production is explicitly introduced into the decision problem of an individual, it usually results in a marginal condition that household production is done up to a point where the marginal product of housework is equal to the wage rate from market work, which is equalised to the ratio of marginal utility from leisure and consumption. Leisure is a residual that is left after the amounts of household production and market work are decided.

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[3] An example is an enjoyment from cooking food. If a person derives direct utility from making food, he/she will devote more time to that activity than the optimum would suggest.

Gronau's original model had only one person. To illustrate this framework we will use Solberg and Wong's (1992) enlargement of Gronau's basic model (1977) to a two-person household. However, we will depart from them in that we omit work related travel time from the model. We also allow the household production function to have durable goods alongside housework time of spouses as inputs. We also enlarge their model to take into account the different productivities spouses have in household work, by introducing productivity parameters α_m and α_f for husband (*m*) and wife (*f*), respectively. These productivity parameters can be thought of as functions of human capital.

The level of aggregation of the time-use is high. We have just three uses of time: housework, leisure and market work. Therefore, with this model it is not possible to investigate the allocation of time to specific housework or leisure activities.

The key assumption in this and other household production models is that the goods produced at home are perfect substitutes to market goods. The reason for using this assumption is that it separates the production decision from the consumption decision. The allocation of time to different activities is purely a technological question driven by different productivities in different activities. For a person who is working in the market, the price he commands for his labour, the wage rate, will determine (when compared with his effectiveness in housework) his time allocation. Changes in the wage rate will cause adjustments to the optimal time allocation and this is the comparative static nexus of the model.

In a household with two consumers, the equilibrium condition is that the ratio of marginal rates of substitution between spouses is equal to the ratio of their wage rates. This means that the amount of time household members spend on housework does not depend on their preferences but on the opportunity cost of time and their productivities.

We will consider a household with two household members, husband *m* and wife *f* , who both are working. The household preferences are represented by a unitary household utility function *U*, which has the leisure demands l_i ($i = m,f$) and goods consumption x as arguments

$$U = U\left(l_m, l_f, x\right)$$

where $x = x_t + x_h$

so goods consumption is composed of goods purchased from the market x_t and household produced goods x_h. We invoke the much used and

controversial assumption that market goods and household goods are perfect substitutes. The household production function is:

$$x_h = z\left(\alpha_m h_m, \alpha_f h_f, d\right),$$

where h_m and h_f are the amounts of housework of husband and wife, α_m and α_f are the corresponding productivity parameters of the housework time and d is the household's amount of durable goods used in household production. Durables enhance the productivity in household production and it is assumed that $\partial z / \partial d > 0$. However, we will treat durables as a fixed element $\bar{d}$ in the production function z. The time constraint faced by spouses is:

$$T = l_i + h_i + m_i, i = m, f\ ,$$

where m_i is the amount of market work done by each household member. The income constraint is:

$$x = w_m m_m + w_f m_f + z\left(\alpha_m h_m, \alpha_f h_f; \bar{d}\right) + v_m + v_f\ ,$$

where v_i are the non-labour incomes of both household members and w_i is the after tax wage rate.

The Lagrangian of the maximization of the household utility subject to the budget constraint is

$$\begin{aligned} L &= U\left(l_m, l_f, x\right) \\ &+ \lambda_m\left(T - l_m - h_m - m_m\right) + \lambda_f\left(T - l_f - h_f - m_f\right) \\ &+ \lambda_x\left(w_m m_m + w_f m_f + z\left(\alpha_m h_m, \alpha_f h_f; \bar{d}\right) + v_m + v_f - x\right) \end{aligned}$$

where time-use of spouses is normalized to one. This results in first order conditions for interior solution:

$$\begin{aligned} &U_j = \lambda_j, \quad j = m, f, x \\ &\lambda_x z_i \alpha_i = \lambda_i, \qquad i = m, f \\ &\lambda_x w_i = \lambda_i, \qquad i = m, f \end{aligned}$$

in addition to fulfilment of budget and time constraints. We get the result that

$$w_i = \alpha_i z_i = \frac{\partial U_i}{\partial U_x}\ ,\ i{=}m{,}f$$

which is the equality, at the margin, of the wage, the marginal productivity in housework and the marginal rate of substitution between leisure and consumption. Further manipulation gives the result that in the interior solution, the ratios of marginal productivities versus ratios of wage rates, which also will be the ratios of the marginal rates of substitution should be the same for both household members:

$$\alpha_f z_f \Big/ \alpha_m z_m = w_f \Big/ w_m = \frac{U_f \Big/ U_x}{U_m \Big/ U_x}$$

Household decision can be interpreted to have two stages. First the household decides how much housework is done in order to maximize the profit from the household production subject to the opportunity cost of the market wage rate for both spouses. Then the household maximizes its utility by choosing the amount of consumption of market goods and leisure, given the maximized level of household production.

We will introduce profit functions for easier characterisation of comparative statics of the model. Assume that the profit from household production can be represented as:

$$\pi \equiv z\left(\alpha_m h_m, \alpha_f h_f; \bar{d}\right) - w_m h_m - w_f h_f$$

Holding the household productivity parameter constant the equilibrium amounts of housework can be expressed as functions of wage rates of household members:

$$h_i^* = h_i(w_m, w_f), \quad i = m, f$$

This can be substituted back to the profit function to derive a maximized profit function:

$$\pi^*(w_m, w_f) \equiv Z\left(\alpha_m h_m^*(w_m, w_f)_m, \alpha_f h_f^*(w_m, w_f); \bar{d}\right) - w_f h_f^* - w_m h_m^*$$

There are three comparative static effects that are of interest. The first is the effect of wage rates on the allocation of time, the second is the effect of non-labour income on the time allocation and the third is how the changes in productivity in housework affect the time allocation.

The rise in non-labour income does not change the trade-off between equilibrium amount of housework and market work. Therefore the amount of housework stays the same although leisure increases and market work decreases. An increase in own wage rate shifts the optimal allocation and leads to a reduction of housework. The income effect will result in a reduction of market work and an increase in leisure. The gross wage effect is therefore indeterminate.

If the housework times of the spouses are complements then the housework of a person increases when the housework time of the other spouses increases. If they are substitutes, then the housework time of one spouse decreases when the housework time of the other increases.

To derive comparative static effects for leisure demand, the profit function is substituted into full-income constraint of Becker's type. Then household's full income can be expressed as a function of wage rates and non-labour income only:

$$I = I\left(w_m, w_f, v\right) = \pi^*\left(w_m, w_f\right) + w_m m_m + w_f m_f + v$$

Now the household demand for leisure and market goods can be expressed at equilibrium as:

$$l_i = l_i\left(w_m, w_f, I\right), \quad i = f, m$$
$$x = x\left(w_m, w_f, I\right)$$
$$\lambda_3 = \lambda_3\left(w_m, w_f, I\right)$$

The change in non-labour income has only income effect. The change in wage rate on the demand for leisure works through following:

$$\frac{\partial l_i}{\partial w_m} = \left(\frac{\partial l_i}{\partial w_m}\right)_{comp} + \frac{\partial l_i}{\partial I}\frac{\partial I}{\partial w_m}$$

where the first term refers to income compensated effects. From the full-income constraint we have

$$\frac{\partial I}{\partial w_m} = \left(\frac{\partial \pi}{\partial w_m}\right)_{comp} + T$$

where T is the total time endowment. This can be substituted to get generalized Slutsky equation:

$$\frac{\partial l_i}{\partial w_m} = \left(\frac{\partial l_i}{\partial w_m} \right)_{comp} + (T - h_m) \frac{\partial l_i}{\partial I}$$

The first term is the income compensated substitution effect and next is the income effect. The third term describes the effect of the change on the profit function. In this case Hotelling's lemma $\partial \pi / \partial w_m = -h_m$ tells that the effect of a rise in wage rate on the profit function is the negative of housework.

We can interpret this as follows: the negative substitution effect of a wage rate rise on the demand for leisure is reinforced by the negative substitution effect from household production. The total effect cannot be determined because the income effect is positive.

The nature of the spouses' leisure time has an impact. The cross substitution effect of a wage rate rise on the other person's demand for leisure is positive if leisure times of household members are substitutes and negative if they are complements. However, again due to the income effect, the total effect is indeterminate. The income effect will also increase the other partner's demand for leisure and cut his/her demand for market work.

The change in housework productivity has a substitution effect that increases the time-used in household production and decreases market work. However, the income effect is indeterminate. If spouses' times in housework are substitutes, then an increase in one spouse's productivity decreases housework time for the other spouse. If they are complements, then the increase will increase also the housework time of the other spouse. The overall effect that takes into account the income effects is once again indeterminate.

This basic model does not include situations where one or both household members are not working in the market. A model that takes into account these features is presented in Kiker and Oliveira (1990, 1992). They explicitly considered corner solutions by estimating probabilities for participating in the market and incorporating these estimates in their production function.

The model presented above is the traditional unitary model of household decisionmaking although there are two household members in the household. There is no bargaining between spouses and the decisions

that are reached are efficient by definition. This makes the model tractable even when household production is introduced into it.

However, there is a growing critical literature on the appropriateness of such models.[4] Some of the assumptions of the unitary model have been empirically refuted and it has also been argued that an explicit reference to the bargaining within the household should be used.

Different modelling approaches that take the intrahousehold decisionmaking explicitly into account have been called collective models or bargaining models. There exist a number of variants of these models, some of which have Pareto efficient outcomes and others that do not.[5]

The general structure of these models is that they first formulate a Pareto-efficient household decision problem, which then is shown to be equivalent to a decentralized model. This decentralized model has individual utility functions and a conflict resolution algorithm in the form of a sharing rule or a bargaining solution concept. The comparative statics of the model is performed and there is an attempt to derive commodity demands and labour supplies, which is usually not fully successful.[6]

Indeed, it would seem natural to treat time allocation in the context of collective models of household behaviour. It would make the explicit study of power relations within the household possible with regard to time allocation. However, there are a number of difficulties with the incorporation of expanded time-use categories in these models, which makes the traditional approach more suitable for the analysis of time-use.

The biggest problem is that introducing household production alongside with bargaining mechanism makes many of the effects intractable. For example, even in the case of allocation of time to market work and leisure, the sharing rule between spouses cannot be fully recovered. By introducing an extra dimension to this problem, the model is not tractable except under very strong and implausible assumptions. Moreover, the household production models reduce the production decision of the household to be contingent on wage rates and production efficiency. By explicitly considering bargaining questions, the preferences of the spouses are introduced back into the decisionmaking. This complicates the models further.

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4 See for example Bourguignon et al. (1993), Browning et al. (1994), Lundberg and Pollak (1994), Thomas (1990), Thomas (1993), Lundberg, Pollak and Wales (1997).

5 For example of collective models see Chiappori (1992) and Browning et al. (1994). For Nash-bargaining models see Manser and Brown (1980) and McElroy and Horney (1981). For non-cooperative bargaining see Lundberg and Pollak (1993).

6 For example in the collective models sharing rule can be recovered only up to an additive constant. See Bourguignon et al. (1993), Chiappori (1988).

The most notable investigation of the possibility to extend collective models to take household production into account was made by Apps and Rees (1997) and Chiappori (1997). Apps and Rees (1997) investigated whether the presence of household production changes the results obtained in multi-person model and whether it is possible to derive a sharing rule by developing a model that includes household production.

In the Apps and Rees model, consumers have a choice over a market good, a household produced good, and pure leisure by deciding the time allocation to domestic production and labour supply. The implicit price of the household produced good is determined within the household and the price of leisure is the market wage rate. The household good is not tradable in the market. Apps and Rees divided the model to production and consumption sides. Decentralization of the production side is achieved as follows: The optimal amount of time to be devoted to household production is determined. The consumption side is decentralized by choosing shares of the full income for both household members, which has both the labour and non-labour income and the profit from the household production as arguments.[7] Then each household member maximizes his/her utility given his/her share of the full income. The solution of this problem gives us the demand functions for the three goods.[8]

In standard models without household production, the sharing rule can be recovered up to an additive constant. In this enlarged model, this is not possible. This is because time can be divided to three different activities so leisure cannot be deduced solely from the labour supply.

Apps and Rees showed that the set of restrictions, which allows the recovery of partial derivates of the sharing rule are that, first, household production is linear homogeneous and, second, that demands for leisure are independent of the price of the domestic good.

In his response to Apps and Rees' contribution, Chiappori (1997) showed that in the case when a household produced good is assumed to be tradable, the sharing rule parameters can be recovered up to an addi-

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7 Chiappori's model can be obtained from the Apps-Rees model by setting household production parameters to zero.

8 In this model the change of wage rate causes a substitution effect to arise in the presence of household production, because the wage rate is the value of the time and it affects the implicit price of the household produced good. This substitution effect affects every household member. The change in wage rate also has an income effect through the change in real income because it affects the implicit price of the household produced good. The response to the change in the non-labour income has both an income and a substitution effect.

tive constant. In the most natural case, where the household produced good is non-tradable, the Apps and Rees results of the impossibility of recovering the sharing rule still hold.

There is a clear case for incorporating bargaining aspects of the household decisionmaking into the models with household production. However, the extra complications that possible enlargements would introduce call for the use of a traditional unitary model with household production in our essays.

The household production model in this chapter was introduced to give the benefit of the theoretical framework with which to conceptualize the time allocation decision and the forces that affect it. Household production theory is a powerful ally in the research of time-use. In the essays themselves, different variants of the household production models, which will be more suitable for the research questions at hand, will be applied.

1.2 Testing Critical Assumption of Household Production Model

Is the household production theory of any use in econometric studies? If most of the postulated entities and their relationships are unobservable is there any point of using it? Pollak and Wachter's (1975) classical conclusion is that there is none.

Regardless of the criticism, household production theory is used in applied work. The way household production has been saved is that additional assumptions have been invoked to get identification. Three critical assumptions are weak separability, lack of jointness in the production process, and constant returns to scale.

The failure of these assumptions would have serious consequences for time allocation models. There still is a paucity of empirical studies that have tested these assumptions. However, some exist and they will be reviewed briefly.

1.2.1 Joint Production

A recurrent theme in household production literature is the question of the type and extent of joint production. Usually joint production is defined to take place when a household member derives direct utility from a productive activity at home. An example would be a housewife who gets pleasure in preparing a meal for the family.

Jointness has serious effects on the household production. With direct utility derived from household work, household members will spend more time on different activities than they would without direct utility. If jointness is not accounted for, this effect will be attributed incorrectly to higher level of marginal productivity in a given activity.

To test the effects of joint production Graham and Green (1984) published a model where joint production was explicitly taken into account in a household production framework. They extended Gronau's (1977) original model by introducing joint production into the model. In this case some of the time-used in household production gave direct utility to the household members. Graham and Green modelled household production as Cobb-Douglas function. The hours of the spouses in the household production went through a transformation function in which a part of the hours were subtracted as pure leisure. However, the model they created was full of difficulties: it was underidentified and additional restrictions imposed on the model produced unexpected estimation results.

Kerkhofs and Kooreman (2003) showed the limitations of Graham and Green's approach. They noted that by introducing jointness functions into the analysis some elements of household's utility function were reintroduced into the otherwise technical relationship and this created problems. They demonstrated that in this formulation, the capability to separate the effects of the jointness function and production function depends on the fact that jointness functions are individual specific but the production function is household specific and contains cross-effects.

Kerkhofs and Kooreman showed that even in the case with information available on both the time-inputs and market goods used in household production, identification of the joint production is difficult. If the household contains only one adult, the identification is not attainable in the case of joint production.

Kerkhofs and Kooreman proposed an alternative functional specification for the estimation of household production based on a quadratic specification for a net product value function. They estimated the model with Swedish HUS-data from 1984. Housework was defined as childcare, repairs and maintenance and household work. They first estimated the model without joint production and sample selectivity and then estimated the model with these variables included.

They found that the introduction of joint production had no effect on the amounts of housework but the utility for doing different activities were more than halved. Joint production was more important for

women than men. The results also gave strong support to the assumption that household members' home production times were substitutes.

Pylkkänen (2002) replicated the Kerkhofs and Kooreman (2003) study with a newer Swedish HUS-survey from 1994. She used Graham-Green's formulation for jointness. Pylkkänen observed that, unlike with 1984 data, it was now the male housework time that exhibited more jointness. Her estimates indicated that almost half of male housework time is valued as leisure but only a quarter of females' housework. In comparison to earlier data, male housework increased by half an hour with the increase in jointness. Jointness in women's time-use had decreased but productivity increased while the time had basically stayed the same.

The assumption that there is some jointness in the activities that household members do seems warranted. However, the question to be addressed is how serious is the introduced bias and how it could be taken into account in examining time-use within families. As Juster and Stafford (1991) noted, there is evidence that there is joint production also in market work, which in some cases is enjoyed per se. This has not stopped labour economists from investigating labour supply. The joint production problem should not do the same to housework either.

1.2.2 Separability

Reduced form equations are prevalent in household production estimation literature, because the output from household production is not visible. In order to study these functions, the assumption of weak separability has to be invoked. The assumption of weak separability is vital because it partitions goods and time-uses in groups of substitutes and complements.

Kooreman and Kapteyn (1987) pointed out that if the condition within which market goods and household goods constitute together the household's total consumption is substituted to the utility function alongside the household production function, both market goods and housework have to be weakly separable from pure leisure activities. The condition can naturally be extended to different leisure and homework activities. The condition of weak separability implies restrictions on the elements of the Slutsky matrix that could be tested with a demand system.

Lecocq (2001) tested the assumption that goods and time devoted to the household production of a given commodity are weakly separable from the goods and time devoted to other activities. He derived a conditional demand function for meal preparation and noticed that the sepa-

rability test consisted of determining whether in the meal preparation equation the coefficients associated with time and market inputs to other activities are different from zero.

His empirical specification was a simple Working-Leser type of demand system, where the dependent variables were the share of raw materials and time inputs to meal preparation. He used a variety of instruments for wages and total expenditure. He restricted the sample to those households where both members were working and where any of the inputs to meal preparation were zero.

As most of the coefficients were not significant, Lecocq concluded that time and inputs used in meal preparation are non-separable from time and inputs to other activities. He additionally divided the sample to weekend and weekday records using a proxy for full-time work. Then he got a result that during a weekend the derived utility function was separable and during weekdays it was not. Furthermore, for the weekend case he got a result that market inputs were separable from each other and from male and female leisure time, but they were not separable from time inputs to other household activities.

The assumption of weak separability has to be invoked regardless of the evidence against it. As the Lecocq study is not conclusive, this question must be studied further before robust conclusions are reached.

1.2.3 Constant Returns to Scale

Only in the case of constant returns to scale can there be an analytically tractable link from different inputs to unobserved outputs in household production. However, as outputs from household production usually have not been recorded, there is not much evidence on the feasibility of this assumption.

The only study to have explicitly taken the outputs from household production process into account is Fitzgerald and Wicks (1990). Their sample consisted of 384 households in Minnesota, from which detailed data were collected concerning the structure, income and labour market status of the households.

Every household recorded data on each activity taking place in the home over a period of one week: frequency of the activity, the person performing it, duration of the activity and the quantity of output. As many as 57 different outputs were defined to have market equivalents. Using a market substitute, they calculated the value of the output from

household production, which was twice as high as the value obtained by estimating just the value of the time spent doing the activity.

Fitzgerald and Wicks observed that the household production process did not exhibit constant returns to scale. In many activities there were increasing returns to scale and in some activities decreasing returns to scale. Their findings casted doubt on the constant returns to scale assumption used in studying household production.

1.2.4 Bargaining Models

The only empirical study to have attempted to incorporate household production and multi-person decisionmaking is Aronsson et al. (2001). They studied Chiappori's as well as Apps and Rees' formulations of the collective model that included household production. They estimated male and female leisure demands, the household production function and the sharing rule parameters using Swedish Survey of Household Market and Non-market Activities (HUS). Their dataset included households with and without children where both partners were between 20-60 years old and working. This resulted in a sample of 326 households for data from year 1984 and 338 households for data from year 1993.

They assumed that household production is characterized by CES production function, which exhibits constant returns to scale. Furthermore, they assumed that the sharing rule is determined by the ratio of men and women in the area, differences in the age, wage, and education, marginal wages and non-labour incomes.

The problems of incorporating household production into collective models were evident from the contradictory results they obtained. They could not reject the unitary model or the restricted model for 1984 data but both models were rejected for the 1993 data. The test of constant parameters over time was also rejected. Also none of the determinants of the sharing rule were significant for 1984 data. For 1993 data the differences in education, age and wage were significant.

1.3 Conclusion

Although the Beckerian household production framework has been criticised as being fundamentally unobservable, it serves as a good heuristic tool for examining time allocation within households. In our essays we will use the theory to obtain predictions about the effects of stress, the amount of variability in time-use, and the desirability of active leisure.

Collective extensions of the theory are still in their infancy. Although the collective approach is a more appealing way of modelling household behaviour, the explicit decisionmaking of the spouses will complicate the model and in many cases make the model with household production intractable.

The main problem of the household production framework is that outputs of the production process cannot be directly observable. Therefore household production theory has its most fruitful application in development economics, where the output from rural households can be measured and the inputs calculated.[9] Another area of application has been the travel economics, where travel choice is based on travel time and other costs are investigated.

There is still a great need for empirical studies to test the basic assumptions underlying household production models. Studies done so far cast doubt on the relevance of these assumptions.

Even with its limitations, household production theory represents the most natural way to model time allocation within households. The suitability of this modelling framework must be decided with regard to each particular research question separately. If the data at hand and the problem seem to be suitable for the use of household production model without too many assumptions being violated, then the model should definitely be used.

II TIME-USE DATA

2 International Time-use Data

Time-use data exist for an increasing number of countries. By 2002 time-use data were available from sixty two different countries.[10] The history of collecting time-use information dates back to the late nineteenth century, but collection has not been systematic either methodologically or temporally. Niemi and Pääkkönen (1989) noted that studies were done in

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9 In development economics there has been a number of applications of the household production model. See for example Skoufias (1993), Khandker (1988) and Mueller (1984).

10 See Fisher (2002).

England and in France in the last half of the 1800's on the time-use of factory workers. Harvey and Pentland (1999) noted that the collection of the time-use data in the United States can be traced to 1913 when the first time-use studies were published there. Notable pioneering studies were also conducted in 1923 in Japan and in 1924 in the Soviet Union. The first Finnish time-use data were collected in 1936 from farm families, but the results were not published until in 1947 (Kirjavainen 1989).

A major breakthrough in the time-use research was Alexander Szalai's Multinational Time-use Study conducted in the mid 1960's in 12 countries and 16 different survey sites. This study, by Szalai et al. (1972), sets out the data collection scheme that has subsequently been used in almost all time-use surveys.

Today, there is a wide variety of time-use studies that have been conducted in various developed and developing countries. However a major problem is that these datasets are often not compatible due to different sample selection criteria, temporal recording periods and aggregation categories used. From the econometric viewpoint many datasets also lack the necessary economic variables, like information on income.

Interestingly there are also many important countries that have not seen the necessity of collecting time-use data by their statistical offices. For example in the United States the Bureau of Labour Statistics conducted the first national time-use survey in 2003 and the preliminary results from this survey were released September 14th 2004. Previously only private parties produced time-use data for the United States. The Institute of Social Research at the University of Michigan produced time-use surveys in 1965 and in 1975. The Survey Research Centre at the University of Maryland conducted surveys in 1985, 1992-94 and 1995, but the data are not compatible with each other.[11]

The lack of compatibility between data from different countries has led to an attempt to coordinate methods for conducting time-use surveys. As in other parts of the world also in Europe a variety of methodologies have been used in collecting national time-use studies, which has meant that most of the studies are incompatible to a certain extent. In order to harmonise time-use surveys in the European Union, Eurostat

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[11] The Bureau of Labour Statistic's new time-use data will be quite elementary. For example each respondent will be interviewed only for one day, so separate observations for the weekend and weekday time-use for a single person will not be available. Only a limited number of background questions will be asked. Furthermore the data will be at the individual level so no information on the time-use of other household members will be collected.

made a number of pilot surveys during the years 1996 and 1997. These resulted in 2000 in the publication of common guidelines for collecting time-use studies: "Guidelines on Harmonised European Time-use Survey". Statistics Finland has followed the Eurostat guidelines in the Finnish Time-use Survey from 1999/2000.

A complication with the European harmonization is that this effort unfortunately has not produced a fully comparable set of surveys from different countries. The aim of the guidelines is to produce output harmonised information on time-use in different European countries. There is no attempt to arrive at an input harmonised system that would cover all participating countries. Therefore, a lot of discretion is allowed by national statistical offices in the production of data.[12] There is an allowance for nationally compiled interview questions and additional time-use categories are allowed. Also there is no requirement to collect information at the household level.

As a result of these options, many important countries have deviated from the guidelines, mostly attempting to keep the results compatible with earlier time-use studies conducted in a given country. The situation in various European countries with regard to compiled or future time-use studies and the level of synchronization with the Harmonized European Time-use Survey (HETUS) as of March 2003 is presented in Appendix 1.

United Nations Statistical Division has also been active in giving guidelines for time-use surveys especially for developing countries. The importance of time-use surveys in developing countries relates to the fact that non-market production, especially household production, is very prominent in these countries. The time-use surveys will help to make this non-market work visible. UN's statistical division is in the process of drafting United Nations International Classification of Time-use Statistics under their United Nations Development Program and Canadian International Development Centre.

One very important project has been the household panel study on household market and non-market activities (HUS) conducted in Sweden in 1984 and 1993. The study used time-use diaries in addition to survey questions on different time-uses, thus making it possible to study the reliability of different collection methods. The study also had a panel subsample.

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[12] One reason for this is that Eurostat's Statistical Program Committee rated time-use studies as low priority in context of 1998-2002 five-year working program and no Eurostat funding was given. The only contribution was the guidelines, see Österberg (2000).

There have also been attempts to assemble internationally comparable time-use data from different time-use datasets available in some countries.[13] The most famous is the Multinational Time Budget Data Archive connected with Multinational Time-use Study (MTUS) project. It is administered by Jonathan Gershuny at the University of Essex and has postharmonized time-use information from 21 countries.[14]

It will still take a long time until internationally compatible time-use data from most important countries are available for the economic research. Present attempts at comparability mainly address the harmonization of the time-use data. Even if time aspects of the data are harmonized, there will still be a lack of comparable economic variables in these datasets. Econometric research on time-use has to use datasets where the most relevant variables are present. For time being this narrows the geographic coverage of the studies to a single or just a few countries.

3 Methods for Collecting Time-use Data

There has been an international convergence in the methodology of collecting time-use data. This has been achieved by a number of studies analysing the reliability of different collection methods. The standard time-use survey today consists of three components: The diary, the household background questionnaire and activity coding schema. This three part structure has emerged as the norm in time-use studies. These will be reviewed in turn.

3.1 Diary

In a time-use diary, a day is divided into intervals that are sequentially filled by the respondent. Usually it is possible to record not only the primary activity but also a secondary activity or even a tertiary one. Alongside with the activities, it is possible to record the location where

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13 For these time-use initiatives see Harvey (1999).

14 For a description of MTUS and the description of the data see Gershuny (2000) Appendix 3.

the activities were carried out and with whom. In some studies it is also possible to record how enjoyable a given activity was.[15]

Juster (1999) pointed out that there are three basic methods of measuring time-use. The first, and the most popular, is 24-hour time diary, where respondents are asked to fill in their time-use for the previous day or for the same day. The second is the use of stylised questions about time-use in a typical day or typical week. The third method is to collect time-use information on randomly selected moments of time signalled by a beeper within 24-hours of day.

The diary in which activities are recorded sequentially has been found to be the most reliable method of collecting information on time-use, as people's ability to recall past behaviour tends to be quite limited.[16] Indeed, as Zuzanek and Smale (1999) pointed out, time budget studies have been found to be less susceptible to the failure of recall and, more importantly, to normative biases in reporting behaviour.

There are a number of ways to collect diary information from the respondent. There can be fixed intervals, for example, of each 10-minute period, where the respondent has to fill in what he/she has done. The other option is to use open intervals, where the respondent gives the starting and ending time for each activity. The interviewer can collect the diary information by phone, in which case open interval reporting is usually used. The other possibility is to use the so called 'left behind' diaries, which are either posted or collected afterwards. In this kind of setup a closed interval reporting is usually used.

An example of fixed-interval left behind time diary is given in figure 1. It is taken from the Eurostat's guidelines for harmonised time-use surveys. This type of time use diary records primary and secondary activities, the place where the activity is done and with whom the activity is done. The recording interval is 10 minutes.

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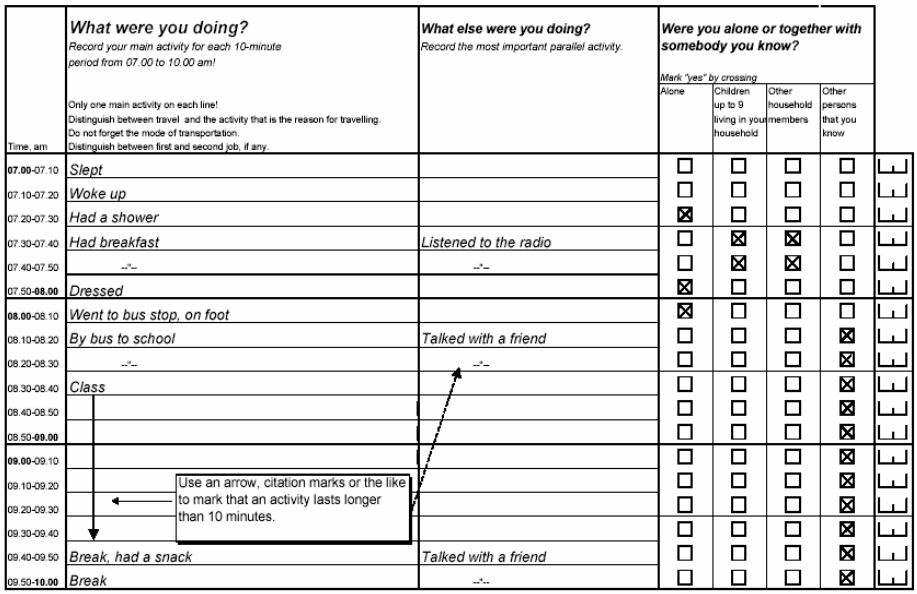
15 Time-use studies, like most surveys, place quite strong requirements for the cognitive capabilities of the respondents. The respondents are assumed to interpret the questions in the same way. They are assumed to be able to divide simultaneous activities to primary and secondary ones. They are assumed to be able to recall all episodes of a given activity and give information of the place and participants to a given activity. Moreover, they are assumed to be comfortable in describing personal or even embarrassing activities without conforming to stereotypic norms of what is socially accepted or expected from a respondent. These problems have been tackled by various methods and their harmful effects are taken into account in the survey setup.

16 See for example Robinson and Godbey (1997), Gershuny (2000), Juster and Stafford (1991).

Figure 1 Example of the time-use diary



Source: Guidelines on Harmonised European Time-use Surveys

In a recent contribution Bryant et al. (2004) argued for collecting weekly time-use data. However, Juster (1999) noted that stylised questions spanning a week overestimate time-use by third, where the degree of overestimation is a function of the regularity of the activity.

Similar evidence was obtained by Niemi (1993), who compared the measurement errors produced by recall and time diary methods. She observed that the severity of the measurement errors depended on the type of activity and the socio-economic group that was answering. Activities that were clearly distinct from other activities could be recalled more easily than routine activities. However, time diary method captured these activities effectively. Therefore the choice of data collection method should depend on the objects measured.

The recall method has some additional problems that speak in favour of using the time diary methods. Winkler (2002) noted that when respondents are asked about the time-used in housework, they define housework very differently. If very specific questions about individual housework categories are used, then there is a problem of recall. Moreover, usually in recall surveys only one person is asked about the time allocation for the whole family. Winkler pointed out that there is a wide discrepancy in the response of spouse and one's own estimate of time-used in housework. In Canadian National Survey of Families and House-

holds the correlation of reports was 0.46 in the estimated time used in housework.[17]

The consensus is to collect the data by diaries from population that has been stratified to take into account not only demographics but also different days of the week and seasons of the year.

3.2 Individual and Household Questionnaire

Time-use diaries are supplemented by individual and household questionnaires that are collected through interviews. Time diary is suitable for often recurring activities but because data are collected for a limited number of days only, activities that are usually performed infrequently are not recorded accurately at the individual level. There is also a need to have information on the demographic features of the household, such as education, employment, marital status and children, living area, living conditions, and health status. It is common in time-use studies to ask also about durable goods in the household.

In individual and household questionnaires, it is also possible to ask about average weekly time-use in different activities such as market work or housework. This makes it possible to relate the daily observations to more general patterns of behaviour. For example in the Eurostat pilot survey, a weekly report of the market work hours of those currently in employment was also collected from the respondents. However, the use of these kinds of questionnaires was not subsequently recommended by Eurostat in the harmonised guidelines.

The problem with these kinds of interviewed questionnaires is the effect of the individual interviewer on the answers. As the respondents have problems of recalling seldom occurring activities or specific information the interviewer can evoke different answers thus biasing the answers. Niemi (1993) compared results from interview based studies and from time budget studies. She got a result that the measurement error varied considerably between different population groups. Everyday routine activities were the most susceptible to recall problems and thus produced biased figures.

From the viewpoint of modelling household behaviour, a common problem in time-use data is the lack of information on income, taxation

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[17] The husband's self-reports and wife's proxy reports of husband's housework time had as low correlation as 0.37.

and transfers. In the interview part some questions about the financial situation of the household is asked. This information is usually on very aggregate categorical level, making it difficult to link time-use behaviour with the earnings of the respondents. The missing background information can also be collected from other registers in addition to interviews. The European Harmonised Time-use Survey Guidelines recommends that information on incomes is merged from official registers.

3.3 Activity Coding Lists

The third component in time-use surveys is the activity coding list. There are two ways to translate the activities of people into common categories. One is to give respondents a ready made list of activities. Then the respondent picks out an activity that they believe corresponds to the activity they are doing. Another way is to let the respondents to describe in their own words what they have been doing. The latter has been more popular in recent time-use studies.[18]

Regardless of the system adopted, the most important characteristics of activity coding schema are the level of aggregation and the possible hierarchical structure. The levels of aggregation are important because the more aggregate categories can hide important variations in time-use. Nested hierarchical structures are also important to unmask the multiplicity of time-use.

In the system of own-word reporting, after the time-use data are collected from the respondents, the time-use is coded according to agreed categories. The challenge in the coding process is to transfer the respondents' written description of their activities to a common classification system, so that the same activities are coded in the same categories regardless of who is coding.[19]

The Eurostat recommendations stipulate a three level hierarchical system, with the three most aggregate levels being the same in all countries. In the third level national statistical offices have the possibility to include additional classification entries. For example, in Finland an additional category is bathing in sauna. The activity codes used in Finnish Time-use Survey are presented in Appendix 3.

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18 See Sturgis (2002).

19 Sturgis (2002) compared these two different methods and found that coding errors in own account reporting were common in the United Kingdom's Time-use Survey 2000.

4 Finnish Time-use Survey 1999/2000

4.1 The Structure of the Data

The dataset used in this thesis is the Finnish Time-use Survey 1999/2000 collected by Statistics Finland. The data were collected between 1 March 1999 and 12 March 2000 according to the Eurostat guidelines for harmonized European Time-use Surveys.

A two-phase, single-cluster sampling was used, where households were clusters and individuals were the elementary units. In the first phase a sample of over 15-year old Finns was collected by Bernoulli sampling. This meant that approximately one person in five hundred was included in the sample. Then every person over 10 years of age living in the same household was taken into the sample. [20]

Before the diaries were collected, each member of the chosen household was interviewed and necessary background information was collected. Data from administrative files were also merged into background information file.

The households kept diaries relative to the weekdays of the year. This meant that the weekly sample covered 92-93 households and the daily sample was 18-19 households for each weekday. A Saturday or a Sunday was matched to each weekday.[21] Each individual kept a diary during the single weekday and a single day during a weekend. Within households, each member was assigned the same days, and each recorded for his/her primary and secondary activity for 10-minute intervals. The 185 possible time-use categories are presented in Appendix 3.

The sample had 10278 individuals of whom 6272 responded. Out of this group 5224 individuals had answered the interview and kept a diary for two days, resulting in time-use data for 10448 days.

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[20] This resulted in 4800 households with 10978 members. Persons who had died or emigrated during the data collection period and those in institutions were excluded. This reduced the number of households to 4677 with 10278 individuals. See Niemi and Pääkkönen (2002).

[21] Saturdays and Sundays were allocated as follows. Sunday was assigned to those respondents who had Monday, Tuesday as their weekday diary days. Saturday was assigned to those who had been allocated Thursday, Friday. Those having Wednesday as the diary date were divided into half between Saturday and Sunday. See Niemi and Pääkkönen (2002) and Väisänen (2002a).

4.2 Finnish Time-use Survey vis-à-vis European Counterparts

Statistics Finland has produced three time-use surveys covering the whole population: in 1979, in 1987/88 and in 1999/2000. In 1979 the survey was collected only from September to November, but the surveys for 1987/88 and 1999/2000 were collected for the entire twelve months period. The other major difference was that in 1979 the sample included ages 10-64 years but in 1987/88 and 1999/2000 the sample included all people over 10 years of age.

The 1999/2000 time-use survey was collected according to Eurostat's guidelines. The use of Eurostat guidelines produced some minor differences compared with earlier time-use studies. Most notable was the fact that the first two surveys were conducted at the individual level but the latest, and the one used in this thesis, was conducted at the household level. This meant that all household members over 10 years of age were interviewed. This produced clustering effect not present in the earlier surveys, but it also increased the usefulness of the data.

Also the guidelines for recording the time spent together were changed. Earlier, a clear identification of the person with whom the time was spent, was required. In the Eurostat guidelines there is a distinction in time-use between children up to nine years of age, between other household members and between other persons.

The lowest level of compatible aggregation between these surveys results in 26 main and 82 detailed categories. Also, in some cases individual subcategories can be compared to each other.

The assignment of diary dates was also changed from the previous surveys. In years 1979 and 1987/88 the diaries were filled in for two consecutive days while in 1999/2000 diary days covered one weekday and either Saturday or Sunday.

In certain areas there was a difference in the coding of activities between Eurostat's recommendation and Statistics Finland. Statistics Finland used more detailed activity codes in their classification schema. For example eating has been divided to five different activities. The same applies to resting. However, the reporting codes are harmonized according to HETUS guidelines.

4.3 Correcting for Sampling and Clustering in Finnish Time-use Data

In a complicated survey like the Finnish Time-use Survey the most important questions concern the handling of the nonresponses and the calibration of the sample. From a microeconometric viewpoint, the more relevant issue is the handling of nonresponse. The calibration has to align the resultant sample averages with the population averages on various dimensions. Problematic in this regard is that calibration and nonresponse can be taken into account by the same statistical measures, thus making it impossible to disaggregate one from the other.

Väisänen (2002b) analyzed the causes for nonresponse. Four types of nonresponse can occur. There can be cluster nonresponse in which all individuals are missing from a household. Unit nonresponse occurs when some people in the household are missing, but the household is still taken into the survey. Then whole diaries can be missing either for both observation dates or one or the other. Lastly there can be nonresponse for certain periods of time in the diary or for some questions in the interview. All these types of nonresponse necessitate adjustment that will result in complications in the calculation of means and variances for given variables.

In the Finnish Time-use Survey, the cluster nonresponse rate was 36 percent. This was corrected by weighting. This will be discussed further in chapter 6.3. At the individual level the nonresponse rate was 38 percent. To rectify unit nonresponse problem, proxy respondents were allowed.[22]

III ECONOMETRIC PROBLEMS IN USING TIME-USE DATA

5 Suitability of Time-use Data for Micro-economic Modelling

Juster (1999) discussed the two competing analytic uses of the time-use data. The first one consists of the filling of social accounting matrix with aggregate time-use categories for different socio-economic groups. The

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22 For more information see Väisänen (2002a).

second is microeconomic modelling of individual time-use. As the data needs in these two frameworks differ, the survey designs based on either one will create difficulties for the other. [23]

Most of the time-use data have been collected for the social accounting use; therefore these have features important to the social accounting research tradition. As the aim is to construct unbiased estimates of average and aggregate time-uses, estimates of time-use for individuals or households for a longer period of time are not required.

Klevmarken (1999) pointed out that there are a number of problems related to time-use data. The most serious is the noisiness of the data due to short collecting periods. This creates a number of problems, such as the frequency of zero observations even in the case of often performed activities. Likewise activities that are seldom performed are underreported. Weekly and seasonal variations affect the reported figures and with just a few observation points the weekly and seasonal effects are very difficult to separate.

As an example of the diverging needs, Juster (1999) considered visits to the opera. The population-wide sampling will result in over 95 percent of the diaries having zero time at opera. For those who happened to visit the opera during a diary day, this appears as a disproportionate time-use for opera. For a population as a whole the estimate for an average or an aggregate time-use at the opera will be unbiased. But at the level of individual the observation for a person who was at the opera has a very low reliability as an overall indicator of time spent at the opera. Of course for those who never go to opera their individual observation is unbiased and reliable.

Indeed, as Juster (1999) pointed out, from the viewpoint of individual behaviour, having a single diary observation for a large sample population that is spread evenly across the year is unsatisfactory except in the case of highly regular activities. What would be needed is a sample design in which each respondent is sampled on a number of days during the year with specific allocation of weekend days alongside weekdays.

For example an inherent assumption in the collection of time-use data from these socio-economic groups is that the diary dates will reflect in some sense a "normal" day of the respondent. Robinson (1999) however noted that in the United States 40 percent of the respondents indicated that the recording day had somehow been unusual.

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[23] For reviews on the national income aspects of the time-use data, see Juster and Stafford (1991), Eisner (1988).

The lack of more than one or two observations from a given household is the main problem from the perspective of microeconomic research, as it makes inference of individual household behaviour quite problematic. Indeed, with data consisting of a very large number of diary days in which time spent on most of the activities is zero, the resulting distributions are such that biases cannot be overcome except under highly special cases.

There have been attempts to satisfy the needs of both research traditions by collecting data from spouses and children residing in same household and for more than one diary date.

The lack of necessary variables in particular makes it difficult to draw correct conclusions, because it forces the investigator to search for proxy variables or instrumental variables.

Concentrating on data needs and collection costs, Kalton (1985) calculated that the optimal number of weekday interviews would be around two. Evidence from the comparative studies made from time-use surveys in Great Britain and Netherlands, having employed seven day diaries, show that the zero reporting problems are not very serious in the context of routine activities.

Moreover, although these problems call for improvements in data collection, the methods in data manipulation and estimation of models can help to overcome some of the difficulties. There have been advances especially in the econometrics of limited dependent variables which can be used in analysing time-use data.

5.1 Characteristics and Problems with Time-use Data

5.1.1 Choosing Between Weekly or Daily Observations

In time-use surveys, a common practice is to ask respondents to record just one or two diary dates. If there is only one diary date, it can be any day of the week. With two diary dates one usually is a weekday and the other either Saturday or Sunday. The data are stratified by assigning different weekdays and different weekend days to each respondent in order to have an observation for each day of the week. This makes it possible to have aggregate information on the daily time-use at the level of the whole population.

In analysing time-use data, one controversial question is whether the information concerning the duration of a given activity should be weighted by the number of weekdays and the number of weekend days for a single respondent. This would lead to a weekly observation where a single diary

date would be multiplied by five times and weekend diary date by two.[24] The other option is to use the weekday observation and weekend observation as they are reported.

There is a long tradition in sociological time-use research to build synthetic weeks. However, fundamental difference exists between synthetic weeks and those constructed in some economic studies. Synthetic weeks are built from the daily observations of different households usually belonging to the same socio-economic group. They do not represent the time-use in an individual household, but portray instead an average weekly time-use for a holistic group. Therefore the problem of multiplying the same daily observations does not arise with synthetic weeks.

Multiplying the same diary dates to arrive at a weekly figure could be used if the activity recurring daily is subject to a small variation only. But in the case of seldom occuring activities, weighting can lead to errors in estimation. For example, assume an activity which is performed only during a single specific day and that activity depends on a variable x. This results in all those having a different diary day to report zero, and those for whom the activity day falls on a diary day to report zero or a large positive amount. This naturally leads to an estimation bias in examining the behaviour of individual household.

The same criticism can be made with regards to the use of weekend days. As noted by Zuzanek and Smale (1999) Saturday and Sunday have very different activity profiles in western countries. In most countries Saturday is a shopping day and Sunday is a day of rest. Although the profiles have converged a little bit, as noted by Niemi and Pääkkönen (2002), the aggregate time-use profile for a weekend will be totally different depending on whether it is based on observations for two Saturdays or two Sundays. Because of these problems in this study, the data will not be weighted by weekdays to get a weekly aggregate figure.

Hill and Juster (1985) studied how weighting of different observation days would affect the estimates of a number of time-use categories. They used 1975-76 time-use survey from United States which had four full-day observations for each respondent. They regressed a set of explanatory variables on a four day average of time-use based on the four observations and compared the results obtained by regressing the same variables on a randomly picked single day.

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[24] For example, Carlin and Flood (1997) and Flood and Gråsjö (1999) use artificially created weeks as their dependent variables in their studies.

They got a result that regressions based on a single day observation tended to yield same patterns as the regression based on the four day average with the most significant predictors. However, the results tended to be less robust with weaker explanatory variables. With the random day observation the variances were twice those obtained with a four day average. Also the explanatory power of the regressions was weaker.

It seems that the analysis of time allocation should be based on the raw time-use data from the observation days. If the diary information is multiplied or averaged to aggregate weekly figures, the process inevitably introduces biases and errors in variables.

5.1.2 The Question of Aggregation

As Gershuny (2000) pointed out, the problem of zero observations depends on the level of aggregation of the time-use data. The more aggregated time-use categories used in analysis, the fewer zero observations are generated. He thus suggested that one should not use very disaggregated data.

The question of the level of aggregation used in the analysis is important. The results of economic models are sensitive to the level of aggregation in the time-use categories. Two examples can be taken from the following essays. First, the level of aggregation affects the estimates of time spent together between spouses. A second important category on which the level of aggregation has an impact, is the variability of time-use. The more aggregated the time-use categories, the less variability the respondents seem to have.

The effect of aggregation on the results has not been studied extensively. An exeption is Daunfeldt (2002) who concentrated on a disaggregated analysis of time-use. He found two regularities in the time-use data. The results on the effects of explanatory variables differed when time-use in aggregate housework was used from those obtained when each category of time-use was studied separately. He also noted that in most of the time-use studies, it was the characteristics of the household more than the economic factors which explained different time-use patterns. One possible explanation for the lack of wage and income effects could have been that they cancelled each other out in the aggregate time-use categories.

The sensitivity of the results on the level of aggregation used necessitates the replication of the results in the conducted time-use studies. A minimum requirement would be to use the most disaggregated categories and to compare them with results obtained with highest aggregation level.

5.2 Measurement Problems and Omitted Variables

Time-use studies also suffer from measurement problems with the variables that are included in the study and those omitted that would be needed for econometric analysis.

Stafford (1985) noted that as time-use data are collected only on a few diary days, this leads to low reliability of the measured time-use if accuracy is measured as the ratio of the variance of the true time-use to the variance of observed time-use.

Klevmarken (1999) discussed the same phenomena and called it high noise-to-signal-ratio. He suggested reducing the ratio in time-use surveys by combining with the time-use data additional information found in other surveys. He derived a ratio estimator for weekly hours by adjusting it with information on the nature of day. His other suggestion was to replace the estimator with a regression predictor which combined this additional information.

There are different measurement problems depending on whether time-use variables are dependent or independent variables in the model. In case of the linear models when the dependent variable is time-use, the low reliability will not result in biased estimates if exogenous variables are measured correctly. However, the coefficients of the exogenous variables are not independent from the variance of these variables if non-linear models estimated with maximum likelihood framework are used in estimation. For example, Stapelton and Young (1984) discussed different ways to estimate tobit-model in the case of measurement errors in endogenous variables. Stafford (1985) proposed that prior to estimation, the potential measurement errors be evaluated and this info be used in subsequent estimation.

Wooldridge (2002) discussed the widely recognised problem of omitted variables in the data. There are a variety of ways to circumvent this problem. As one solution Wooldridge suggested averaging problematic variables across the population to derive average partial effects which can be used as proxy variables.

The other solution is to use the variables found in the data as proxies for the missing variables. The use of proxy variables calls for special tests before they can be used and can affect the resulting variances unfavourably. However, in time-use studies the limited set of demographic variables usually makes it necessary to employ proxy variables.

5.3 Tobit, Heckman and Double-hurdle

The large number of zero responses is a common problem in time-use surveys. There are two sources for zero observations that reflect the nature of the data collection method. One source is that there are those individuals who never do an activity and therefore zero is recorded in the diary. The other source is that although this activity is usually done, for some reason, it was not done during the recording period. The problem is to distinguish one from the other.

There are a number of methods to try to account for the prevalence of zero observations in time-use surveys. These have been surveyed by Flood and Gråsjö (1999). Usually this zero-observation problem is handled by an application of either Tobit model, Heckman's selection model or double-hurdle model.[25] Each of these models represents a more refined method of taking into account the process with which zero observations are generated. In Tobit model by James Tobin (1958) the censoring is taken into account in the distributional assumptions concerning the parameters to be estimated. In Heckman's model (1979), which is sometimes called generalized Tobit or Tobit-II, the zero observations are explained by specifying, alongside the outcome equation, a probit selection equation, which models the determinants of zeros.[26] In double-hurdle model there are two selection equations: one for the zero observations caused by the behaviour of the subject, and the other for modelling the zeros caused by the sample design. Two variants of the double-hurdle model exist. In the formulation presented by Cragg (1971), the two hurdles are independent of each other. Jones (1992) constructed a double-hurdle model in which two hurdles were not independent of each other.

In the case of Tobit the latent variable y_i^* for the person *i* is described by the equation

$$y_i^* = \mathbf{x}_i\beta + \varepsilon_i \quad \text{where} \quad y_i = \begin{cases} y_i^* \; if \; y_i^* > 0 \\ 0 \; else \end{cases}$$

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25 There is also a variant called *p*-Tobit-model, which is compared to Double-Hurdle model by Maki and Nishiyama (1996) and Garcia and Labeaga (1996).

26 There are different opinions on what is the proper usage of Heckman's model. Some think that it should be used only to describe Heckman's two step estimation. Recently most econometric software packages have started to offer Heckman's model in a maximum likelihood framework. We will use the name Heckman's model for the maximum likelihood version, but indicate when referral is made to two-step method.

where $\mathbf{x}_i$ is the vector of explanatory variables and β is the vector of parameters.

The assumption behind Tobit is that the same stochastic process determines both the value of the outcome equation and the discrete switch from zero to one. In this case, zero realisation represents a corner solution. The likelihood of Tobit can be written as:

$$L = \prod_{y=0}\left(1-\Phi_1\left(\frac{\mathbf{x}_i\beta}{\sigma_y}\right)\right)\prod_{y>0}\left\{\frac{1}{\sigma_y}\phi\left(\frac{\mathrm{y}_i-\mathbf{x}_i\beta}{\sigma_y}\right)\right\}$$

where Φ_1 is the normal cumulative distribution function and φ is the density function of the normal distribution.

The assumption that the same process governs both the outcome and selection is quite restrictive. In many cases the process by which selection is determined is entirely dependent on other factors than the outcome. By modelling the selection separately from the outcome, it is possible to study these different covariates. The standard Heckman model thus has two equations:

$$y_i^* = \mathbf{x}_i\beta + \varepsilon_i \text{ where } y_i = \begin{cases} y_i^* \ if \ d_i = 1 \\ 0 \ else \end{cases}$$

$$d_i^* = \mathbf{z}_i\gamma + v_i \text{ where } d_i = \begin{cases} 1 \ if \ d_i^* > 0 \\ 0 \ if \ d_i^* \le 0 \end{cases}$$

and where in addition $\mathbf{z}_i$ is the vector of explanatory variables and γ is the vector of parameters in the selection equation. The error terms in both equations can be correlated with correlation coefficient ϱ.

If this is solved via the maximum likelihood, the likelihood function can be written:

$$L = \prod_{y=0}\Phi_1\left(-\mathbf{z}_i\gamma\right)\prod_{y>0}\left\{\Phi_1\left\{\frac{\mathbf{z}_i\gamma+\frac{\rho}{\sigma_y}\left(y_i-\mathbf{x}_i\beta\right)}{\sqrt{1-\rho^2}}\right\}\frac{1}{\sigma_y}\phi\left(\frac{y_i-\mathbf{x}_i\beta}{\sigma_y}\right)\right\}$$

The double-hurdle model is an extension of Heckman model. There is an explicit modelling of the censoring at *y*. It can be written as:

$$y_i^* = \mathbf{x}_i\beta + \varepsilon_i \text{ where } y_i = \begin{cases} y_i^* \text{ if } d_i = 1 \text{ and } y_i^* > 0 \\ 0 \text{ else} \end{cases}$$

$$d_i^* = \mathbf{z}_i\gamma + v_i \text{ where } d_i = \begin{cases} 1 \text{ if } d_i^* > 0 \\ 0 \text{ if } d_i^* \le 0 \end{cases}$$

If information on the censoring is available, the likelihood function can be written as

$$L = \prod_{y=0}\left\{1-\Phi_2\left(\mathbf{z}_i\gamma, \frac{\mathbf{x}_i\beta}{\sigma_y}, \rho\right)\right\}\prod_{y>0}\left\{\Phi_1\left\{\frac{\mathbf{z}_i\gamma + \frac{\rho}{\sigma_y}\left(y_i - \mathbf{x}_i\beta\right)}{\sqrt{1-\rho^2}}\right\}\frac{1}{\sigma_y}\phi\left(\frac{y_i - \mathbf{x}_i\beta}{\sigma_y}\right)\right\}$$

where Φ_2 is the bivariate normal cumulative density. This corresponds to the formulation presented by Jones (1992), in which hurdles are not independent.

Flood and Gråsjö (1999) and Flood and Gråsjö (2001) compared the suitability of double-hurdle model, Heckman's model and Tobit model with Monte Carlo simulation. According to their results the suitability of different estimation methods depends on how well the equation which models the selection to zero-observations and participation observations can be specified. They pointed out that given the special nature of time-use data, it is not obvious that more refined methods, like the double-hurdle model, should be preferred to Heckman's selection model or even to the simpler Tobit-model. If the process by which zero observations are determined is well known, a double-hurdle or Heckman's model should be used. If the zero-generating process is unknown, then an attempt to model it with ad hoc selection equations can lead to serious biases.

Daunfeldt (2002) modelled household members as Nash-bargainers trying to maximize constant returns to scale household production function with time as an only input. Daunfeldt corrected zero observations with the use of double-hurdle model. He tested it against Heckman's model, and observed that double-hurdle is more preferable, although when using this model, the first hurdle gave non-significant results.

Klevmarken (1999) noted that as time-use data usually have very few background variables, an additional problem is to find instruments when using Heckman's model or a double-hurdle model. The lack of background variables then leaves the identification to be obtained solely from the nonlinearity of the model, which is often questionable.

Carlin and Flood (1997) also observed evidence that simpler approaches to estimating models on time-use data are usually sufficient. When estimating the labour supply responses of Swedish men with children, they tested the double-hurdle model with Heckman's model. After testing different formulations they concluded that the double-hurdle model could not be said to be superior to Heckman's model.

These findings show that in applied econometric research, it is very important to find suitable methods for conducting the research. The data at hand often preclude the use of very advanced and complicated methods. Instead, the best results are obtained by a balanced approach, in which the structure of data determines the selection of econometric methods used.

IV PRELIMINARY IMPUTATIONS DONE IN THE ESSAYS

There are a number of preliminary calculations that need to be done before the research questions that are of interest to us in our research can be investigated. The most important are the calculation and imputation of net wage rates as well as the calculation and imputation of the daily market work hours. Furthermore, decisions have to be made regarding weighting the sample and taking the seasonal and weekly variations found in the sample into account.

The imputation of the net wage rate is based on the sample that includes all households in the labour force and where at least one person is working. In the following essays the research question at hand might call for an additional restrictions on the sample, which means that the resulting samples might be less than the one on which the net wage rate calculations are based. The imputed net wage rate is used in the subsequent estimation of the market work hours. The imputation of the hours worked is done at the beginning of the essay one, three and four. In essay two there was no need for imputed market work hours in the estimations.

6.1 Calculating and Imputing Net Wage Rates

The Finnish Time-use Survey has no information on the respondents' gross or net wage rates. However, the dataset used in these essays pro-

vides information on the annual incomes, benefits and taxes paid by the individuals, which had been merged from official registers by Statistics Finland. Moreover, the interview part of the time-use study included extensive questions on the type of work and holiday arrangements.

In order to test the different effects of the economic variables on the time-use, information on the hours of work was used with the yearly income figures to calculate the hourly wages for the employed. Then the resulting wage rates were used to impute the wage rates for those not in employment with the use of Heckman's model.[27]

To obtain the hourly wage rates for the employed, the following procedure was used: Each respondent who was in the labour force had information on the type of working arrangement and holiday arrangements he/she had with his/her employer. Those in the labour force had indicated whether they were working full-time, part-time or in various shifts. In addition there was information on whether they had normal holidays or not. Most of the individuals doing market work had normal working and holiday arrangements. In the case of atypical vacation arrangement, there was information on how many days off a respondent would get. For those who were unemployed with the unemployment duration being less than a year, a net wage rate could be calculated based on the annual wage income and work and holiday arrangement prior to becoming unemployed.

The information available was used to derive a gross hourly wage by dividing the yearly income from paid work by the number of weeks worked and by the weekly working time.[28] Child benefits allocated to both parents were added to the non labour income.

The calculation for hourly wage rates was based on the hours worked per week obtained from the interview, instead of the hours reported in time-use diaries. Hours per week give a better indication of the contracted wage rate while diaries give a better indication of the true hours worked, which includes breaks, sickness and other interruptions. Hours of worked found in diaries are not suitable for calculating wage rates based on contracted time. If used, the deviation can lead to differences

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27 There is a potential endogenity problem, if net wage rate is used to explain time allocation. The allocation of time into different activities is done simultaneously and net wage rate is one determinant of the this allocation. This potential endogenity problem cannot be solved with time-use data. One must acknowledge it.

28 There was also information on the how many weeks a person had been unemployed. If less than 52 weeks, then the weeks of unemployment were deducted from the calculations.

in the estimation results.[29] As our purpose was to derive the net wage rate we resorted to using data from the interview.

The information was then used to calculate the net hourly wage rate.[30] The calculation of the net wage rate was based on the taxation code for the year 2000. Capital gains were taxed at a constant rate of 29 percent. The progressive nature of labour income caused some problems. With regard to the yearly labour income, taxes were calculated by taking the average tax rate of a given progressive bracket. Also communal tax and employee social security contributions were calculated.[31] The general features of the Finnish tax system is presented in appendix 2.

The net wage thus relates to the average tax rate and not to the marginal tax rate. This problem of a non-linear taxation system complicates the analysis as the decisions of the individuals are based on marginal tax rates rather than on average tax rates. However, this is a common problem with all data relating to income and taxation.

Hallberg (2000) also used the normal hours reported instead of diary data in calculating net wage rates in his test of the unitary model with Swedish time-use data. He divided non-labour income by the number of days of the year to get a daily non-labour income.

Naturally it is possible to calculate the gross and net wage rates for only those individuals who are employed. We calculated the imputed wage rates for all observations using Heckman's model, which is a common practice in econometric work.

Usually the imputed wage rates are estimated separately for males and females, because there is evidence that different mechanisms determine the male labour force participation contra the female participation.[32]

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29 For example Carlin and Flood (1997) showed that only with time-use data there is evidence of a negative effect on the male labour supply resulting from the presence of children.

30 Gross wage rate was also used as a check in the estimations. However, the results did not change to a great extent.

31 For example income tax for a person earning FIM 200 000 was calculated by deducting a lower limit of the progressive bracket (178 000) from the income and multiplying the result (22 000) by 0.25 percent. To this figure the taxes from the lower limit was added (25 790). To which an average communal tax of 20 percent from the labor income (minus the communal deduction) was added. Also employee social security contributions (5.7 percent) were deducted. The resulting net labor income was divided by hours of work. All calculations are available on request from the author.

32 For empirical facts and recent trends in female and male participation rates, see for example Blundell and Macurdy (1999).

Male participation rates are high throughout the Western world and non-participation in the labour force is usually linked to old age, low education, poor health and abuse of addictives and spells of unemployment. Female labour force participation rates, although increasing rapidly in industrialised countries, are far lower than those for males. The decision by a female to participate in the labour force usually has to do with the number of children, the education level of the female and the income of the spouse. Because male participation rates are very high, the ordinary least squares estimation is usually sufficient for males. In the case of female labour force participation, estimation results must be adjusted by using Heckman's (1979) model.

In this study, the wage is predicted for both females and males simultaneously using Heckman's model. Using the whole sample produce predictions much closer to already existing wage variables than the predictions using only female and male subsamples separately.

We use Heckman's sample selection model to first estimate the probability of market work and then to correct the estimates for the wage rate equation. The specification is typical Mincer-type wage equation:

$$w_j^* = x_j\beta + e_{1j}$$

where w_j is the log of net hourly wage rate of the person j and the x_j are the exogenous variables and e_{1j} is the error term. The selection equation for person j is:

$$H_j^* = z_j\gamma + e_{2j}$$

where

$$w_j^* = \begin{cases} w_j \ \ if \ \ H_j^* > 0 \\ 0 \ \ \ o.w. \end{cases}$$

where H stands for exogenous variables determining the selection and e_{2j} is the error term. These error terms have the following structure:

$$e_{1j} \text{ follows } N(0,\sigma),$$
$$e_{2j} \text{ follows } N(0,1),$$
$$\text{corr}(e_{1j}, e_{2j}) = \rho$$

The exogenous variables in the wage equation include dummies for age-cohort, gender, educational level, disability and rural living area. It also includes the years of work experience and the years of work experience

squared. The exogenous variables in selection variables for doing market work include dummies for age cohort, gender, educational level, work status of a spouse, disability, number of children and rural living area.

Table 1 Descriptive Statistics for the Sample Used in Wage Estimation

	Male	Female
Net wage rate (euros)	9.6	8.0
Annual income (euros)	27 792	18 392
Age	43	41
Number of Children	1	1
Basic education	24.5 %	20.1 %
Secondary education	41.6 %	40.4 %
University level education	33.9 %	39.5 %
% in employment	96.2 %	83.4 %
% unemployed	3.4 %	7.0 %
% at home	0.4 %	9.7 %
	n=787	n=787

Table 1 presents some descriptive statistics for the sample used in this study. The average age for males in this sample is 43 years and 41 years for females. The households has on average one child. The net hourly wage rate for a male is 9.6 euros and a female 8 euros. This results in an annual income of 27 792 euros for a male and 18 392 euros for a female. The annual income figure include non labour income which amounts to 1 240 euros for a male and 881 euros for a female.[33] In the sample 96 percent of males and 83 percent of females are employed.[34] Out of the employed persons 92 percent of males and 86 percent of females have a full time job.

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[33] Child benefits are a large component of the non-labour income in Finnish households. This is usually paid to the mother of the child. Therefore it is usually women who have higher non labour income than men. We divide child benefits into two allocating half to each parent.

[34] The reason why women have a higher unemployment rate in data is that we have concentrated only on married couples. If single households had been taken into account, the unemployment rate among men would have been greater.

Table 2 Heckman Estimation Results

	Outcome equation	Participation equation
Gender	-0.183***	-0.119*
	(0.033)	(0.067)
Age 35-44	-0.002	-0.040
	(0.071)	(0.095)
Age 45-54	0.009	-0.013
	(0.108)	(0.093)
Age 55-56	0.077	-0.265**
	(0.132)	(0.116)
Secondary education	0.037	0.117
	(0.045)	(0.085)
University education	0.226***	0.347***
	(0.048)	(0.089)
Work experience	0.038***	
	(0.011)	
Work experience squared	-0.006***	
	(0.002)	
Disabled	-0.036	0.076
	(0.034)	(0.071)
Rural	-0.052	0.291***
	(0.038)	(0.065)
Number of Children		-0.059**
		(0.027)
Spouse Working		0.105**
		(0.048)
Constant	3.675***	0.091
	(0.101)	(0.114)
Observations	1574	1574
Rho	-0.212 ***	
	(0.000)	

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Wald test of independent equations:
chi2(1)=155.76 Prob > chi2 = 0.000

The estimation results are presented in Table 2. In the participation equation positive and significant variables are having a university education, having a working spouse and living in a rural area. Having children, being a female and being between 55-64 years of age has a negative and significant effect on participation in the labour force.

In the outcome equation the positively significant variables turn out to be university education and work experience. Negatively significant are female dummy and work squared work experience. The net wage is thus higher for those with university education and more work experience. The effect of work experience declines as work experience is accumulated. The net wage rate is lower for women.

There have been a number of Finnish contributions on the returns to schooling, making it possible to compare our results with others. In his study of changes in the Finnish wage structure, Roope Uusitalo (2002) estimated a log gross monthly earnings model where explanatory variables included six post compulsory education levels, age, age squared, regional and industry dummies from the Finnish Income Distribution Survey. Taking average of the educational categories used by Uusitalo and forming our university education dummy resulted in a gross return of 38 percent. This gives net return of 23 percent, which is exactly the figure we get. His gross return for secondary schooling was 5 percent, which resulted in a net effect of 3.5 percent. Our figure is 3.7 percent. The gross effect on gross wage of being female was minus 22 percent in Uusitalo's estimation and in our estimation the net effect was minus 18 percent. Similar results were obtained by Korkeamäki (1999).

Uusitalo (1999) estimated the returns to education with census data. His basic estimation result, without taking into account ability measures, gave the gross wage of five percent return per year from work experience, which decreased at the rate of 0.1 percent per year. Asplund (1999) compared different Finnish studies and got an average figure of less then two percent on the return on work experience.

Our estimation results for net wage rate gives 3.8 percent return, which decreases 0.6 percent per year. If compared with Uusitalo's figures for 1999, this implies average tax of 34 percent on labour income. In our estimation, the work experience becomes negative relatively early if education and age are controlled for.

6.2 Predicting Market Work Hours

A major controversy in time-use data has been the estimate of time-used in market work. Other official statistics, mainly based on the recall method, diverge a lot of those obtained with time-use studies.[35] Moreover, some datasets, like Swedish HUS, have collected information on market work hours, both through the time diary and a survey. The calculations based on these two estimates also differ.[36]

This introduces the question of which is the most accurate estimate of the actual hours of work and what are the impacts of differing estimates for example on the productivity measures or the time bind discussion. For example Robinson and Godbey's (1997) main argument is that time-use data for the United States show that people do less market work than indicated by estimates that are based on other data collecting methods. This anomaly was also noted by Juster and Stafford (1991).

Usually in time-use surveys the hours of market work comprise both the hours spent at the actual workplace and also work-at-home. The running of personal errands and meal breaks during the work day are excluded from the estimate, but coffee breaks are not.

As the hours of market work are also included as an explanatory variable in our estimations, there is problem of simultaneity if the dependent variable is also a time-use variable. Another problem is missing observations. People might have zero working hours due to sickness-leave, holiday or for other reason. To correct for the simultaneity, for the zero observations and to dampen the high degree of noise in the daily observations we estimated the hours of work using Tobit and used fitted values to replace original information.[37]

The dependent variables in predicting market work hours are the imputed net wage rate, yearly non labour income, spouse's net wage rate, spouse's annual income, age cohorts, educational level, gender, number of children, living in the rural area, dummy for unemployment and dummy for taking care of the household. Seasons are included as dum-

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35 Robinson (1999) noted that using a recall method for the evaluation of free time is especially problematic. Estimates obtained from Japanese and American men were only half as large as those obtained from time-use diaries.

36 See for example Carlin and Flood (1997).

37 The use of this procedure is in spirit to two-stage probit least squares that was introduced by Amemiya (1978).The problem that arises is the validity of standard errors when using generated variables, which is also discussed in Wooldridge (2002).

mies in predicting market work hours in essays three and four and only fall is included in the essay one.

6.3 Weighting the Sample

In many surveys the sample is stratified with regard to geographic area, clustered in units in which individual observations are part of the cluster, and missing observations are corrected by weighting different responses. When this is the case the structure of the survey violates the assumptions of sample selection that are the foundations of normal econometric methods. Therefore, the method of collection and the corrections that are made to the dataset can have considerable, yet unintended effects on the results, if not accounted for.[38]

When calculating weights, Statistics Finland combined many aspects of the survey to get a single summary weight statistic.[39] The weights were calculated in various stages to take into account the sampling design, information on the population on the household level, the household level non-response adjustment, the calibration of demographic data, the allocation of the sample to diary days, and the balancing of diary weights.[40]

This caused a number of problems as noted by Väisänen (2002b). Because persons have different weights from the allocation of survey days for the two diaries, the estimates calculated with person weights differed from the those calculated with diary weights. Stratification was used to take into account the household size, NUTS3 area and capital area. The problem with the stratification was that individual level variables were estimated only for those who had responded. This meant that the totals got biased downwards and the individual level weights did not add up to population totals. Moreover, instead of post-stratification the individual level corrections were done by calibration. However, only one weight was allowed per household and each household member was weighted by the same weight in all domains, subgroups and variables. This produced some large weights for the subsets with only very few respondents.

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38 For excellent surveys on the problems with survey data look Carrington and Eltinge (2000) and Deaton (1997).

39 This description relies on Väisänen (2002b).

40 Klevmarken (1999) discusses in length the possibilities to improve the estimates by the use of different weighting techniques.

It can also be argued that the survey weights have relatively little relevance for the subsample used in these essays. Because only those households are selected where spouses are employed, unemployed or taking care of the household, this results a quite homogenous group which exhibits a very little non-response variation except in the case of education. And lastly, we used the raw 10-minute interval data in our study, so corrections for summary statistics are not needed.

We decided to use weights when possible. When weights are not used, the sensitivity of the results is checked. We also correct for clustering by households in deriving the variance-covariance matrix.

6.4 Correcting for Weekly and Seasonal Variations

Lastly, a few notes on the variability of time-use during a day, a week and a year based on Niemi and Pääkkönen (1992). Finnish time-use studies show that since 1979 the active period during the day has shifted to a later hour. People go to bed later and wake up later. During a week the composition of the weekend days in particular has changed. The deregulation of the opening hours for shops has produced an increase in time-used in shopping during Saturdays. Sundays have become more oriented for resting and doing domestic chores.[41] Finnish time-use during Sunday centres around home. In contrast, in the United States, organizational activities and socialising are popular during Sunday, mainly due to participation in religious activity.

Hill (1985) estimated the effects of seasonal variation in the time-use of adults in the United States in 1975-76. Her results showed that television viewing and educational activities were the two time categories that responded strongly to time of the year. There was also seasonal variation in time-use.

Niemi and Pääkkönen (1992) noted that there is also seasonal variation in Finnish data since holidays are spent during July and August. During the winter, leisure is more sports oriented and during summer more socially oriented. Market work is done during spring and autumn.

Laaksonen and Pääkkönen (1992) analysed with the Finnish Time-use Survey from 1987/88 the effect of seasonal variation on different housework activities. They divided the year into four seasons. There was clear

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[41] These changes correspond to similar results found in weekly time-use studies on Canadian families. See Zuzanek and Smale (1999).

indication that especially during the summer the time-use was significally different from other seasons. They also made regressions using different months of the year and found out that monthly variation is greater for men than for women.

In our essays we use seasonal dummies when the sample covers the whole year. We divide weekly time-use to weekday and weekend time-use mainly by using a weekend dummy in our estimations.

V SUMMARY OF THE ESSAYS

These four essays represent an attempt to analyze time-use data with econometric methods. By considering the different aspects of household behaviour, we are able to get new insights into the way Finnish households allocate their time and what determines this allocation.

In the following, we present summaries of the research objectives, the method used and the results obtained for each of the four essays separately.

Essay 1 Is Time Spent Together in Finnish Households?

The first essay in this thesis studies what are the determinants of the time spouses spend together. This is done by using episodal data found in the unedited time-use files, where the activities of spouses are recorded in ten minute intervals. This makes it possible to study when the spouses are together, how long they are together, what they are doing together and where they are spending the time together. Our interest is focused on the effects of economic variables, like wage rate and non labour income, on the time spent together.

There is quite strong evidence to support the hypotheses that spouses like to spend time together. When interviewed with regard to different activities, the time together ranked high. Even in the case of housework, which usually does not get high points, the housework done together is preferred to solitary housework. These findings indicate that joint time could be classified as a normal good in economic sense.

If time spent together is a normal good, then the demand for it should rise with income. However, there is contradictory evidence on the effect

of economic variables on joint time-use. Recent studies by Hamermesh (2000), Hallberg (2003) and Jenkins and Osberg (2004) all give different results.

We look what the Finnish data reveal by using in our estimation a fractional logistic model. Fractional logistic model has desirable theoretical properties for estimating dependent variables whose value ranges between 0 and 1. We use Generalized Linear Models framework to do the estimations thus being able to conduct a variety of diagnostic tests. We will use a subsample, which includes only those observations that have information on with whom the activity was done.

Our estimation results indicate that the share of joint time of spouses decreases with an increase in the own net wage rate or with the income of the other spouse. The non labour income of the respondent has no effect on the share of joint time.

This could be taken as evidence that Finnish labour markets are quite inflexible. Although there is a willingness to spend time together, the constraints imposed by labour markets make it impossible. These constraints could partly explain the decisions on early retirement prevalent in Finland.

Our results also show that it is mainly the same variables that affect both joint time in housework and in leisure. This is interesting, because leisure and housework are very different activities and the jointness in these activities should obey different logics.

Previous studies have used activity categories with different levels of aggregation. We show that this has an effect on the estimates of joint time-used in families. The variability of the estimates is quite large depending on the aggregation. Our results show that care should be exercised when selecting the level of aggregation at which the analysis of time allocation is done.

Essay 2 Daily Variation in Time-use – A Count Data Application

The second essay looks at how many activities people pursue during a day. Our interest is to determine whether human capital affects people's propensity to do different activities. This has been suggested by Gronau and Hamermesh (2001) as being the case.

The economic model for variety in time-use is based on the Beckerian household production framework. It is assumed that human capital reduces the time it takes to switch from one activity to another. Moreover,

as the wage rate of the more educated is higher, and the more educated tend to have more human capital, it is in their interest to do more activities in less time.

We use data on the total number of different total activities and the number of different leisure activities people engage in during a day. As we have weekday and weekend observations, we can also study whether there are more activities carried out during working day or the weekend.

The econometric method used in this essay is a negative binominal model that is suitable for modelling positive integer counts with heterogeneity. We take the person's educational level as the proxy for his/her human capital.

We observe that people with a higher educational level do more activities than people with less education. There are also gender effects: women do more activities than men. We also test whether there are differences in routine. Once again, people with a higher educational level have less routine in their time-use than those with less education. When we included secondary activities, the results do not change. Still more educated people do more activities.

One of the most serious objections against the counting of the number of activities is the claim that people with higher education are able to record their activities better. Therefore the increase in variety is just an indicator of linguistic aptitude, nothing more. This counterargument has not been tested before. We get the surprising result that the better educated men spend more time also in unspecified activities.

Another common objection is that the more educated live in urban areas which can offer more varied time-use than the countryside, which has a population with lower educational credentials. We investigate whether the increase in variety can be explained by the area of residence, but it can not.

Essay 3 Active Life during Leisure Time – Are the Winners Taking it All?

Our third essay looks at the composition of leisure activities. Are there differences between the times used in active versus passive leisure? Which are the typical characteristics of people who watch TV? Are there gender differences?

Our theoretical framework is once again Becker's household production theory. In this essay the Biddle and Hamermesh's (1990) model on

the demand for sleep is applied to model the demand for active leisure. In this model a specific leisure activity increases the human capital of the person and raises his wage rate. This makes it economically advantageous to spend time in these activities compared with leisure activities that do not have productivity enhancing effects. If one has a high wage rate, then the reward will be higher and so is the incentive to spend time on those activities.

The leisure time is divided into two different groups: active and passive. Passive leisure includes resting and inactivity, TV and video watching and radio listening. Active leisure covers all the rest.

First a standard Tobit model is used to explain the amount of active and passive leisure time people have. In order to control for the sensitivity of definitions, we also use a more narrow definition of the active time. Our results show that the educational level and gender are important determinants of the time spent on active leisure and have negative effects on the time-used in passive leisure. However, income variables do not have an effect. This would mean that the time spent on active leisure depends more on the amount of human capital then on the labour market rewards.

The passiveness in daily time-use is closely linked to time spent watching TV. It accounts for over 80 percent of the passive time-use. Therefore the studies that look only at the length of time spent in active versus passive leisure easily measure only the prevalence of TV viewing in different socio-economic groups. It would therefore be advantageous to have more data on the participation of activities.

In order to do that we use a unique dataset from the background interview records of the time-use survey. There is data on whether the respondents have participated in any of the 153 different activities during last 12 months. These include a number of cultural activities, sport activities, volunteer work situations and organizational activities.

One way to estimate a model with a number of simultaneous choices is to use simulated maximum likelihood estimation of the multinominal probit models. In the second stage we use this simulated maximum likelihood estimation of the multinominal probit model to look whether there are differences in participation on active leisure. Multivariate probit makes it possible to study a situation where a number of choices are made simultaneously.

Our estimations show that there are also strong educational effects on the propensity to do certain active leisure categories. The highly educated are active in cultural activities and women in sports activities.

Essay 4 More than Two Hands: Is Multitasking an Answer to Stress?

The last essay investigates multitasking during leisure and housework and its correlation with the indicators of stress. Multitasking means that multiple activities are done at the same time. We want to find out what types of people are likely to do many activities at the same time. Especially interesting is to look at whether self-reports of general rush and rush during a day have an effect on the amount of multitasking done.

The theoretical framework is derived from household production theory. We hypothesis with Hamermesh and Lee (2003) that all activities which diminish the time constraint faced by the people will reduce stress. One way to reduce the time constraint is to do many things at the same time.

In our time-use data there is information on the primary and secondary activities that respondents have done during a day. Our data are of high quality in comparison to data from other countries. Over 95 percent of the respondents have recorded secondary activities. In datasets from other countries the response rates have been much lower.

Leisure activities are mostly done as secondary activities while doing housework or leisure activities as primary activities. Two types of housework are done simultaneously quite seldom. This would indicate that secondary activities are done mostly for their relaxing components in time-use.

Our econometric model is Heckman's selection model. In Heckman's model there are two different processes that govern the amount of multitasking. First, there is the selection equation that determines whether multitasking is done at all. The other is the outcome equation which explains how much multitasking is done.

Our results indicate that the general rush and rush during a day have a different effects on the amount of multitasking. Rush during a day is usually associated with less multitasking while general rush increases multitasking in some cases. Net wage rate, which is the shadow price of time, has a negative impact on the amount of multitasking. Educational level, especially university level, has a significant positive effect on the amount of multitasking done.

In gender studies there has been a strand of literature called 'double burden'-literature, where a justified claim has been made that women's participation in the labour force has decreased their high-quality leisure time. One indication of this high quality leisure has been the length of

leisure times when no secondary activity is done. As women do more secondary activities than men, this has been taken as an indicator of the gender inequality. We suggest, however, that multitasking is a natural response to feeling of rush. Therefore, it should not be used as an indicator of inequality.

VI CONCLUSIONS

Time-use data offer a rich source of information for the researcher. Questions that have direct policy relevance can be studied with the information on how people allocate their time. Thus the paucity of economic research using time-use data is surprising.

Time allocation has been approached in economics through the use of household production theory created by Gary Becker. By making time visible in the allocation process, the approach still represents, in spite its weaknesses, the standard apparatus for time allocation studies.

The problem in economic modelling with time-use data is that time-use data has been collected to give an aggregate picture of the use of time in a society. They have not been collected to record the time allocation of individual households, which would make it more suitable for microeconomic research. The underlying assumptions in the time-use data are that by sampling a given number of households within different socio-economic groups in the society and weighting the sample by the population weights of these groups, a picture of the societal use of time is obtained. This can then be investigated by simple statistical estimation techniques. The methodological approach is holistic, not individualistic. To use these data to make interferences about the behaviour of the households calls for advanced econometric methods and suitable economic models.

The limitations of the data also restrict the methods available. Sometimes simple approaches are more fruitful than the more advanced ones. Sometimes very complicated methods are called for to compensate for the weaknesses of the data. Sometimes neither helps. These essays are an attempt to find most suitable methods for the questions at hand. They show that economic factors play an important role in households' decision regarding time allocation and that economics can contribute to time-use studies.

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Appendix 1 European Time-use Surveys by March 2003

Member States/ EFTA Countries	Participation	Fieldwork period, Sample size etc.	Previous TUS
Austria	Conditional	A TUS will be carried out as soon as financing is guaranteed.	1992
Belgium	**Ensured**	Carried out a TUS in 1999, linked to the HBS. S.s.: 4 275 hh	1988
Denmark	**Ensured**	The Danish National Inst. of Social Research has carried out a Time-use Survey in March, April, Sept and Oct 2001. S.s.: 4 000 ind.	1987
Finland	**Ensured**	Fieldwork carried out March 1999 - February 2000. S.s.: 2 600 hh.	1987/88
France	**Ensured**	Fieldwork carried out February 1998 - February 1999. One diary day; lower age limit 15 years.	1985/86
Germany	**Ensured**	Fieldwork carried out April 2001 – March 2002. S.s.: 5000 hh. First results available in June 2003	1991/92
Greece	Conditional	Not sure about main TUS. A TUS will be carried out as soon as financing is guaranteed. S.s.: About 5000 hh.	1996 HETUS Pilot
Ireland	Not ensured	CSO will not carry out any TUS.	1996 HETUS pilot
Italy	**Ensured**	Fieldwork carried out April 2002 – March 2003 S.s: 24 000 hh. First results in Sept 2003	1988/89
Luxembourg	Conditional	CEPS/INSTEAD has no plans to carry out a TUS	1996 HETUS pilot
Netherlands	Conditional	Eurostat guidelines have not been followed. The Social and Culture Planning Office has carried out a TUS with ref. period one week in Oct 2000. CBS has carried out a TUS with a light diary 2001. Not sure about main TUS.	Pilot in Oct. 99 linked to HBS

Norway	**Ensured**	Fieldwork carried out February 2000 - January 2001. S.s.: 7 500 ind.	1990/91
Portugal	**Ensured**	Fieldwork carried out in October/ November. 1999. Simplified survey design, not all Eurostat guidelines have been followed. S.s: 5 500 hh.	1996
Spain	**Ensured**	Fieldwork carried out Oct 2002 – Sept 2003. S.s.: 24 000 hh Two diary days. First results in May 2004.	1996 HETUS pilot
Sweden	**Ensured**	Fieldwork carried out October 2000 - September 2001. S.s: 4 500 ind.	1990/91
Switzerland	Conditional	Will find out if it is possible to carry out a less expensive survey.	1979/80
United Kingdom	**Ensured**	Fieldwork carried out June 2000 - September 2001. S.s: 11 000 ind.	Pilot in 1999

Candidate Countries as of march 2003	Participation	Fieldwork period, Sample size etc.	Previous TUS	Sign
Albania	Conditional	Not before 2000 (?). S.s.: 2 000 hh. The TUS might be linked to the HBS.	1996 HETUS pilot	
Bulgaria	**Ensured**	Fieldwork carried out Oct 2001 – Oct 2002. S.s.: 3 100 hh. Persons 7+ are covered.	1988	
Cyprus				
Estonia	**Ensured**	Fieldwork carried out April 1999 - April 2000. S.s.: 3 500 hh.	1988	
Hungary	**Ensured**	Fieldwork carried out Sept 1999 - Sept 2000. S.s.: 3 500 hh.	1986/87	
Latvia	**Ensured**	Fieldwork to be carried out Feb 2003 – Jan 2004. S.s.: 3 500 hh	1987	
Lithuania	**Ensured**	Fieldwork to be carried out Jan – Dec 2003 S.s.: 2 700 hh First results in May 2004	1987	
Macedonia	Conditional	Plans to carry out a TUS in 2003, after the 2001 Census.	1996 HETUS pilot	
Malta				
Poland	**Ensured**	Fieldwork to be carried out June 2003 – May 2004. Persons age 15+ will be covered S.s.: About 10 000 hh.	1984	
Romania	**Ensured**	A TUS carried out in Aug – Sept 2000. S.s.: 9018 hh. Plans for a 12 months survey in 2004	1991	
Slovak Republic	**Ensured**	Plans to carry out a TUS in Oct 2003 – Sept 2004	1986	
Slovenia	**Ensured**	Fieldwork carried out April 2000 - March 2001. S.s.: 4 500 hh.	1987	

Appendix 2 Finnish Tax System in year 2000

Preliminary deductions from income

	euro
Communal deduction from income tax	403
Earnings deduction from income tax	1479

Deduction from income tax base

Lower	Upper	%	euro
12605	-	0,035	
2521	12605	0,2	
0	2521		1647

Taxes on income after preliminary deductions

Limits		Income tax	Communal tax	
Lower	Upper	%	%	%
52941	-	0,375	0,21	0,057
29916	52941	0,31	0,21	0,057
18992	29916	0,25	0,21	0,057
13613	18992	0,19	0,21	0,057
10689	13613	0,15	0,21	0,057
8000	10689	0,05	0,21	0,057
0	8000	0	0,21	0,057

Capital gains tax 0,29

Non-taxable benefits

Child Benefits

	euro
First	90
Second	110
Third	131
Fourth	151
Fifth	172

Appendix 3 Main and Secondary Activities in Finnish Time-use Survey 1999/2000

0 PERSONAL CARE
000 Unspecified personal care

01 Sleep
010 Unspecified sleep
011 Sleep
012 Awake in bed
013 Sick in bed

02 Eating
020 Unspecified eating
021 Meals
022 Snacks and drinks
023 Alcohol
029 Other specified eating

03 Other personal care
030 Unspecified other personal care
031 Washing and dressing
032 Sauna
039 Other specified personal care

1 EMPLOYMENT
100 Unspecified employment

11 Main job
111 Working time in main job
112 Coffee and other breaks in main job

12 Second job
121 Working time in second job
122 Coffee and other breaks in second job

13 Activities related to employment
130 Unspecified activities related to employment
131 Lunch break
139 Other specified activities related to employment

2 STUDY
200 Unspecified study

21 School or university
210 Unspecified activities related to school or university
211 Classes and lectures
212 Homework
219 Other specified activities related to school or university

22 Free time study
221 Free time study

3 HOUSEHOLD AND FAMILY CARE
300 Unspecified household and family care

31 Food management
310 Unspecified food management
311 Food preparation
312 Coffee and snack preparation
313 Baking
314 Dish washing
315 Preserving
319 Other specified food management

32 Household upkeep
320 Unspecified household upkeep
321 Cleaning dwelling
322 Cleaning yard
323 Heating and water
324 Various arrangements
329 Other specified household upkeep

33 Making and care for textiles
330 Unspecified making and care for textiles
331 Laundry
332 Ironing
333 Producing textiles
334 Handicraft
339 Other specified care for textiles

34 Gardening and pet care
340 Unspecified gardening and pet care
341 Gardening
342 Caring for pets
343 Walking the dog
349 Other specified gardening and pet care

35 Construction and repairs
350 Unspecified construction and repairs
351 House construction and renovation
352 Repairs of dwelling

353 Making, repairing and maintaining equipment
354 Vehicle maintenance
359 Other specified construction and repairs

36 Shopping and services
360 Unspecified shopping and services
361 Daily consumer goods
362 Other goods
363 Commercial and administrative services
364 Personal services
369 Other specified shopping and services

37 Household management
371 Household management

38 Childcare
380 Unspecified childcare
381 Physical care and supervision
382 Teaching the child
383 Reading and playing with child
384 Accompanying child
385 Outdoors with child
386 Talking with child
389 Other specified childcare

39 Help to an adult family member
391 Help to an adult family member

4 VOLUNTEER WORK AND PARTICIPATORY ACTIVITIES
400 Unspecified volunteer work and participatory activities

41 Organisational and volunteer work
410 Unspecified organisational and volunteer work
411 Work for an organisation
412 Volunteer work through an organisation
419 Other specified organisational and volunteer work

42 INFORMAL HELP TO OTHER HOUSEHOLDS
420 Unspecified informal help
421 Food management as help
422 Household upkeep as help
423 Making and care for textiles as help
424 Gardening and pet care as help
425 Construction and repairs as help
426 Shopping and services as help
427 Childcare as help
428 Help in employment and farming
429 Other specified informal help

43 Participatory activities
430 Unspecified participatory activities
431 Meetings
432 Religious activities
439 Other specified participatory activities

5 SOCIAL LIFE AND ENTERTAINMENT
500 Unspecified social life and entertainment

51 Social life
510 Unspecified social life
511 Socialising with family
512 Visiting and receiving visitors
513 Feasts
514 Telephone conversation
519 Other specified social life

52 Entertainment and culture
520 Unspecified entertainment and culture
521 Cinema
522 Theatre and concerts
523 Art exhibitions and museums
524 Library
525 Sports events
529 Other specified entertainment and culture

53 Resting and inactivity
530 Unspecified resting and inactivity
531 Resting
532 Inactivity indoors
533 Inactivity outdoors
539 Other specified resting and inactivity

6 SPORTS AND OUTDOOR ACTIVITIES
600 Unspecified sports and outdoor activities

61 Physical exercise
610 Unspecified physical exercise
611 Walking and hiking
612 Jogging and running

613 Biking
614 Ball games
615 Gymnastics
616 Fitness
617 Water sports
618 Skiing and skating
619 Other specified physical exercise

62 Productive exercise
620 Unspecified productive exercise
621 Hunting and fishing
622 Picking berries, mushrooms and herbs
629 Other specified productive exercise

63 Sport related activities
631 Sport related activities

7 HOBBIES AND GAMES
700 Unspecified hobbies and games

71 Arts
710 Unspecified arts
711 Visual arts
712 Performing arts
713 Literary arts
719 Other specified arts

72 Hobbies
720 Unspecified hobbies
721 Collecting
722 Computing - programming
723 Information by computing
724 Communication by computing
725 Other specified or unspecified computing
726 Correspondence
729 Other specified hobbies

73 Games and play
730 Unspecified games and play
731 Solo games and play
732 Parlour games and play indoors
733 Parlour games and play outdoors
734 Computer games
735 Gambling
739 Other specified games and play

8 MASS MEDIA
800 Unspecified mass media

81 Reading
810 Unspecified reading
811 Reading newspapers
812 Reading periodicals
813 Unspecified reading newspapers or periodicals
814 Reading books
819 Other specified reading

82 TV and video
821 Watching TV
822 Watching video

83 Radio and music
830 Unspecified listening to radio and music
831 Listening to radio
832 Listening to recordings
839 Other specified listening to radio and music

9 TRAVEL AND UNSPECIFIED TIME-USE

90 Travel purpose
900 Unspecified travel purpose
901 Travel related to personal care
911 Travel as part of/during main job
912 Travel as part of/during second job
913 Travel to/from work
921 Travel to/from school or university
922 Travel related to free time study
931 Travel related to household care
936 Travel related to shopping and services
938 Transporting a child
939 Transporting an adult family member
941 Travel related to organisational and volunteer work
942 Travel related to informal help
943 Travel related to participatory activities
951 Travel related to social life
952 Travel related to entertainment and culture
961 Travel related to sports and outdoor activities
971 Travel related to hobbies
991 Travel related to changing locality
992 Driving for pleasure
995 Filling in the time-use diary
999 Other unspecified time-use

LOCATION AND MODE OF TRANSPORT

00 Unspecified location (travelling or not)
Not travelling:
10 Unspecified location (not travelling)
11 Home
12 Second home or weekend house
13 Working place or school
14 Other people's home
15 Restaurant, cafê or pub
19 Other specified location (not travelling)
20 Unspecified private transport mode
21 Travelling on foot
22 Travelling by bicycle
23 Travelling by moped, motorcycle or motorboat
24 Travelling by passenger car
25 Travelling by lorry, van or tractor
29 Other specified private travelling mode
30 Unspecified public transport mode
31 Travelling by taxi
32 Travelling by bus or coach
33 Travelling by tram or underground
34 Travelling by train
35 Travelling by aeroplane
36 Travelling by boat or ship
39 Other specified public transport mode
40 Unspecified transport mode

ESSAY 1.

Is Time Spent Together in Finnish Households?

Abstract:

Concentrating on the instantaneous use of time we study what determines the joint time-use of spouses in Finnish households. In our estimation we apply fractional logistic model introduced by Papke and Wooldridge (1996). The data used are the recent Finnish Time Use Survey from 1999/2000 with matched income records. Our results show that net wage rate and yearly income of the spouse have a negative impact on the share of the joint time spent together when market work hours have been controlled for. The number of children reduces joint leisure time of the spouses, but does not affect the housework time. University education increases the time spent together in housework and in leisure. These findings are robust to the aggregation of time-use categories.

1 Introduction

Recently there have been a number of contributions in economics of household behaviour, where the interest has focused on the sequential use of time. This is in clear contrast to earlier research where interest was on the aggregate allocation of time to work, housework and leisure within the household. This new approach makes it possible to study the timing of activities: when something is done and with whom.

One reason for the appearance of the sequential studies has been the availability of episodal time data from some time-use studies. These diary records usually show the behaviour of the household within 5- or 10-minute intervals and make it possible to test empirically the relevant hypotheses.

An especially interesting research question that can be studied with episodal time-use data is the joint time-use of household members. When they have a choice, do household members try to spend time together or not? If they do, then household members should do the same activities during the same time periods together. If they do not, then the simultaneity of the activities and company should be a mere accident. The subsequent question, which is the topic of this paper, is whether economic variables affect this choice and how.

There exists evidence (Sullivan 1996, Jenkins and Osberg 2004, Hallberg 2003) which shows that there is a greater amount of joint time-use between actual spouses than is the case in experiments where the data from men and women are randomly matched together and their time-use is investigated. This has been taken as an evidence for the preference of spouses to spend time together. This tendency shows even in fractions of spouses working at given time as was reported in Hamermesh (2000) and Hamermesh (2002).

The effect of this synchronization of joint time-use is, however, moderate. Hallberg (2003) gets a result that the time that real couples have in addition to the pseudo couples that were created by matching statistically, is approximately 45 minutes per day, a 12 percent increase.[1] As his subsequent exploration shows that only 64 percent of the potential time is used jointly, this figure drops to 7-8 percent. This low figure is also obtained by Sullivan (1996). Indeed, Jenkins and Osberg (2004) get only a 5 percent difference between statistically matched couples vis-à-vis real couples. This would mean an increase in the joint time-use of approximately 20 minutes. However, in all cases, this difference is statistically significant.

Hamermesh (2000) and Hallberg (2003) and Jenkins and Osberg (2004) study the effects of economic variables in the decision to spend time together. But they all get different results. In Hallberg none of the economic variables turn out to be significant. In Jenkins and Osberg only some of the economic variables turn out to be significant. In Hamermesh all economic variables analysed play a role. The differences in these results are partly due to different definitions of the dependent variables but they also show that the effect of economic variables on the choice merits an additional investigation.

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[1] As he tests the effect of composition of time-use with the Blinder-Oaxaca decomposition, which divides the time between general and behavioural difference, only main part of this observed difference is due to behavioural differences. This means that not all of the 45-minutes could even in this case be attributed to the purposeful joint time-use.

With a number of novel features we study the effect of economic and demographic variables on the joint time-use of spouses. The studies cited above used an ordinary least squares framework or probit analysis in their econometric analysis. As our dependent variable, the time spent together out of total time, is a fraction, we are using a fractional logistic model proposed by Papke and Wooldridge (1996) in order to take into account the special nature of the dependent variable.

We also try to enlarge the analysis conducted by Hamermesh (2000) and Jenkins and Osberg (2004), by using a more varied dataset. Our time-use data have information on not only the activities carried out but with whom the activity is done. Hamermesh had information only on the starting and the ending of working hours. He was restricted to aggregate the rest of the time to one category "not-working" and to study whether the work hours of spouses correlate. Jenkins and Osberg used Household Survey with some time-use information added.

Except for Sullivan (1996) the research has not studied time-use during the weekends. However, it would seem natural to assume that the weekends offer the best possibilities for spending time together. Therefore, in this paper also the time-use during the weekends is studied.

The studies have also been concentrated on households where both members work. Less attention has been directed on the question whether there is more synchronization of time in households where only one member is working, while the other is unemployed or stays at home. If the other person is not constrained in his/her time-use, does this result in more joint time-use with spouses? Kingston and Nock (1987) get a result with data from the United States that spouses in single earner families have approximately 30 minutes more time together than in dual earner families. They take this modest amount (less than 10 percent) as evidence that dual earners try hard to find time together.

Empirically, one common problem that is not directly addressed in earlier studies is the effect of the level of aggregation in time-use data. The studies have been conducted using very aggregate time-use categories. There is evidence that in time-use studies, the results that are obtained with the use of aggregate data are often different from those obtained by disaggregated data. This was noticed by Kooreman and Kapteyn (1987) and Daunfeldt (2002). In this paper we will look at the different levels of aggregation and study what their implications are for the analysis of joint time-use.

In this paper housework and leisure are studied both separately and in combination. Time allocation decisions to spend it with others doing

housework or as leisure may obey different principles. The issue then is how joint time-use in these different activities is determined? Is there more jointness in pursuing leisure time activities than housework activities? Is the joint time-use in housework driven by a household production technology and is the joint time-use in leisure driven by consumption?

The study of joint time-use within households is important in many respects. If household members like to spend time together, a change in the time allocation of one spouse will affect the allocation of time of the other spouse. This has implications for example for labour supply and the demand for services. It will not only affect decisions when people choose to work, but also when to take holidays and even when to retire from the work force. It also has an impact on the demand for child care and other services. The analysis of instantaneous time-use promises many new insights on the understanding of household behaviour.

2 Sequential Model of Time Allocation

The sequential model of time allocation was formulated by Hamermesh (2000). It is a standard work-leisure choice model extended to sequential periods. A household utility function U is postulated:

$$U = U(Z_m^P[l_{m1}, l_{m2}, ..., l_{mT}], Z_f^P[l_{f1}, l_{f2}, ..., l_{fT}], Z^J[l_{J1}, l_{J2}, ..., l_{JT}], x)$$

where Z_i^P $i=m,f$ is the subutility function of private leisure for male household member m and for female household member f respectively. Z^J is the subutility function for joint leisure and x is the joint household consumption. The leisure l sequences, which include both housework and leisure, run through each time period up to T. The leisure l is an integer with value 0 or 1 so the time is either allocated to work or leisure and within the leisure either to solitary leisure or joint leisure. This also means that the fractions of time periods t cannot be allocated to multiple activities.

The budget constraint is:

$$\sum_{s=m,f} \sum_{t=1}^{T} (1 - l_{st}) w_{st} = x, \quad s = m, f$$

where w_{st} is the wage rate of a spouse s at a given time period t. $\frac{\delta U}{\delta Z_i^J} > 0$ if both spouses are not working at a given time s. Maximisation of the utility function subject to budget constraint gives the optimal choices of goods and leisure sequences of the household members, which are not derived explicitly. The time spent together is naturally constrained by the person wanting less time together.[2]

As Hamermesh (2000) himself points out, it is impossible to identify with this formulation whether the reason for jointness is the couples' preferences or the technology of household production. He also notes that the amount of time spent together might be decided by some bargaining mechanism not captured here.[3]

When the interest is on leisure, Hamermesh's formulation seems general enough. The demand for the joint leisure can be thought of as an independent commodity which is wanted among the other leisure pursuits. Therefore it is possible to study the effects of the changes in price (wage) and income (annual income) on the demand for joint leisure.[4]

When the interest is on housework, it would seem more natural to incorporate some model of household production into the model at hand. In household production the housework is considered as an input into the household production process (usually along with intermediary goods and household durables). As housework is only an input to the production process, the demand for it follows the behavioural patterns of factor demands in the production function literature. In this setting the joint time-use in housework arises when it is possible to increase the output from the household production by working together. The amount of joint time-use in housework obeys therefore technological and production constraints and can be expected to differ from the demand for an end product, which in this case is joint leisure. Whether the Hamermesh formulation is appropriate or whether it would need a formulation which includes household production depends on the effect different variables have on these two distinct activities.

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2 For a game-theoretical model of the constrained time-use see Haaparanta (1990).

3 Totally different point of view to the joint consumption of leisure is taken by Fong and Zhang (2001), who look at the conditions with which it would be possible to recover unknown spousal joint leisure in a cooperative household model.

4 There have also been studies trying to isolate sleep from rest of the leisure, see Biddle and Hamermesh (1990).

For example Hill and Juster (1985) study to find out how good a predictor is the spouse's time-use in housework and leisure to the time spent in housework and leisure by the other spouse. They have a result that the time spent in a given leisure activity by a spouse is the strongest predictor of the time spent in that same activity. However, there is no effect for housework, except for shopping and certain home repairs, like gardening. They conclude that spouses' time-uses in housework are substitutes but in leisure they are compliments.

3 Is Joint Time Normal Good?

There is empirical evidence to indicate that leisure spent together with a spouse yields utility. Sullivan (1996) uses British data to determine how enjoyable the activity-at-hand was for the respondent. He is able to distinguish the enjoyment rating in joint time-use and solitary time-use. According to his results people rate joint time-use higher than solitary time-use. The highest enjoyment ratings are obtained for socialising, sleeping and relaxing. Hallberg and Klevmarken (2003) utilize information on the Swedish HUS-surveys from 1984 and 1993, where respondents were asked to rate different activities. Although the data were not differentiated between joint or solitary time-use, activities that could be considered social got high ratings.[5] Robinson and Godbey (1997) report evidence from five American time-use surveys in which all socializing activities yield very high satisfaction ratings. The high satisfaction ratings in interactive activities in United States and Sweden are recorded also by Juster and Stafford (1991).

It is interesting to note that all kinds of housework, except being with children, are rated very low in these datasets. However, even in case of the housework, Sullivan (1996) is able to report a higher enjoyment rating, especially when females are concerned, when housework is done jointly.

Hill and Juster (1985) also obtain information on the level of satisfaction with given activities in their 1975/76 United States data. The satisfaction of a leisure activity is among the strongest predictors for the amount of time-used in the activity. For housework activities other variables turn out significant.

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[5] The only exception is the high rating of reading books and magazines, which is to very great extent solitary activity.

The enjoyability of joint time-use in marriage is extensively studied by Kingston and Nock (1987) using the University of Michigan Time-use Study from 1981. They construct a marital quality index based on answers on the enjoyability of time spent together, the stated mutual understanding, and subjective happiness in marriage. This index is used to explain time spent together in various activities. As they find the causality problematic, they also explain the happiness index by the time spent together. For both spouses the quality index has the strongest positive effect on time spent together talking. As time spent together also has positive effect on marital quality the effect of causality is left unanswered.

Hill and Juster (1985) claim that the amount of joint time-use between spouses should increase over time. This is because time-use in activities enjoyed by both spouses will replace those activities enjoyed by one and disliked by the other. Therefore there should be more time spent together as the duration of living in the same household increases. They however did not test this hypothesis.

All these contributions show that leisure time together can be considered of as being a normal good. Both spouses' utility increases with being together. There is also some evidence that although housework time is not as enjoyable as leisure time, it is enjoyed more when done together. If joint time is a normal good, then the increase in income should have a positive effect on the demand for it.

4 Previous Empirical Evidence

There are two interlinked questions in studying the effect of economic variables on the joint time-use of spouses. The first question is whether economic variables play any role in the decision whether or not to spend time together. One could argue that demographic variables, like presence of children, have a much greater impact on the time-use than economic factors.

The second issue is relevant only if economic variables are significant in explaining the time-use. This question concerns the sign of the effect. Does a change in the wage rate or in annual income have positive or negative effect on the joint time-use?

In studying the effects of economic variables on the joint time-use, it is difficult to assess how much of the time-allocation found in the data is

caused by the general structure of the society and how much results from the decision making of the individual.[6] As Hallberg (2003) notes, one of the most difficult problems in studying the instantaneous allocation of time is that the general organization of the society influences the timing of certain activities. Therefore it is difficult to differentiate how much of the time allocation results from the concentrated effort of spouses and how much results from the general patterns of society.[7]

Hamermesh (2000) uses U.S. Current Population Survey data from 1990's on the time spouses' work started and ended. As there was synchronisation in the timing of the work, Hamermesh maintains a hypothesis that time spent together is a normal good and its demand should rise with income. He estimates the impact of spouses' earnings on the potential time together by holding hours of market work constant, and the result indicates that couples with higher income had potential time to spend together. He calculates income elasticities that were positive but not very large. Testing whether the impact of spouses' earnings to potential joint leisure was equal, in the 1970's sample that Hamermesh used, it was rejected, but in the 1990's sample it was not.[8]

Hamermesh also studies the impact of an extra hour of work on potential joint time. He notes that in both samples the effect of husband's extra hour is the same as wife's extra hour. Also he observes that one-unit increase in both spouses work time affects potential joint leisure

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6 It is very difficult to find a situation in which the time-use constraint is artificially relaxed. Hamermesh (2002) had a natural experiment in his disposal when he investigates how people allocate a windfall surplus hour. He utilizes the time-use information during the change to winter time in Netherlands in October 1990. This change happened during the night and he notes that most of the extra time was used for sleep. The only group where less than half of the extra hour was used for sleeping was unmarried men who used it for radio listening or TV-watching and in the category "Sports and leisure". The group that used the extra hour entirely for sleep was females with small children. Pääkkönen and Niemi (2002) report that working parents of children under seven years old who said that they suffered from lack of time would like to do more sports and more housework if given an extra hour. Extra reading was the third most popular alternative.

7 Indeed, one would need to study why market work is done jointly. Hamermesh (1999) shows evidence that the percentage of people doing evening and night work has decreased. He attributes this to the general rise in real wages coupled with inferiority of evening and night work. He discusses the possibility of technological induced causation but rules this out.

8 Hamermesh studies also whether the arrival of a child changes the time-use pattern of the spouses and observes that it affects the potential joint time by reducing it. Furthermore it is female time-use that changes more than male when a child arrives.

little more than one unit so spouses are unable to synchronize marginal increases in market work.[9]

Contrary evidence on the effect of economic variables on the joint time-use is obtained by Hallberg (2003). He runs a regression to investigate how time spent together is affected by a number of exogenous variables. He estimates the share of joint time-use in combined housework and leisure by ordinary least squares. Concentrating on the responses given between Monday and Friday by two-earner households, the explanatory variables include age cohort dummies, a dummy for being a male, dummies for different number of children, years of schooling, and dummy for self-employment. Hallberg uses a number of different specifications in his estimations. As to economic variables his first specification is without economic variables, the second with wage rates of both spouses, the third with yearly incomes of both spouses and the last with both wage rates and yearly incomes of both spouses.

Hallberg does not get stable support for the hypothesis that wage rates of spouses affect the share of joint time-use. In only one case is the wage rate of the husband significant. The yearly income of a male is significant in both specifications where it is used, where it is significant only in one specification for the female. However, the effect of husband's yearly income is miniscule. Moreover, years of education are not significant in any of the estimations.

Hallberg also estimates a Tobit model for the determinants of the potential time in housework and in leisure and in combining the two. In his specification, he also includes the market work hours of both spouses. He notes that income has no effect on the potential time spent in these activities.

Jenkins and Osberg (2004) study the effect of wage rate on the probability of synchronised market work hours between spouses by utilizing British Household Panel Survey from years 1990-1999. They examine the work time synchronisation of the spouses with a probit model using hourly wage rates, work hours, number of children, the presence of small child in the household, and measures for working at odd hours as ex-

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[9] Further evidence on the shifts of time-use within a day is obtained by Hamermesh (1999). He studies the allocation of work time between United States workers with Current Population Survey datasets from 1973, 1978, 1985 and 1991. He hypothesises that work during untypical hours is considered inferior and the increase in real wages would have lead to reduction on evening and night work during the period. He finds strong support for this hypothesis, with the result that workers who had seen the biggest increase in real wages had been able to shy away from non-routine hours of work.

planatory variables. Their dependent variable is set to one if a couple works at the same time and zero otherwise. They estimate their model separately for couples with children and without children.

According to their results, female's wage rate increases the probability of work time synchronisation but the male wage rate only if couple has children. An increase in the female's hours of work leads to more work time synchronisation, while the husband's hours of work have no effect. Children decrease the probability of synchronisation. Jenkins and Osberg's results are thus similar to those observed by Hamermesh in the case of females, but contrary to his results in the case of males.

Hill and Juster (1985) test to determine whether a spouse's time in an activity is a good predictor for the other spouse's time spent in the same activity. Using the 1975/76 University of Michigan's time-use study on United States Hill and Juster test hypothesis with 13 different time-use categories and a sample of 384 married couples. They use imputed gross hourly wage, years spent not working, a subjective assessment of the satisfaction with the activity, and a set of demographic and skill variables in their estimation. They note that a spouse's time spent on leisure is a strong indicator of the time spent on leisure also by the other spouse. However, the time spent on housework by one spouse is not a good indicator of the time spent on housework activity by the other. Another significant variable in time allocation is gender. Interestingly, wage rate has no effect on the time-used in leisure activities but does have a negative effect on certain housework activities.

Kingston and Nock (1987) uses the 1981 United States Time Use Study to investigate the determinants of joint time-use in households where both spouses work, and include 177 households in their sample. They hypothesise that time together increases with income and social status, but decreases with market work hours and with the time spouses have been married.

They explain joint time-use in seven different leisure and housework categories that they had constructed themselves.[10] As independent variables they use the time in market work, off-scheduling, income, socioeconomic status[11], number of children, years in present marriage and

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[10] They include child care, recreation, housework and personal care, service, watching TV, eating, and talking.

[11] Lesnard (2003) uses indicator of social position to explain the amount of time spouses are able to spend together. He hypotheses that the further away spouses are in a social space that Lesnard constructed, the less possibilities they have for spending time together. His result indicate that the social position of the individuals within the marriage effects the time spouses spend together.

race. Off-scheduling is calculated by subtracting the time the other is working from the time the other is not.

According to their observations, the only significant variables in explaining time spent together are total minutes of work and off-scheduling time. Also contrary to their expectations, but conforming to the Hill and Juster (1985) hypothesis, the length of time in current marriage has a positive effect on time spent together. The family total income and social status have no effect on the time spent together. The number of children is not significant either.

In summary, although there is evidence that spouses try to synchronize their timing, the evidence on how different economic variables affect this attempt is still mixed. Most of the results are not based on formal models but are merely descriptive features and correlations found in the data. With more disaggregated data and with more accurate estimation methods, we attempt to shed more light on the question whether and to what extent, economic variables affect the choice of joint time.

5 Sample

The joint time-use between spouses is studied with data from Finnish Time Use Survey 1999/2000 by Statistics Finland, which had been collected between 1 March 1999 and 29 April 2000 following the Eurostat guidelines for harmonized European Time-use Surveys. Data on earnings, taxes and transfers from administrative files were merged into this background information file, giving us necessary economic variables to study the economic aspects of the time allocation problem.

The sample had 10278 individuals of whom 6272 responded. Out of the 5224 individuals, who had both answered the interview and kept diary for two days, we selected households where spouses were either married or living in consensual union, and where adults were between 18 to 65 years of age.[12] At least one adult member of the household had to

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[12] From these households the records for over 15-year old respondents and other household member were living elsewhere were deleted. If spouses reported different number of children in their household, these records were also deleted. This left with 3026 persons.

be employed. The other adult could either be employed, unemployed or taking care of the household.[13]

It was obligatory to indicate in the diary with whom the activity was done. There were four categories: being alone, being with children up to 9 year old in the household, being with other household members, and being with other persons. Unfortunately this information was coded from the diaries into the data file by Statistics Finland for only seven months: From March to July and for November and December.[14] Our focus on only those households which also included information on joint time-use reduced the size of the sample used here to 1520 observations on 760 persons in 380 households.

Table 1 Descriptive Statistic for the Sample

	Sample	
	Male	**Female**
Gross hourly wage rate (euro)	15.5	12.0
Net hourly wage rate (euro)	9.6	8.0
Non labour income (euro)	1 240	881
Age	43	41
Number of children	1	1
Basic education	24.8 %	18.7 %
Secondary education	40.0 %	41.3 %
University level education	35.1 %	40.0 %
% employed	95.8 %	83.0 %
% unemployed	3.4 %	6.6 %
% homekeepers	0.8 %	10.3 %
	n=380	N=380

[13] Some technical deletions were also made: exclusions included households which had missing diaries, had inconsistent information about the number of children, had two adults of same sex, or were married but living separately, or reported that they were working full-time but did not report any fixed working schedule in an interview. Also some households were excluded with missing income variables, hourly wage-rates that clearly were outliers and those with negative work-experience.

[14] For the whole sample this amounted to 1893 individuals and 3786 diary dates.

Table 1 gives some descriptive statistics for the sample used. The average age for males is 43 years and for females 41 years. The households have, on average, one child. The imputed hourly wage rate is calculated by Heckman's (1979) method.[15] The imputed hourly net wage rate is 8.3 euros for men and 6.4 euros for females. The males have on average non labour income of 1 240 euros and females have 881 euros[16]. In the sample 96 percent of the males and 83 percent of the females are employed. Out of the employed persons 92 percent of males and 86 percent of females have full time job.

6 Some Preliminary Features about the Joint Time-use of Spouses

In our sample of 760 households there are clear differences in the total amount of housework and leisure done by each spouse.[17] The allocation of time is presented in table 2. During a weekday males do, on average, 2 hours 25 minutes of housework versus on average of 4 hours 28 minutes for females. This disparity is reversed if we look at the market work. On average males do 7 hours and minute of market work and females do 4 hours and 48 minutes of market work. As noted in many time-use studies,[18] the difference balances out if market and housework are added together: total work is 9 hours 26 minutes for men and 9 hours 16 minutes for women. Gender differences are compounded during the week when females use 35 minutes more for sleeping and personal hygiene while males use 25 minutes more for leisure.

During weekends the gender differences remain. Although both spouses sleep almost as long, males have 1 hour 13 minutes more leisure time while females do 1 hour 40 minutes more housework. Some of this difference is explained by the fact that even during the weekends males work in the market almost 40 minutes longer than females.

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15 For details see introductory essay in this thesis.

16 Child benefits are a large component of the non-labour income in Finnish households. These are usually paid to the mother of the child. Therefore it is usual for a women to have a higher non labour income than men. We divided child benefits into two allocating it to both parents.

17 Some activities are reclassified. For example eating, free-time study or going to the sauna are classified as leisure activities.

18 See for example Robinson and Godbey (1997) and Gershuny (2000).

Table 2 Time-use in Different Activities during a Weekday and Weekend (in minutes)

	Weekday		Weekend	
	Male	**Female**	**Male**	**Female**
Housework	145	268	195	295
Leisure	379	354	577	504
Market Work	421	288	94	55
Studying	3	3	1	2
Personal Care	489	524	570	580
Others	5	3	3	4

The level of aggregation in time-use categories has a considerable impact on the estimates of how much time is spent together during leisure and during housework.[19] It is a well known fact, as pointed out by Klevmarken (1999), that the coding chosen and the questions posed by the interviewer affect the detail and content of the survey data. In our dataset we can choose different levels of aggregation for presenting the time-use categories. If the most detailed level is chosen then time-use is divided into 185 basic activities, while in most aggregate level there are only six major categories (i.e. housework, leisure, market work, studying, personal care, others). The level of aggregation has an impact on the estimates of the amount of joint time-use in households.

In order to record time as joint time-use, the spouses have to carry out disaggregated activity in the same place at the same time. This is indicated as 'Housework together' and 'Leisure together' in table 3. According to the most disaggregated level of time-use categories, spouses did joint housework only 22 minutes during the weekday and 43 minutes during the weekend. These figures on the joint housework increased, when all different housework activities were aggregated together, producing a joint housework time of 47 minutes; an increase of over 200 percent. Likewise the estimate of time spent together in doing housework during weekends more than doubled to 1 hour 37 minutes.

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[19] Joint time-use is defined as a situation where both spouses record the same activity in the same place with relatives other than children up to 9 years of age. This means that both partners must fulfil these conditions. For the discussion of differing responses see Hallberg (2003).

The level of aggregation has a similar impact on the estimate of joint leisure. If the basic time-use categories are used, spouses spend 1 hour and 27 minutes leisure together during weekdays and 3 hours and 6 minutes during weekends. With the aggregate categories the figure for a weekday increases to 2 hours and 40 minutes and for weekends to 5 hours and 11 minutes. Thus there is an increase in the estimate of joint leisure of about 73 minutes during the weekdays and about 125 minutes during the weekends.

Some datasets lack information on the presence of other individuals. In that case it is often assumed that couples do things together if they are engaged in a same activity in the same recording period. Our dataset shows that this leads to even greater differences in estimation. Table 3 also records the time spent in exactly the same activity as the spouse, but not in his/her company. These figures are presented in rows 'Same kind of housework alone' and 'Same kind of leisure alone'. If these activities are classified as joint time-use, then in the worst case the figures for joint time get inflated by 20 percent. Using aggregated categories, this translates into an estimate of over an one hour more in joint time what in reality is spent between spouses. The differences of this magnitude in these estimates cannot be neglected.

One explanation for the increased joint time, when the level of aggregation is increased, could be that the aggregation does not capture gender differences in specific housework activities. There is some evidence, for example Robinson and Godbey (1997) and Niemi and Pääkkönen (2002) that men engage in home repairs and other mechanical housework while women still continue to concentrate more on domestic chords like cooking and cleaning. At a disaggregated level, this would translate into a reduction in joint time-use if it is examined at the level of single activity. If housework is taken as an entity, this implies that gender-specific housework activities are recorded as joint time-use. This would not, however, explain the increase in joint time in leisure.

Table 3 hides the fact that there are a great number of households where there is no joint time-use at all, as is indicated in table 4. We see that with the most disaggregated time-use categories, no joint housework is done during the weekdays in over 60 percent and during weekends in over 40 percent of households. In the case of leisure the figure is smaller: 20 percent of households spend no leisure together during weekday; the corresponding figure is 10 percent during the weekend. It is interesting that almost a fifth of the households have neither joint leisure nor joint housework during a weekday – this drops to 8 percent during a weekend. It is also interesting to note that in the joint time-use of childless couples, these percentages change very little.

Table 3 Time-use in Housework and Leisure by Spouses during Weekday and Weekends (in minutes)

	Disaggregated (128 time-use categories)				Aggregated time-use calculated without using information about with whom the activity was done (two time-use categories)			
	Weekday		Weekend		Weekday		Weekend	
	Male	Female	Male	Female	Male	Female	Male	Female
Doing housework together	22	22	43	43	47	47	97	97
Same kind of housework, but alone	4	4	7	7	17	17	19	19
Doing housework alone	119	242	145	244	81	204	79	179
Total housework	**145**	**268**	**195**	**295**	**145**	**268**	**195**	**295**
Leisure together	87	87	186	186	160	160	311	311
Same kind of leisure alone	22	22	38	38	44	44	68	68
Leisure alone	270	245	353	280	175	150	197	124
Total leisure	**379**	**354**	**577**	**504**	**379**	**354**	**577**	**504**

Table 4 Households without Joint Time-use

	Weekday	Weekend
No joint housework	60 %	41 %
No joint leisure	21 %	10 %
Neither housework nor leisure	18 %	8 %

The high number of spouses who do no housework together during weekdays can mean that there is an increased division of housework into single activities carried out during weekday. This result can also be caused by the survey set up, where each household has only one weekday as the observation day. It could also be the case that joint housework is concentrated on a random day during a week and is not captured by this sampling scheme. If more days were sampled for a single household, then this figure would perhaps decrease.

The percentage distribution of the joint time is presented in table 5, where the effect of the level of aggregation is clearly visible. The figures become approximately double for using more disaggregated categories. The percentage distribution shows also that during weekends the level of time spent together in different activities is approximately the same for both sexes. However, during weekdays men spent proportionately more time doing joint housework or joint leisure out of their total amount, which they have less. Because women do more housework in aggregate, the share of joint housework is smaller for them. The reverse holds for leisure.

Hallberg (2003) reports that based on Swedish data couples spend together 64 percent of the total time available for spending it together. On average Swedish spouses spend 3.6 hours together during weekday out of 5.6 hours that were spent in housework and leisure. This figure is two and half times our result for disaggregated categories but quite close to our figures based on aggregated categories similar to Hallberg's.

The subsequent analysis is conducted using the most disaggregated level of information. It contains fewer joint time reports, but it is also more accurate than the levels of aggregation used in previous studies. More aggregated time categories are also used for checking the robustness of results.

Table 5 Joint Time-use as Percentage of Total Time-use between Spouses

Week	Disaggregated	Aggregated
Housework: % joint time for males	15 %	32 %
Housework: % joint time for females	8 %	18 %
Leisure: % joint time for males	23 %	42 %
Leisure: % joint time for females	25 %	45 %
Total males	21 %	39 %
Total females	18 %	33 %
Weekend		
Housework: % joint time for males	22 %	50 %
Housework: % joint time for females	15 %	33 %
Leisure: % joint time for males	32 %	54 %
Leisure: % joint time for females	37 %	62 %
Total males	30 %	53 %
Total females	29 %	51 %

For example, our disaggregated data reveal interesting facts about the activities spouses do together. The main five activities where spouses spend most time in absolute terms together during weekdays and weekends are presented in table 6.[20] Communicating with other household members takes most of the time both during weekdays and weekends.

The second activity most common activity with the spouse is shopping for goods and services. One reason why less shopping is done

[20] Sleeping is excluded, because that is solitary activity regardless of a shared bed.

Table 6 Time-use Categories with Longest Joint Time between Spouses

	Weekday	Joint time
1	Talking with other household member	1h 57min
2	Shopping for goods and services (includes travel)	1h 32min
3	Eating together	35min
4	Reading newspapers and periodicals	35min
5	Drinking coffee and eating snacks	20min
	Weekend	
1	Talking with other household member	2h33min
2	Shopping for goods and services (includes travel)	53min
3	Outdoor exercising	22min
4	Eating together	20min
5	Drinking coffee and eating snacks	15min

during weekends than weekdays is the fact that weekend includes Sunday, when most shops are closed. The observation that shopping is joint activity is also corroborated by Hill and Juster (1985) who note also a result that shopping is one of the few housework activities that respond positively to the amount of time spent in the activity by the other spouse.

As most of the recreation is done during weekends, it is not surprising that outdoor exercising together is in third place during weekends. During weekdays eating together and sharing newspapers and periodicals account for approximately 35 minutes. During weekends eating together and drinking coffee and eating snacks are in the fourth and in fifth place. Snacks are also the fifth joint time-use category during the weekdays.

Is there more joint time-use in household where the other spouse is not constrained in his/her time-use? If the other spouse is not time-constrained, this should show up as increased time together especially during weekdays, when the problems of synchronization are most severe. During weekends, the employed person is usually off-work, so the employment status of the spouses should not have such an impact.

Table 7 **Difference between Joint Time-use in Households where both Spouses are Working and Households where only one Spouse is Working (in minutes per day)**

		Joint time when both spouses working	Joint time when other spouse un-employed or taking care of household	Difference in minutes	%-difference
Weekday	**Housework**	19	31	12	63 %
	Leisure	81	109	28	26 %
Weekend	**Housework**	44	38	-6	-14 %
	Leisure	178	199	21	12 %
		n=300	N=80		

Table 7 compares the amount of joint time-use by couples where both are working versus the situation where one spouse is either unemployed or taking care of the household. In our sample there are 80 couples in which only one spouse is working. Interestingly, for these single earner families there is a clear increase in the joint leisure during weekdays and weekends. However, the effect is opposite on the joint housework during weekdays and weekends. One-earner families do, on average, more housework during weekdays and less housework during weekends. The opposite is true for dual-earning families. One explanation could be that in time pressed dual-earner households' housework activities are shifted to weekends when there is not so much pressure on time use.

7 Fractional Logistic Estimation

Our dependent variable is the time spent together as a fraction of the time available for different activities. Therefore our dependent variable is bounded in the unit interval 0 and 1.

Usually in a case that none of the values of the independent variables are strictly 0 or 1, the common way forward is to make a log-odds transformation

$$\log\left[y \Big/ 1-y \right]$$

and to use ordinary least squares in estimation. This transformation makes the value of the dependent variable range between zero and one. However, as Wooldridge (2002, 662) points out, the use of ordinary least squares in these circumstances creates a number of problems. If the dependent variable takes values 0 and 1, this transformation cannot be used without making some arbitrary adjustments to the boundary values. Furthermore, with this transformation the estimated coefficients are hard to interpret.

Papke and Wooldridge (1996) investigate the problem of estimating fractional values in the case of pension plan contributions. They propose a non-linear function for estimating the expected values of dependent variables y_i conditional on a vector of covariates $\mathbf{x_i}$

$$E\left(y_i \middle| \mathbf{x_i}\right) = G\left(\mathbf{x_i}\boldsymbol{\beta}\right)$$

where G is any cumulative distribution function and betas are the true population parameters. They chose a logistic distribution

$$E\left(y_i \middle| \mathbf{x_i}\right) = \frac{\exp\left(\mathbf{x_i}\boldsymbol{\beta}\right)}{1+\exp\left(\mathbf{x_i}\boldsymbol{\beta}\right)}$$

and suggested the use of Bernoulli log-likelihood function

$$l_i(\boldsymbol{\beta}) \equiv y_i \log\left[G\left(\mathbf{x_i}\boldsymbol{\beta}\right)\right] + \left(1-y_i\right)\log\left[1-G\left(\mathbf{x_i}\boldsymbol{\beta}\right)\right]$$

to get the quasi-maximum likelihood estimator $\hat{\boldsymbol{\beta}}$ of true population parameters $\boldsymbol{\beta}$.

Papke and Wooldridge (1996, 622) propose asymptotically robust interference for the conditional mean parameters. To derive an asymptotically robust estimate $\hat{\sigma}$ for variance σ, they first define

$$g\left(z\right) \equiv dG\left(z\right) \Big/ dz \;,\; \hat{G}_i \equiv G\left(\mathbf{x_i}\hat{\boldsymbol{\beta}}\right) \equiv \hat{y}_i \text{ and } \hat{g}_i \equiv g\left(\mathbf{x_i}\hat{\boldsymbol{\beta}}\right).$$

Then the estimated information matrix is

$$\hat{\mathbf{A}} \equiv \sum_{i=1}^{N} \frac{\hat{g}_i^2 \mathbf{x_i}'\mathbf{x}_i}{\left[\hat{G}_i\left(1-\hat{G}_i\right)\right]}$$

In order to get true asymptotic standard errors a outer product of the score is also needed. The residuals from the estimation are $\hat{u}_i \equiv y_i - G(x_i\hat{\beta})$. Let

$$\hat{\mathbf{B}} \equiv \sum_{i=1}^{N} \frac{\hat{u}_i^2 \hat{g}_i^2 \mathbf{x}_i' \mathbf{x}_i}{\left[\hat{G}_i\left(1-\hat{G}_i\right)\right]^2}$$

Then a valid estimate of the asymptotic variance $\hat{\beta}$ is a modified sandwich type:

$$\hat{\mathbf{A}}^{-1}\hat{\mathbf{B}}\hat{\mathbf{A}}^{-1}$$

As Papke and Wooldridge (1996, 623) note, standard errors are obtained as the square roots of the diagonal elements of this equation.

Additional support for using Papke and Wooldridge's method comes from Kieschnick and McCullough (2003). They compare two different methods of estimating fractional dependent variables: a beta distribution based parametric regression model or Papke and Wooldridge's quasi-likelihood based fractional logistic model. They recommend the use of the Papke and Wooldrige method especially if the sample size is large enough to justify the asymptotic properties.

8 Empirical Specification

We use the following empirical specification for the fractional model:

$$\frac{J_{si}}{T_{si}} = \alpha_i x_i + \beta_i y_i + e_i, \quad s = L, H, L+H; i = m, f$$

where x_i includes the economic variables, y_i represents the demographic variables and e_i is the error term. J represents the joint time in pure leisure, housework or combined housework and pure leisure. T represents total amount of time, solitary or joint, spent in these activities by the male or female. Dividing one with another results in a fraction of time spent together out of the total amount spent in these activities. We estimate joint time-use separately for housework H and for leisure L. The estimation of housework and leisure in combination (H+L) is done to

facilitate comparisons with Hallberg's (2003) results. To be able to compare our results to those of Hamermesh, Jenkins and Osberg (2004) and Sullivan (1996), a specification is used that has the absolute amount of joint time-use as dependent variable.

The economic variables used in the estimation include the net hourly wage rate and the non-labour income of the person. Also the net annual income of the spouse is included. The demographic explanatory variables are dummies for age cohorts, a dummy for female respondent, dummies for educational levels using ISCED-97 classification, the imputed market work hours, the number of children, a dummy for living in rural area and a dummy for a person with disability.[21]

Because the sample that has information on the joint time-use was coded for five spring months and two fall/winter months, a dummy was created to take into account fall/winter observations. A weekly variation in the data is taken care of by a dummy variable for weekend. A dummy is also included to take into account whether the respondent indicated that the diary day was an unordinary day.[22] In addition to limited seasonal scope, our sample includes only those households where at least one spouse is in paid employment. This reduced the size of the sample considerably. It also makes the characteristics of the sample uniform.[23]

An important departure from Hallberg (2003) in our specification is that the hours of market work are one explanatory variable in the share of the joint time-use. Hallberg uses hours of work in explaining the total amount of housework and leisure, but not for explaining the joint time-use. This is in contrast with Hamermesh's (2000 and 2002) formulations, where the effects of economic and demographic variables on the joint time-use are studied, given the market hours worked. Hamermesh argues that only when market hours are held constant, can there be evidence on whether the changes in variables under study have an impact on the share of time spent together. We also extend Hamermesh's approach by concentrating on the share of

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21 The imputation of net wage rate and the imputation of the weekly market work hours are described in the introductory chapter of this thesis.

22 An unordinary day is one in which a person is on holiday, sick-leave, parental leave, on strike, taking care of sick relative, or on a part-time pension arrangement.

23 The use of weights creates problems because most of the diagnostic routines that are usually applied in this context are not available in the econometric software when weights are used. Therefore we chose to conduct our subsequent estimations without the weights.

joint time in various activities instead of the aggregate amount of joint time-use.[24]

Because the fractional logistic model has non-normal response distribution, the most convenient way to estimate it is to use a Generalized Linear Models (GLM) framework, which is a method of extending Ordinary Least Squares regression to incorporate a variety of response distributions. In GLM framework a linear predictor is mapped through a so called link function to model the mean of a dependent variable that has a distribution belonging to exponential family of probability distributions.[25]

The theory of Generalized Linear Models was developed by Nelder and Wedderburn (1972) and it has subsequently been enlarged to incorporate a wide class of distributions. They include, for example, normal, binominal, Poisson, Gamma and negative binominal distributions. By transforming the relationship to exponential representation, many problems encountered by non-linear estimation methods can be avoided.

In our case this probability distribution is binominal and the link used is a logit link. The estimation is done by a maximum likelihood. We are using Newton-Raphson method. The estimations are corrected for clustering using modified sandwich estimators which also provide robust standard errors in Huber/White sense.

In respect of diagnostics there are a great variety of suggested residual measures that can be used in GLM post-estimation analysis are summarized in Hardin and Hilbe (2001, chapter 4). One of the most popular is Anscombe residuals, which have been defined for different distributional families used in GLM. Anscombe residuals should have a normal probability density and the plot of Anscombe residuals versus fitted values should not show any systematic differences.

To asses the potential misspecification in our functional specification, we use the link test proposed by Pregibon (1980). In this test fitted values of the estimation are squared and the function is re-estimated with

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[24] Naturally, the use of the amount of market work as an explanatory variable creates endogeneity problems because the hours of market work are simultaneously decided with housework and leisure. Therefore, to correct for the endogeneity we estimate the hours of work by ordinary least squares and use fitted values instead of real market values. For similar method see Amemiya (1978). The problem with generated variables is the correction of standard errors.

[25] A good introduction to GLM-framework is given in Hardin and Hilbe (2001).

the squared residuals. If there is no misspecification then squared residuals should not have any explanatory power.[26]

In our estimation the link function is logit function, where the cumulative probability distribution follows logistic distribution. A close variant to logistic and a potentially fruitful other alternative is to use probit function as a link function. Then the cumulative probability distribution would be a normal distribution. We also use a probit link for estimating our equations in order to assess the appropriateness of the link function.

The normal way to assess the link function is to look at both the Akaike information criterion or Baysian information criterion. Akaike information criterion (AIC) is calculated as follows:

$$\mathrm{AIC} = \frac{-2L + 2p}{n}$$

where L is the log-likelihood value, p is the number of parameters and n is the number of observations.

The Bayesian information criterion (BIC) is calculated as:

$$\mathrm{BIC} = D - \mathrm{df} \ln(n),$$

where D is the deviance between observed and fitted values for each observation, df is the degrees of freedom in the equation and n is the number of observations.

With non-linear estimation methods we cannot use an ordinary R-squared statistic but have to resort to some other method of trying to determine how much of the variance is explained by the regression. In order to do this we calculate McFadden's (1974) likelihood ratio index, which has following form:

$$R^2_{McFadden} = 1 - \frac{L_{full}}{L_{only.cons}}$$

Where L_{full} denotes the log-likelihood of the full model and $L_{onlycons}$ denotes the log-likelihood of the equation where only constant is included in the estimation. The interpretation is the same as with ordi-

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[26] Another, more popular, possibility is to use RESET-test. However, the test available could not take survey structures into account.

nary R^2: the bigger the number the more of the variance is explained by the function.

9 Results

Estimation results are presented in table 8.[27] To take the overall pattern of our estimates, they show that economic variables do affect the share of joint time-use in both housework and leisure. So for the most part, our results do not agree with those obtained by Hallberg (2003), who finds that economic variables do not affect the choice.

Table 8 Fractional Logistic Estimation Results for Joint Time-use

	Leisure Weekdays	Leisure Weekends	Housework Weekdays	Housework Weekends
Net wage rate	-0.028**	-0.055***	-0.037*	-0.059***
	(0.047)	(0.000)	(0.100)	(0.003)
Non labour income	0.000	0.001	-0.004	-0.003
	(0.796)	(0.435)	(0.607)	(0.378)
Spouse's annual income	-0.002***	-0.002**	-0.004***	-0.001
	(0.002)	(0.025)	(0.003)	(0.131)
Age 35-44	0.211	0.698***	-0.163	0.506*
	(0.321)	(0.000)	(0.617)	(0.069)
Age 45-54	-0.053	0.730***	-0.059	0.711*
	(0.855)	(0.007)	(0.898)	(0.074)
Age 55-64	-0.013	0.996***	-0.398	0.591
	(0.972)	(0.004)	(0.566)	(0.242)
Secondary education	0.160	0.245**	0.092	0.210
	(0.236)	(0.041)	(0.703)	(0.249)

[27] It should be noted that the explanatory power of these estimations is quite low. The resulting McFadden likelihood ratio index is between 2 to 6 percent. The explanatory power of the regression explaining joint time-use in leisure is around 3 percent. The likelihood index for housework during weekends is 4 percent but for weekdays 6 percent. For joint housework and leisure the index is four percent and three percent, respectively.

University education	0.561** (0.014)	0.806*** (0.000)	0.744** (0.041)	0.927*** (0.005)
Female	-0.127 (0.482)	-0.389** (0.026)	-0.670** (0.017)	-1.027*** (0.000)
Number of children	-0.152** (0.012)	-0.195*** (0.002)	-0.085 (0.505)	-0.096 (0.324)
City	0.046 (0.735)	-0.098 (0.444)	0.207 (0.430)	0.177 (0.359)
Market hours	0.000 (0.517)	0.001 (0.291)	0.002* (0.086)	0.002* (0.062)
Unusual day	0.211 (0.189)	-0.043 (0.783)	0.473 (0.110)	0.041 (0.835)
Disabled	0.026 (0.804)	-0.181** (0.045)	0.048 (0.793)	-0.044 (0.761)
Fall observation	0.118 (0.399)	0.003 (0.982)	0.039 (0.878)	0.164 (0.409)
Constant	0.687 (0.397)	2.608*** (0.001)	0.631 (0.631)	1.966* (0.084)
Observations	760	760	760	760
Log pseudo likelihood	-304	-358	-194	-277
McFadden R^2	0.032	0.027	0.056	0.039
Perigbon link test	P>|z| 0.460	P>|z| 0.545	P>|z| 0.884	P>|z| 0.59
Sfrancia test with Anscombe residuals	Z = 6.04 Prob> z 0.000	Z = 5.66 Prob> z 0.000	Z = 9.48 Prob> z 0.000	Z = 9.35 Prob> z 0.000

p values in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Our results show that the effect of wage rate on the joint time-use is negative for leisure and for housework even when market work hours are controlled for. Spouse's annual income has a negative effect except with housework during weekends. These effects are presented in table 9. This means that the higher the net wage rate, the smaller share of the joint time spent together during both a weekend and during a weekday for leisure and for housework. As we control for the market work hours, the reason for smaller share of joint time cannot be that people with higher income or wage rate work more and thus have smaller amount of time to allocate

to leisure and housework. The non labour income of the person has no explanatory power on the time spent together.

Table 9 Effect of Wage-Rates and Annual Incomes on the Share of the Joint Time-use (+) or (-)

		Net wage rate	Non-labour income	Spouse's annual income
Weekday	**Leisure**	Yes (-)	Not significant	Yes (-)
	Housework	Yes (-)	Not significant	Yes (-)
Weekend	**Leisure**	Yes (-)	Not significant	Yes (-)
	Housework	Yes (-)	Not significant	Not significant

If we aggregate housework and leisure together and estimate it with the same explanatory variables, then the net wage rate and the spouse's annual income have a negative effect in all cases. The estimation results are presented in Appendix 1.

This negative effect of one's own wage rate and the spouse's annual income is present also in the estimations which use the actual time spent together in housework and leisure rather than in fractions of time. In both respects the results indicate that the substitution effect of the change in the wage rate is stronger than the income effect and thus reduces the amount of joint leisure both in housework and in leisure.

The change in non labour income has no effect on the joint time-use in housework and leisure. This is as expected, because the non-labour income does not change the relative prices between different time-use categories.

Our results lead in a direction different than that obtained by Hamermesh (2000) and by Jenkins and Osberg (2004). They find that income has a positive effect on the amount of potential joint time. Their results show that people with higher income have more potential time for themselves. However, our results, which are based on the actual amount of joint time, show that this potential time gain is in fact not used for doing things together.[28] In

[28] As a further check we also estimate equations explaining the total time-use, joint or solitary, in housework and in leisure. Neither the net wage rate nor the spouse's annual income is significant in explaining the total amounts. Instead it is demographic variables, like being female or having children turn out to be significant. All the estimations are available from the author upon request.

certain respect our results are more in line with the traditional Gronau-type model of the time allocation to housework, market work and leisure.

The observation that the spouses' annual income, which could represent a pure income effect for a spouse, has a negative impact on the joint time-use is more problematic. It could be argued that this effect should be positive.

We also estimate our specification with the share of the joint time calculated using only eight aggregate time-use categories. It does not change the main result that the net wage and the income of the spouse has a negative effect on the share of the joint time-use. Therefore, our results seem to be robust to the aggregation level used in the estimation.

As we included educational variables in our estimation, it is interesting to note that having a university level education has a positive and significant effect on the share of joint time. There is some indication that more educated men participate more in housework in Finland. The positive effect of university level education found in our estimation would be evidence for that.

Being a female reduces significantly joint time in housework during weekdays and weekends and joint time for leisure during weekends. This fact is also reported by Sullivan (1996) who concludes that the little housework males do is usually done together with females, but that females do a lot of housework on their own. Therefore the share of men in joint housework is much larger than females.

The dummies for age cohort for ages 35-44 and 45–54 turn out to be significant in explaining joint time-use in leisure and housework during weekends. In both cases the effect is positive. For the years 55-64, there is a positive effect on leisure during the weekends. The data lack information on the length of the marriage. Therefore the hypothesis of Hill and Juster (1985) that spouses who have been married longer engage in similar activities could not be tested. If the length of the marriage is correlated with the age of the spouses, and similar activities are done mostly during weekends, then our data do support this hypothesis.

The variable for the number of children turns out to be very significant and negative in the case of joint leisure. In the case of housework the variable turns out statistically insignificant. Jenkins and Osberg (2004) argue that child care is usually done by one of the spouses while the other is doing housework, thus resulting in less time doing the same activity together.

Hamermesh (2000) considers the effects of children on the joint time-use of spouses. He had longitudinal data so he could look for the change in time-use when the first child arrives in the family, when an additional child comes and when a child leaves the family in contrast to families without children. He finds that the only significant differences in the joint time-use between different groups are between those who had children and those who did not. It was the presence of children that mostly determined the lack of jointness in these groups. Moreover, the reduction falls mostly to women.

Contrary evidence comes from Hallberg and Klevmarken (2001) who note that parents complement each other in the time-use with children. This means that there is jointness in the sense that in a given day if one parent spends considerable time with the children so then the other parent as well. The effect is close to one.

If we look at the possible difference between joint time-use in housework and leisure, it is interesting to note that the economic variables have mostly the same effect in both time-use categories. Some demographic variables affect the joint time-use differently in leisure and housework. The observation that the number of children decreases spouses' joint leisure time is not surprising, but the fact that it does not affect the joint time in housework is more curious. Urban residence increases joint leisure during weekdays and joint housework during weekends. However, in other cases the same demographic variables affect both categories the same way. Therefore our previous conjecture that the amount of joint time in housework and leisure is determined by different factors does not seem to get confirmation.

This result is in contrast to that obtained by Hill and Juster (1985). They find that the overall time-use by a spouse in different leisure activities is a good predictor on the time-used in a same leisure activity, but not a good predictor on the time-used in housework. Here our result indicates that a set of explanatory variables has same kind of effect on the joint time-use whether it is in housework or leisure.

Based on the estimations, we calculate an estimate of the joint time-use for a set of households with different socio-economic characteristics. This is calculated by taking the linear prediction of the GLM binominal logit link model and evaluating it with the chosen values as recommended by Wooldridge (2002, 662). We select a high-income university educated couple in their forties living in metropolitan area with both spouses working and having two children. For another type sample couple, we choose low-income childless couple in their fifties

with elementary education living in the countryside. For both couples, the estimate of the joint time is calculated for a weekday and for a weekend.

During weekdays joint housework is done in both kinds of households for approximately 15-20 minutes. This represents 13 percent of the male's housework time and 10 percent of the female in the high-income family. For the low-income couple, the share is 9 percent for the male and 7 percent for the female. During weekends the high-income couple does 10 minutes more housework together - approximately 48 minutes in total. This difference translates to a 26 (17) percent share for high (low)-income females and 16 (11) percent share for males.

As for the leisure it is interesting to note that a high-income university educated middle-aged couple has 15 minutes more leisure time together, approximately 1 hour 15 minutes, than a low-income lower-educated older couple. The increase in joint time is explained mainly by having a university degree. A household with exactly the same profile, but with only a secondary schooling, would have almost the same amount of joint leisure time than the low-income couple. However, during a weekend the low-income couple has 30 minutes more leisure together, than the high-income couple. In total over 3 hours. These time estimates translate to an average share of joint time of 65 percent out of the total leisure time for a low-income couple and 45 percent share for a high-income couple. During a weekday the share is approximately 25-30 percent for both types. These differences are mainly driven by demographic factors. Economic variables, like the wage rate, have very limited impact although they are statistically significant.

Some notes about diagnostics to end this chapter. We test for the appropriateness of the link function by also specifying a probit link. When comparing Akaike and Bayesian information criteria for probit and logit links, the differences in values are minimal. However, the logit link gets smaller values in every case, giving evidence that our link is appropriate. Pregibon's link test is computed for each specification and shows no misspecification. Anscombe residuals are used to compare the fit of the model. In most cases these residuals do not pass the normality test imposed. There is a bias to Anscombe residuals having bigger positive values than negative ones. When comparing with fitted values, no other systematic biases are visible. Moreover, the estimations are done by excluding the largest outliers, but this does not change the results to any great extent.

10 Conclusions

This study looks at the determinants of the time spent together by spouses, using a Finnish Time Use Survey from 1999/2000. Previous work by Hamermesh (2000, 2002) Jenkins and Osberg (2004) and Hallberg (2003) is extended to estimate the demand for leisure, housework and the combination of both and by looking at the time-use both during weekends and weekdays.

The data used are aggregated at different levels. As there has been evidence that the level of aggregation affects the results, the implications of the different levels of aggregation for the amount of joint time-use are studied. The analysis shows that the estimates are sensitive to these assumptions and the results can differ.

Using the most disaggregated classification in estimation the results indicate that economic variables play a role in the determination of joint time-use. The net wage rate has a negative effect on the share of joint time, while non-labour income has no effect. As our results show that higher wage rate and annual income also decrease the absolute time in housework and leisure, the explanation cannot be that wealthier households have more overall time at their disposal so that the share of joint time is lower. Our results show that both the absolute time-used in leisure and housework and relative time spent together in these activities are lower. A standard explanation would be that substitution effects are stronger than income effects in the Finnish households.

In most cases the variables that are significant in explaining joint time-use during weekends and weekdays have same signs. During weekends spouses do more housework and spend more leisure and a greater percentage of these activities are done together. Older cohorts spend more time together than younger cohorts.

It has been maintained that housework and leisure are two distinct activities that obey a different logic. Housework is done out of necessity but leisure is enjoyed for itself. Therefore different variables should influence their composition and the amount of joint time-use in both. According to our results, it is the same variables that affect both of these activities.

Huovinen and Piekkola (2002) and Piekkola (2003) note that Finnish labour markets have quite inflexible working hours. Part-time employment possibilities are limited. Especially for older men, who have the longest work weeks, the only possibility to increase leisure time is to go

into part-time retirement or early retirement. Both studies also show that one of the reasons for cutting back on employment is to have more leisure time. With rigid Finnish labour markets, this can lead to the decision to exit the labour force. Therefore our results could be interpreted to indicate that there are limited possibilities for working spouses to increase their joint time together. Thus our results do not measure the aspirations of the spouses but the reality faced by them.

Hamermesh (2000) concludes his study by noting that the timing of each spouse's activities reflects "their relative power, the market price of their time, their total resources and their desire for joint leisure." Our study shows that there are diminished possibilities within a household for joint leisure when economic incentives are greater.

Appendix 1 Fractional Logistic Estimation Results for Combined Joint Housework and Leisure

	Weekdays	Weekends
Net wage rate	-0.034**	-0.062***
	(0.013)	(0.000)
Non labour income	0.001	0.000
	(0.722)	(0.845)
Spouse's annual income	-0.002***	-0.001*
	(0.001)	(0.062)
Age 35-44	0.204	0.702***
	(0.322)	(0.000)
Age 45-54	-0.013	0.838***
	(0.965)	(0.001)
Age 55-64	-0.007	1.049***
	(0.984)	(0.001)
Secondary education	0.122	0.251**
	(0.360)	(0.022)
University education	0.601***	0.931***
	(0.006)	(0.000)
Female	-0.405**	-0.672***
	(0.024)	(0.000)
Number of children	-0.177***	-0.192***
	(0.005)	(0.003)
Rural	0.099	-0.075
	(0.475)	(0.544)
Imputed market hours	0.002**	0.001**
	(0.014)	(0.033)
Unusual day	0.239	-0.053
	(0.170)	(0.711)
Disabled	0.023	-0.200**
	(0.829)	(0.021)
Fall-observation	0.098	0.049
	(0.486)	(0.677)
Constant	0.986	2.840***
	(0.224)	(0.000)

Observations	760	760
Log pseudo likelihood	-270	-331
McFadden R^2	0.036	0.030
Perigbon link test	P>|z| 0.573	P>|z| 0.303
Sfrancia test with	Z = 5.87	Z = 5.73
Anscombe residuals	Prob> z 0.000	Prob> z 0.000

p values in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

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ESSAY 2.

Daily Variation in Time Use – A Count Data Application

Abstract:

Human capital, in addition to having an impact on productivity in market work, can influence people's ability to enjoy non-work activities. Gronau and Hamermesh (2001) argue in a recent paper that human capital increases the number of activities people can engage in during their spare time. This paper studies the variability in time use of the Finnish households with Finnish time-use data from 1999/2000. Our results indicate that the number of activities increases with the educational level of the individual. We test to ascertain whether this increase is caused by the coding schema used in most time-use studies or whether it can be explained by other factors, such as living environment. Our results indicate that these features cannot refute the increase in the variety of people with a higher educational level. The inclusion of secondary activities does not change this conclusion either.

1 Introduction

Human capital is manifested in many ways. By increasing the productivity at market work, it enables a worker to command a higher wage and thus to enjoy a better standard of living. But, in addition to market work, the amount of human capital can affect other spheres of life as well. For instance, the ability to use complicated technology helps to program a VCR or to operate a microwave. The ability to speak a foreign language, Italian for example, advances possibilities to do business with that country, but also adds to one's enjoyment of the opera.

Inevitably, human capital has many uses. But the way it affects our daily lives has been studied far less than its impact on paid work. One recent contribution to this overlooked field of study is the paper by Reuben Gronau and Daniel Hamermesh (2001) on the number of activities enjoyed by people in Australia, Israel, Netherlands, United States, Sweden and West Germany. They argue that an increase in human capital increases the number of activities people do during their spare time. The number of activities done has a price in terms of the time costs of the lost wage and also of the set-up cost to switch from one activity to another. They claim that these set-up costs are lower for people with higher human capital. Also the ability to plan and coordinate is better for people with a greater amount of human capital and this result in a greater amount of activities done in a given time.

Gronau and Hamermesh take education as the proxy for the amount of human capital. They find strong support for the view that people with higher educational level engage in more activities than those with elementary education. From this observation, they infer that human capital also has effects during the off-work hours.

In this article we investigate further the Gronau-Hamermesh argument by using Finnish Time-use Survey from year 1999/2000. Gronau and Hamermesh (2001) conduct their study in the ordinary least squares framework.[1] In recent times, the econometrics of count data has progressed rapidly and with the application of count data specific methods, more varied testing, prediction and diagnostic routines can be used. We therefore choose to conduct our study with negative binominal regression models in generalized linear models (GLM) framework.

We expand the study of the effect of variety in four areas:

First, the manner in which people record their activities in the time-use diaries can affect the estimates of time-use variety. If people with more years of schooling are linguistically better trained, then it is possible that an individual with basic education would describe their time use in a more aggregated way than someone with a higher educational level. The more finely-detailed the description, the more variety is recorded. We look at this possible problem by examining the quantity of unspecified activities recorded by people with varying educational backgrounds.

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[1] Although the number of activities is in fact a count variable, this number of activities is quite large and therefore the resulting distribution is close to the normal distribution. This makes it possible to use an OLS-framework in estimations.

Second, Gronau and Hammermesh (2001) do not examine how the supply of activities can affect their results. One would assume that people with higher education tend to live in cities, which offer far greater variety of time use than the countryside. Thus the increase in variety could be partially explained by the choice of living environment of people with different educational backgrounds. We study whether the area of residence affects the variety.

Third, the empirical part of Gronau and Hamermesh's (2001) study lacks income variables in many cases. Of the countries covered, hourly wage information exists only for the Swedish sample. As we have detailed information on net wage rates, we are able to determine whether the hourly wage rate has an impact on the variety.

Fourth, there is some evidence that people with a higher educational level also tend to do more things simultaneously.[2] This multitasking makes it possible to do more activities at a given time. Therefore it is interesting to examine whether this has an effect on the variety. Gronau and Hammermesh (2001) had information on secondary activities for Australia, West Germany and Sweden. However, the recording of secondary activities in these datasets has been haphazard. As 95 percent of the respondents in Finland have also recorded secondary activities, it is possible to look at multitasking more accurately. We test to see how our results change when secondary activities are included.

2 Previous Empirical Literature

In economics, only a few studies exist on the structure of peoples' daily activities. Until recently it was customary to aggregate all non-work activities under the term "leisure" and to study only the choice between the amount of market work and leisure during a day.[3] The advent of household production literature has introduced the distinction of daily time use into market work, housework and leisure.[4] Recently there has been an increase in data availability in the form of time-use surveys, making it

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2 See for example essay 4 in this thesis.

3 For recent survey on labour supply literature see Blundell and Macurdy (1999).

4 For household production theory see Becker (1991), Gronau (1977) and Gronau (1986). For an early study with a number of different time use categories, see Kooreman and Kapteyn (1987).

possible to study the patterns, amounts and variability of people's daily activities in a very detailed manner. Naturally the economics perspective guides the choice between different activities and the impact of economic variables on these choices.

Human capital has been under intense research since its introduction into economics by Becker in the early 1960's. The interest has focused mainly on the effect of human capital on market work and the effects of schooling in increasing the amount of and the reward for human capital. Less research has been done on the effect of human capital on non-work time in addition to the time used in studying.[5] Therefore, the recent contribution by Gronau and Hamermesh (2001), where human capital is also said to affect non-work activities, is interesting as it offers a new explanation on the variability in a number of different activities found in data.

Gronau and Hamermesh conduct their study in the household production theory framework. According to these researchers, the activities produced by the household production process have a price in terms of the time it takes to earn the money to purchase the market goods used for the activity and the time it takes to perform the activity. They also argue that the investment in human capital leads to differences in these extended prices as well as to an increase in the variety of activities chosen.[6]

In their analysis Gronau and Hamermesh use time-use data from six different countries,[7] choosing households with members aged between 18 and 69 years olds and dividing the sample to three educational categories: low, middle and high. They use an untypical division of time use into two categories. The first is work which includes not only market work but also laborious types of housework. The rest of the time-use categories are included in non-work activities, covering leisure, child care and personal care activities. They concentrate their study on the number of non-work activities.

Gronau and Hamermesh run a regression to explain the number of non-work activities with schooling, age, number of children, and the day of the week. According to their result, schooling has a positive effect on

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5 See Fahr (2004).

6 Traditional consumer theory postulates that an increase in income diminishes marginal utility which results in an expansion of the spectrum of goods consumed. Another factor that has an impact is the setup costs. A good is consumed only if the consumer surplus is greater than the setup costs.

7 They are Australia 1992, Israel 1991-2, Netherlands 1990, Sweden 1993-4, United States 1985 and WestGermany 1991-2.

the number of non-work activities in all the other countries in the dataset except Sweden. Each extra year of schooling increases the variety by about 2 percent. The number of children in the household increases the number of activities done by spouses.

Few countries have detailed information on income and earnings, and only Sweden has information on wage rates. Gronau and Hammermesh (2001) utilize the income or wage information that is available for some of the countries, using it in their regressions. Inclusion of this information does not change the impact of education on variety, and there are positive, but not very large, cross-wage effects in most countries.

The increased amount of variety of activity by the more educated is an interesting fact because in all datasets there is a positive relationship between schooling and the time used in market work. The more educated have less time to spend in non-market activities and have thus less time to create variety. Nevertheless, they still engage in a greater number of activities.

Gronau and Hamermesh also test to determine whether the less educated engage more frequently in routine activities. To account for this, they construct a variable denoting an activity performed in both reporting days as routine, and those activities that were reported only in one of the reporting days, as non-routine. They observe that the impact of schooling on variety works by producing variety in non-routine activities. Also the number of long lasting activities falls and the number of short-term activities rises, except in Sweden. They also find evidence that the less educated spend their time in more time-intensive activities.

Overall, there is evidence across the different countries that education increases the number of activities people engage in despite the fact that the more educated people have less non-work time.

3 Model

The model used to study the number of chosen activities comes from Gronau and Hamermesh (2001) and is based on beckerian household production model.[8] The object of interest in this case is examining what determines the selection of chosen activities.

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[8] See for example Becker (1991).

We have a household production function that combines time and goods to produce so called 'basic' commodities or activities in this context. The household utility function *U*:

$$U = U(Z_1, Z_2, ...Z_n)$$

has arguments *Z,* which stand for the outputs from the household production function:

$$Z_i = f(X_i, T_i)$$

where T_i is the time input and X_i is the goods input. The maximization of utility is subject to two constraints, a time constraint:

$$\sum_{i=1}^{n} T_i = \overline{T}$$

where $\overline{T}$ is the total time available, and income constraint:

$$I = wL + V$$

where *w* stands for wage, *L* stands for market work hours and *V* is the non-labour income. The maximization leads to the selection of those activities that fullfill the condition:

$$\frac{u_i}{\pi_i} = \lambda$$

where $u_i = \partial U / \partial Z_i$ is the marginal utility of activity *i*, and λ is the marginal utility of effective time

$$\overline{T} + L + \left(V / w\right)$$

and π_i is the marginal time cost of producing activity i. This cost consists of the market work time needed to earn the goods used in production time, their relative cost p_i / *w*, and the housework time to produce the activity, where p_i is the price of the good *i* :

$$\pi_i = \left(\frac{p_i}{w}\right)\frac{\partial X_i}{\partial Z_i} + \frac{\partial T_i}{\partial Z_i}$$

It should be noted that in this shadow price equation, both market work time and housework time are derived with respect to the household production function. The activities chosen are those where the reservation price $\pi_i^* = u_i(0)/\lambda$ is higher than the marginal time cost:

$\pi_i^* > \pi_{i,}$ $i = 1,\ldots,m.$

Gronau and Hamermesh (2001) contrast this model to the traditional explanation of the number of activities, where the variety is explained by the dispersion of preferences and incomes. In the household production model the diversity is caused also by differences in time costs.

Gronau and Hamermesh argue that the different investments in human capital directly affect the cost of undertaking these activities. According to them, education can enhance a person's ability to plan, coordinate and streamline tasks and this should also become apparent in household production. Also setup costs play a big part in the switch between activities and the more educated people are better able to reduce the setup costs. This means that the higher the amount of human capital, the lower the time costs $\partial T_i / \partial Z_i$ will be.

The economic variables in Gronau and Hamermesh's model are the wage rate and non-labour income. The higher the wage rate, the more costly time is and thus more activities are pursued in a given time. Interestingly in their model, an increase in non-labour income V increases the effective-time constraint and has the traditional income effect on variety. This is in contrast to the standard household production theory, as advanced for example by Gronau (1977), where non-labour income does not have an effect.

4 Sample

The dataset used in this study is the Finnish Time-use Survey 1999/2000 by Statistics Finland. The data were collected between 1 March 1999 and 29 April 2000. Collection followed the Eurostat guidelines for harmonized European Time-use Surveys.

5224 individuals answered both the interview and kept the time-use diary for two days. From this sample, we selected those households where spouses were either married or living in consensual union. This left 3402 persons. Households where adults were between 18 to 65 years of age were selected.[9] At least one adult member of the household had to be employed. The other adult was allowed to be either employed, unem-

[9] From these households, records for over 15-year old respondents and other household member living in the household were deleted. If spouses disagreed on the number of children in their household, these records were also deleted. This left 3026 persons.

ployed or taking care of the household. Some technical deletions were also made.[10] The final sample included 1568 persons living in 784 households.

Table 1 gives the descriptive statistics for the sample used in this study. The average age for males in this sample is 43 years and for females 41 years. The households have, on average, only one child. The imputed hourly net wage rate, calculated with Heckman's method, is 9.5 euros for males and 8.1 euros for females. The males have on average annual non-labour income of 1 183 euros and females 869 euros per year. In the sample 96 percent of males and 83 percent of females are employed. 3.4 percent of the males and 7 percent of the females are unemployed. Only half a percent of males are at home versus 9.7 percent of the women.

Table 1 Descriptive Statistic for the Sample

	Male	Female
Net hourly wage rate (euro)	9.5	8.1
Non labour income (euro)	1 183	869
Age	43	41
Number of children	1	1
Basic education	24.5 %	20.0 %
Secondary education	41.6 %	40.6 %
University level education	33.9 %	39.4 %
% employed	96.2 %	83.3 %
% unemployed	3.4 %	7.0 %
% homekeepers	0.4 %	9.7 %
	n=784	n=784

The educational categories used for educational levels are based on Unesco's International Standard Classification of Education (ISCED) from the year 1997. Elementary education is the lowest category, and

[10] We excluded those households which had (i) missing diaries, (ii) two adults of same sex, (iii) had married spouses who were living separately, or (iv) reported to be working full-time but did not have fixed working schedule. Also some households were excluded because of missing income variables, or where hourly wage-rates or yearly incomes clearly resulted in outliers or where members had negative work-experience.

upper secondary education corresponds to a middle category. The highest category, university level education, also includes vocational university degrees. As can be seen, the percentage division for men follows a ratio of 25-40-35 from lowest to highest and for women 20-40-40. Women have more university level education than men, whereas the share of secondary education is the same for both genders.

5 Variety in Time Use in Finnish Households

An example of how to measure variety and routine during two diary dates is presented in table 2. When we look at the occurrence of different categories of activities during a day, we note that seven unique activities have been done during a weekday and nine during the weekend day. Routine can be calculated by looking at how many times the same activity has been repeated during these two recording days. In this example, there are four routine activities: sleeping, having breakfast, viewing TV and dinner (shown in italics).

Table 2 Variety and Routine in Time-use Data

	Weekday	Weekend day
8:00	***Sleeping***	***Sleeping***
9:00	***Breakfast***	***Sleeping***
10:00	**Bus**	***Breakfast***
11:00	**Work**	**Lovemaking**
12:00	**Work**	**Shopping**
13:00	**Work**	**Movies**
14:00	**Bus**	**Sports**
15:00	**Snack**	**Sports**
16:00	***TV***	**Reading**
17:00	***TV***	***TV***
18:00	***Dinner***	***Dinner***
19:00	***TV***	***Sleeping***
	Variety = 7	**Variety = 9**

We start by presenting some stylised facts about the general time use in our sample of 18-65 year old Finnish couples. Table 3 presents the allocation of time to different activities by the level of education. As can be seen, during a weekday men with secondary education do the most work while women with the same educational level do the least. However during a weekend, in the case of men, the time devoted to market work decreases with education. This can be attributed to a fact that workers with low education tend to be employed in jobs with shiftwork, or in the service sector. Interestingly this effect is not present in the case of women during a weekend. The extra work time is mainly taken from leisure.

Table 3 Average Allocation of Time (in minutes) and the Level of Education

Weekday	Male			Female		
	Basic	Secondary	University	Basic	Secondary	University
Market work	414	456	449	322	295	327
Housework	127	127	132	246	261	250
Studying	2	2	5	3	3	1
Personal care	488	491	489	522	527	522
Leisure	399	360	360	344	351	337
Weekend	Male			Female		
	Basic	Secondary	University	Basic	Secondary	University
Market work	131	103	53	53	52	62
Housework	161	176	209	275	290	288
Studying	1	1	2	0	5	4
Personal care	580	582	580	598	590	581
Leisure	557	572	592	507	504	500

Personal care seems to be invariant to the level of education. Biddle and Hamermesh (1990) argue in their article on sleep that the more educated sector of the population, who usually have higher earnings, try to

cut back on sleep. Women make up the only group where, with education, the amount of sleep decreases during a weekend. Interestingly, men with the highest education have the highest amount of housework both during a weekday and during a weekend. With women there is no clear trend in the amount of housework.

Overall, there seems to be little variation between the different aggregate time-use categories as identified by the educational level in Finnish households. This is especially the case with the time allocation of women. The lack of variation at the aggregate level indicates that approximately the same time is used in aggregate to leisure, housework and market work. This naturally hides the variation within the categories.[11]

The aggregate number of activities includes tasks related to market work, where hours of work and the type of activities are determined largely by the market place and not by the individual. Also many of the household tasks are manual and repetitive in the sense that a person does not have much choice as to whether or not to do them. These include, for example, cleaning and cooking. As we are mostly interested in the activities which an individual can freely choose to do, a measure that excludes the compulsory/necessary activities should be constructed.

Table 4 Distinguishing activities between work and non-work categories as per Gronau-Hamermesh

Work	Non-work
Market work	Child and family care
Cleaning	Personal care
Cooking	Leisure activities
Shopping	

Here, we follow Gronau and Hamermesh in dividing the total time use between work and non-work activities (table 4). This means that a part of the housework is categorized as work in the expanded sense and part of the housework as non-work. According to the Gronau-Hamermesh definition, work includes market work, cleaning and cooking and shop-

[11] There might be cultural variations in time use. In Gronau and Hamermesh (2001) data Swedish time use had the most equal division of time between spouses and educational categories.

ping, while non-work covers child and family care, personal care and leisure activities. Studying, sleeping and personal hygiene are excluded from the analysis. The variable they investigate is the number of different non-work activities an individual has engaged in during a day. [12]

With this schema on hand, we turn to the amount of different activities. The averages are shown in the table 5. During a weekday, out of 185 possible activities, the average Finnish male does approximately 15 different activities and the average woman 18. The first interesting thing to note is that if we look at the total number of activities, there is virtually no difference between weekdays and weekends when the examination is restricted just to men or just to women. However, women and men do, on average, one leisure activity more during a weekend than during a weekday. Second, if we look at the total number of activities, females engage in more activities than males; women do approximately 20 percent more activities than males. The difference is around 10 percent if we consider leisure activities only.

Table 5 Average Number of Total Activities and Pure Leisure Activities

	All Activities		Non-work Activities	
	Male	**Female**	**Male**	**Female**
Number of activities (weekday)	14.7	17.9	9.4	10.3
Number of activities (weekend)	14.7	17.6	10.6	11.3

It is not surprising that the average number of activities represents only about 10 percent of the possible 185 activities given/listed on the classification system. A characteristic feature in all conducted time-use studies is the limited number of activities in which a person participates versus the number of activities available across the countries. In the Fin-

[12] One difficult area in categorizing is activities related to travel. Is travel work or non-work? It might also be argued that travel should be incorporated in the activity that it is part of. In this paper, as in Gronau and Hamermesh's paper, travel is a separate activity. Therefore, an increase in travel related activities (due to living in suburbs, having access to car etc.) might be one reason for an increase in the number of different activities by the more educated.

nish data, the maximum number of activities done by an individual during a single day is 32 out of a possible 185. The theoretical maximum number of different activities in the Finnish data is 144, which corresponds to the total of the different 10-minute periods during a day. Gronau and Hamermesh (2001) note that in the datasets they use the coding of different activities ranges between 40 and 202, but in none of the datasets does a single person have more than 32 activities.

As can be seen from table 6, the total number of activities a person engages in increases with education. In the case of females, the increase in non-work activities alone accounts for this increase. With education there is increase in non-work activities for males, but also slightly in work activities. The overall increase in the total number of activities, when moving from basic level of schooling to academic schooling, is 13 percent for males and 8 percent for females. If we consider non-work activities only, we see that the increase is quite high (13-14 percent) in the move from basic education to university level education.

Table 6 Number of Activities by Educational Level

	Non-work		Work		Total	
	Male	Female	Male	Female	Male	Female
Basic	9.4	9.8	4.6	6.9	14.0	16.7
Secondary	9.7	10.9	4.6	7.1	14.3	18.0
University	10.7	11.1	5.1	6.8	15.8	18.0
%-change from lowest to highest	+14%	+13%	+10%	+-0%	+13%	+8%

It should be noted that the intervals at which time is measured can affect the number of activities recorded. As the measuring interval increases, all the shorter-term activities may not get recorded, which would bias the number of activities to include only those of longer duration. If more educated people are better able to participate in short duration activities, because of lower set-up costs, spreading out the data collection period would underestimate the number of activities of the educated.

One explanation for the increased number of activities recorded by people with more education might be that they are better equipped to provide more specific time-use categories in a time-use diary than

those with basic education. The European Harmonised Time-use Study Guidelines include instructions about how to code different time-use entries recording in the completed time-use diaries. If time use is reported in a very general way, it is documented in the 'unspecified' category. Detailed entries, however, are recorded in an appropriate category.

An example in table 7 illustrates this problem. In the category for 'Eating', there are five sub-categories: 'unspecified eating', 'meals', 'snacks and drinks', 'alcohol', and 'other specified eating'. If the diary entry simply states: 'I ate', this is listed in the 'unspecified eating' category, because it is impossible to know what kind of eating was done. However, an entry 'Had foie gras with a bit of champagne' will be tallied in snacks and drinks.

Table 7 Example of Coding Categories Used in Finnish Time-use Survey

02	Eating
020	Unspecified eating
021	Meals
022	Snacks and drinks
023	Alcohol
029	**Other specified eating**

If time use is described in a very general terms by people with elementary education, while it is described in a very detailed matter by those with higher education, then this will result in more variety being prescribed to the better education. The result will, thus, be a characteristic of the coding schema and need not have anything to do with actual variety of time use.[13]

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[13] One explanation for an increase in the variety of activities can be haste. If people are constrained in their time use, they might do activities in shorter periods of time. This would increase the number of activities for people who are in a hurry. If people with higher education are in more of a hurry, they would do more activities than those not pressed for time. However there is the problem of causality. Does the increase in the number of activities cause time-pressure or does time-pressure induce people to do more? See Essay 4 in this thesis.

We look at the average amount of unspecified time use identified according to different genders and by different educational levels (table 8). The unspecified categories are collected from each second digit aggregate category, including, for example, entries like unspecified eating, unspecified household upkeep and unspecified social life. We note that there is no clear trend between the different educational levels with regard to the length of unspecified time observed in the diaries. A notable increase is obvious for academic men, who have the highest amount of unspecified time use. In women, the amount of unspecified time use peaks for those with secondary education.

Table 8 Average Amount of Unspecified Time Use (in minutes) by Educational Categories

	Men	Women
Basic	125	125
Secondary	112	131
University	195	109

Variety can also manifest itself in the number of routine versus non-routine activities. Gronau and Hamermesh (2001) argue that if education increases the time-cost of the activities, then people with lower education should engage in more time-intensive activities, like sleep, rest and TV watching. As people with higher education engage in a greater number of activities, this should also increase the number of different activities done on a daily basis. This should increase a number of non-routine activities.[14]

In the Finnish data, the amount of non-routine activities can be measured by comparing the composition of activities between the two diary days recorded by each respondent. If the activity is done on both days, then we classify it as routine, whereas if it is conducted only during one of the diary dates, we classify it as non-routine. The breakdown is done only for non-work activities, because the other diary date is a weekend observation.

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[14] For an extensive treatment, see Hamermesh (2004).

Table 9 Routine versus Non-Routine in Non-Work Activities by Educational Level

	Male		Female	
	Routine	**Non-Routine**	**Routine**	**Non-Routine**
Basic	3	3.8	3.1	4
Secondary	3	4.1	3.4	4.4
University	3.2	4.7	3.4	4.8
%-change from lowest to highest	+7 %	+24 %	+10 %	+20 %

Table 9 presents the results. Both the number of routine and non-routine activities increases with education, and the effect is large, particularly when looking at the percentage. Looking just at the non-routine activities, going from elementary education to university level education, there is a 25 percent increase for men and 20 percent for women. Thus it seems that education has its biggest impact in these non-routine activities.

One explanation for the increase in non-routine activities by the more educated might be the location where they live. In Finland people with higher educational level tend to live in the urban areas rather than the rural areas. In urban areas more activities, especially non-routine, are available. The increase in variety is determined by supply and people with higher education are able to enjoy more variety.

Table 10 Variety and Residence

	Non-Work		Total	
	Male	Female	Male	Female
Urban	10	11	15	18
Semi-urban	10	11	15	18
Countryside	10	11	14	18
%-change	0	0	- 5	0

Table 10 presents the number of activities people do in different living environments. The effect between rural and urban is non-existent for females and there is a 5 percent drop in the total variety of men between the countryside and other areas. It is quite clear that the effects of supply have only a moderate impact on variety.

The number of activities a person engages in depends on the type of his/her household. As Hill and Juster (1985) note, there can be a division of labour between certain necessary and basic household chores in a multi-person household. This either leaves room for an increased number of other non-routine activities or more time for a given routine. Single person households do not have such freedom, as the individual him/herself must take care of the basic household chores.

It is possible in the time-use diary to record a secondary activity that is done alongside with the primary activity. A typical situation of multiple activities would be, for example, cooking a meal while watching the children. Usually in studies analyzing time-use data, only primary activities are considered. Gronau and Hamermesh are an exception as they also examine how secondary activities affect the estimates of the variety, when this possibility is available in the data. They note that including secondary activities does not change their results to a great extent.

In the Finnish time-use survey, 95 percent of the interviewees recorded some secondary activities. If compared with other time-use surveys, this is a high figure.[15] The impact of secondary activities can either dampen or increase the occurrence of variety between people with different educational levels. As there is some evidence to support the assumption that more educated people do more activities simultaneously[16], this could mean that even a greater amount of variety done by the more educated.

In order to study the effects of secondary activities, we combine secondary time-use information with primary time-use information by adding together both time-use elements into a given category. This enables us to circumvent the problem of duplicate identification of the same activities which occur in either the primary category or secondary category. For example, if child-minding is recorded as secondary activity in the morning and as primary activity in the evening, this is recorded as one activity only (child-minding) in our combined figure.

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15 In the Australian Time Use Survey from 1992, a secondary activity is reported only in 5 percent of the time use analysis. In the Swedish HUS data from years 1993-94, a secondary activity is reported in less than third of the time-periods during the day.

16 For example see Essay 4 in this thesis.

Table 11 Impact of Secondary Activities on Total Variety

	Male			Female		
	Primary activity	Primary + secondary combined	% Increase	Primary activity	Primary + secondary combined	% increase
Basic	14.0	16.7	+20%	16.7	19.9	+19%
Secondary	14.3	17.4	+22%	18.0	21.5	+20%
University	15.8	19.0	+20%	18.0	21.6	+20%

Looking at the combined figures, we see that secondary activities increase variety, and that the increase is distributed evenly across the educational categories (table 11). The incorporation of secondary activities increases variety by 20 percent for both sexes in all educational categories.

Although the increase in variety occurs all across the sample, the amount of the increase of the educational categories stays mostly the same regardless of either secondary activities are included or not. This can be seen in table 12, which shows an almost exactly same percentage change in variety as in the results when only primary activities are studied.

Table 12 Variety in Combined Primary and Secondary Activities by Educational Level

	Non-work		Work		Total	
	Male	Female	Male	Female	Male	Female
Basic	11.8	12.6	5.0	7.2	16.7	19.9
Secondary	12.5	14.1	5.0	7.4	17.4	21.5
University	13.5	14.4	5.5	7.3	19.0	21.6
%-change from lowest to highest	+14%	+14%	+10%	0%	+14%	+9%

Another area within time use that has a similar response to human capital is multitasking, i.e. many activities are done at the same time. Multitasking also requires coordination and switching between activities, and it can thus be used to investigate the effect of education on time use. In

order to see whether Gronau and Hamermesh's hypothesis is supported by multitasking, we combine housework and leisure and examine at the amount of time used in multitasking by educational categories. The results are presented in table 13.

Table 13 Effect of Education on Multitasking in Minutes and in Percentages

	Minutes		% of available time	
	Male	Female	Male	Female
Basic	137	180	22 %	26 %
Secondary	160	220	26 %	31 %
Academic	195	237	30 %	35 %

We see that both males and females with an academic degree spend approximately an hour more per day in multiple activities than people with elementary education. The increase in percentages is even more pronounced, because people with higher education have less time for housework and leisure. Moving from elementary education to academic education, the incidence of multitasking increases from 22 to 30 percent in the case of men. In the case of women this increase is from 26 percent to 35 percent. This seems to imply that more educated people do more activities simultaneously.

6 Econometric Methods

The number of activities people engage in during a given time period is an integer count variable, which gives rise to a non-normal distribution, especially if the number of counts is not large. There is a large and increasing literature on the use of count data models in econometrics.[17] In

[17] See for example Wooldridge (2002) chapter 19 and Greene (2003) chapter 21.9. For a definite treatment see Cameron and Trivedi (1998).

count data a dependent variable y_i can have only nonnegative integer values. Usually the application of count data models begins by examining whether the data satisfy the assumptions of the Poisson distribution. The probability function of Poisson distribution for y_i-variable is:

$$\Pr(y_i) = \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!}, \quad \text{for} \quad i = 0,1,2,...,n$$

where λ_i is the rate or exposure parameter defining the shape of the distribution. It is usually formulated as loglinear model $\ln \lambda_i = \mathbf{x}_i'\boldsymbol{\beta}$. A major problem with the Poisson regression models is that the assumption has to be made on the conditional variance equalling the conditional mean:

$$var(y|x) = E(y|x)$$

As Wooldridge notes (2003, 646) this assumption has been rejected in numerous cases and is violated for fairly simple departures from the model. The variance is usually more than the mean, in which case there is a problem of overdispersion. In order to decide what model to use, a test of overdispersion must be carried out.

Cameron and Trivedi (1990), in their paper on testing for overdispersion in Poisson models, propose a regression based test, which is straightforward to implement. A statistic z_i is calculated by using a fitted values $\hat{y}_i$ from the Poisson estimation:

$$z_i = \frac{(y_i - \hat{y}_i)^2 - y_i}{\hat{y}_i\sqrt{2}}$$

Then z_i is regressed on a constant. The test of overdispersion will be the test of following hypothesis:

$$H_0 : V(y) = E(y)$$

$$H_1 : V(y) = E(y) + \alpha g(E(y))$$

The goodness of fit is tested by using the following test based on deviances of Poisson estimation. The Poisson log likelihood is given by:

$$\ln L(\beta) = \sum_{i=1}^{n} \left\{ -e^{\mathbf{x}_i\beta} + (\mathbf{x}_i\beta)y_i - \ln(y_i!) \right\}$$

The Poisson log likelihood attains its maximum (and the function its minimum) at the point.

$$\ln L_{\max} = \sum_{i=1}^{n} \left\{ -y_i \left\{ \ln\left(y_i\right) - 1 \right\} - \ln\left(y_i!\right) \right\}$$

Then the goodness of fit can be tested by chi-statistic.

$$\chi^2 = -2\left\{ L\left(\beta\right) - L_{\max} \right\} \sim \chi^2$$

If either of these tests is rejected, then a negative binominal model should be used instead of Poisson model.

In negative binominal model the heterogeneity found in the data is taken into account. The generalization is achieved by introducing into a Poisson model an unobserved individual effect μ_i into the conditional mean:

$$\ln \mu_i = \mathbf{x}_t'\boldsymbol{\beta} + \varepsilon_i = \ln \lambda_i + \ln u_i$$

where the disturbance ε_i can result from specification error or cross-sectional heterogeneity. Then the distribution of y_i that is conditioned on $\mathbf{x}_i$ and u_i remains Poisson with conditional mean and variance .

$$f\left(y_i \middle| \mathbf{x}_i, u_i\right) = \frac{e^{-\lambda_i u_i}\left(\lambda_i u_i\right)^{y_i}}{y_i!}$$

The unconditional distribution $f(y_i \mid x_i)$ is expected value over u_i

$$f\left(y_i \mid x_i\right) = \int_0^{\infty} \frac{e^{-\lambda_i u_i}\left(\lambda_i u_i\right)^{y_i}}{y_i!} g(u_i)\, du_i$$

The density of u_i is usually taken to be gamma distributed. This will result after some manipulation in an estimable negative binominal density that has mean λ_i and conditional variance $\lambda_i\left(1+\left(1/\theta\right)\lambda_i\right)$, where θ is an inverse of a variance of a gamma distribution where $E(u_i)$ is set to unity.

There is various ways in which this kind of model can be estimated. The most popular is using likelihood based methods. The other alternatives are generalized linear (GLM) or moment-based methods.

However, as Cameron and Trivedi (1998) note, the use of maximum likelihood requires a complete specification of the distribution. The resulting interference is based on the assumption of correct specification. By

using a less parametric analysis makes it possible to relax this stringent condition. Cameron and Trivedi (1998) note that consistency of maximum likelihood estimation can be maintained for some specific densities even if the model is partially misspecified. One such class of densities arises from generalized linear models, developed by Nelder and Wedderburn (1972). In this framework a pseudo maximum likelihood is used, where some of the moments in the distribution are permitted to be incorrectly specified.[18]

Therefore in this paper a method of generalized liner models is used to derive our results.

When GLM framework is used to estimate a model, then a linear predictor is mapped through a so called link function to model the mean of a dependent variable that has a distribution belonging to exponential family of probability distributions.[19] In negative binominal case the link function is logarithmic and distribution family is exponential representation of negative binominal distribution. This corresponds to Cameron and Trivedi's (1998) negative binominal model II.

Furthermore, as the amount of activities in our dataset is always more than zero, there is no need to use Tobit-model, which is often used with time-use data. However, as there are no zero counts in our data, it might instead be necessary to use zero truncated Poisson model in our estimation. If our average number of activities were close to zero, this would be appropriate. However, our average count is very large and the resulting Poisson distribution resembles normal distribution.[20]

7 Specifications Used

We use the following empirical specification for our estimation of the number of activities:

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[18] There is other, computational aspects, that also make generalized linear models desirable. See Cameron and Trivedi (1998, 35-36)

[19] See Hardin and Hilbe (2001).

[20] Even theoretically the probability of predicting zero counts is very low. It is also possible/feasible, as Hardin and Hilbe (2001, 131) note that estimates and standard errors do not greatly differ between standard Poisson and zero truncated Poisson models. When we estimate the total number of activities by the zero truncated Poisson method, the coefficients and standard errors are identical with the standard model to the fifth digit. Therefore we resort back to standard count models.

$$E(y|\mathbf{x},\mathbf{z},\mathbf{m}) = \exp\left(\mathbf{x}\boldsymbol{\alpha} + \mathbf{z}\boldsymbol{\beta} + \mathbf{m}\boldsymbol{\chi} + \varepsilon\right)$$

where *y* is either the number of leisure activities or the total number of activities, **x** stands for a vector of economic variables, **z** stands for a vector of educational variables and **m** stands for a vector of demographic dummy variables. The ε is the error term. The vectors of coefficients **α, β, χ** will be determined by estimation.

The economic variables used in our estimation are the net hourly wage rate of the person and his/her non-labour income. As the net hourly wage rate is the price of time, we assume that the higher the wage rate, the more variety people will try to get into their time use. The non-labour income has a normal income effect on the variety, so the effect should be positive.

The most important variable with regard to this study are educational levels, which are the proxies for human capital. As in our estimation the basic level is the base case, there are two dummies for educational attainment. We expect that the increase in educational level will increase the variety in time use.

We employ a number of dummy variables to take into account the structure of the time-use data, and also introduce four control variables for seasonal variation. Also as each person has two diary dates, a weekday and a weekend day, we have dummy for a weekend. [21]

There is also a set of demographic variables, which are dummy variables for age cohorts, the number of children in the family, for being disabled and for being unemployed or taking care of the household. Also dummies for living in a semi-rural area or countryside are used to control for the supply of activities.

We correct for clustering in case of households and weight the sample. As Wooldridge (2003, 133) notes, the data at hand have a very simple structure: a large population of relatively small clusters. In this study the effect of clustering is corrected by calculating modified sandwich estimators for variance. The weights used in the estimation are population weights composed by Statistics Finland.

There are a number of ways in which the goodness of fit of count data model can be measured. One of these is McFadden's (1974) likelihood ratio index, which has following form:

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[21] Due to the different recording days among the datasets, Gronau and Hamermesh use dummies for each day of the week.

$$R^2_{McFadden} = 1 - \frac{L_{full}}{L_{only.cons}}$$

Where L_{full} denotes the log-likelihood of the full model and $L_{onlycons}$ denotes the log-likelihood of the equation where only a constant is included in the estimation. The interpretation is the same as with ordinary R^2: the bigger the number the more of the variance is explained by the function.

There are also many different residual measures that can be used in post-estimation analysis in the case of count data models. One of the most popular is Anscombe residuals, which have been defined for different distributional families.[22]Anscombe residuals should have a normal probability density and the plot of Anscombe residuals versus fitted values should not show any systematic differences. We also investigate the fit of the model with deviance residuals.

For count data models, Pregibon (1980) proposes a link test for assessing the potential misspecification in functional specifications, whereby fitted values of the estimation are squared and the function is re-estimated with the squared residuals. If there is no misspecification then squared residuals have no explanatory power.[23]

8 Results

Whether the number of activities follows a Poisson process can be investigated by comparing the dispersion of the numbers from the data with those generated by the Poisson process. This is done in figures 1 and 2. When the total number of activities is used, then there seems to be slight overdispersion in the counts from data vis-à-vis those produced by true Poisson process. When only leisure activities are considered, then the data seem to be characterised by underdispersion.[24]

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22 See Table A.9 in Hardin and Hilbe (2001, p.229).

23 Another—and more popular—possibility is to use RESET-test. However, the test available cannot take survey structures into account and therefore is not used.

24 We also estimate the same specifications by ordinary least squares; the results do not change to a great extent.

The determinants of variety in total time use and in leisure time use are first estimated with Poisson specification. Then the tests of overdispersion and the goodness-of-fit are conducted. In all cases, the assumption of Poisson process is rejected. These results are given in Table 14. Therefore the negative binominal model is used to estimate the models. Total leisure activities are used first as dependent variables, after which work-related activities are used in the estimation.

Table 14 Overdispersion and Goodness of Fit tests for Poisson Models

		Cameron & Trivedi overdispersion test		Deviance based goodness of fit	
		t-value	P>|t|	chi2(22,3114)	P>chi2
Non-Work	**Male**	16.07	0.000	530716	0.000
	Female	24.95	0.000	445598	0.000
Total variety	**Male**	3.41	0.001	728147	0.000
	Female	-3.03	0.003	548802	0.000

The diagnostics of our estimations using negative binominal models are encouraging as shown in the Table 15. The normality of Anscombe residuals could not be rejected. Also Pregibon's link test shows no evidence of misspecification. The estimations have a low explanatory power, as is usually the case. For total number of activities, the McFadden likelihood ratio index is only around 1.5 percent.

Our results for variety in non-work activities are presented in Table 15. They show that educational variables are significant in explaining the amount of different activities a person engages in. This corroborates the first part of the Gronau and Hamermesh hypothesis (2001) of the possible role of human capital in increasing the ability to pursue many activities.

Table 15 Estimation Results for Variety in Non-Work Activities by Gender

	Male	*Female*
Net wage rate	**0.002** **(0.452)**	0.001 (0.565)
Non-labour income	**0.000** **(0.693)**	-0.001 (0.138)
Age 35-44	**-0.064** **(0.165)**	-0.076** (0.048)
Age 45-54	**-0.028** **(0.650)**	-0.043 (0.389)
Age 55-64	**-0.067** **(0.344)**	-0.080 (0.177)
Secondary education	**0.054*** **(0.060)**	0.118*** (0.000)
University education	**0.079*** **(0.100)**	0.127*** (0.001)
Number of children	**0.022**** **(0.022)**	0.059*** (0.000)
Semi-rural	**-0.024** **(0.356)**	-0.014 (0.553)
Countryside	**-0.051*** **(0.068)**	-0.026 (0.299)
Unemployed	**0.117**** **(0.011)**	0.055 (0.141)
Homekeeper	**0.450***** **(0.000)**	0.073*** (0.005)
Disabled	**0.051**** **(0.019)**	0.065*** (0.001)
Weekend	**0.111***** **(0.000)**	0.092*** (0.000)
Winter	**-0.007** **(0.802)**	0.009 (0.721)
Summer	**0.040** **(0.192)**	0.032 (0.212)
Fall	**-0.046*** **(0.079)**	-0.012 (0.593)
Constant	**2.063***** **(0.000)**	2.108*** (0.000)

Observations	**1568**	1568
Log pseudo likelihood	**-2 033 226**	-1 501 234
Deviance/df	**32.9**	25.6
McFadden R^2	**0.013**	0.018
Pregibon's link test	**P>|z| 0.910**	P>|z| 0.575
Sfrancia test with	**z = 0.524**	z = -0.240
Anscombe residuals	Prob> z 0.300	Prob> z 0.595

Robust p values in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

However, in the case of non-work activities, there is no evidence to support the second part of Gronau and Hamermesh's hypothesis that the cost of time makes people try to economize on time-intensive activities. Our results indicate that the net hourly wage rate and non-labour income do not have an effect on the number of non-work activities people engage in. Our estimations indicate that the second part of the Gronau and Hamermesh hypothesis is not supported in the case of Finland.[25] As we will shortly see, this is not the case when total activities, or primary and secondary activities combined, are considered.

With non-work activities, the only significant cohort dummy is for 35-45 years old females. The effect on the number of activities is negative. We test the combined significance of all age dummies and find that they do not explain variety.

The presence of children in the family is expected to have a significant positive effect on the number of activities and this is indeed the case.

[25] Gronau and Hamermesh obtain weak support from some countries on the role of economic variables, but the effects are negligible.

Weekend increases the number of non-work activities. As is seen in the table 5, the total number of activities changes very little between a weekday and a weekend. As expected, during weekend the number of non-work activities increases while work-related activities decrease. This result is in line with Gronau and Hamermesh, and more different non-work activities are done during a weekend. There is a statistically significant negative effect on the number of non-work activities done by males living in countryside; other than that, the dummies for semi-rural area and countryside are not significant. This is as expected; as table 10 indicates, there is almost no change in the number of activities according to living environment. The only significant seasonal dummy is the fall season in case of males, and its effect is negative.[26]

The change in the number of activities caused by changes in the explanatory variables can be investigated by calculating the marginal effects at the mean values of the variables. In the GLM estimation, marginal effects are calculated by first taking the inverse link of the linear prediction and then using numerical simulation with sample values to derive marginal effects. These are presented in table 16. Looking at just the number of non-work activities, their average number during a weekday is 9.7 for a male with basic education, and for a corresponding female 10.6. An academic education increases the number of activities by 1.4 in case of females and 0.8 in case of males. The weekend introduces one activity more. The effect of children is moderate, only around 0.2 to 0.6 activities per child, but the presence of children increases the activities of females more. Interestingly, the men who are staying home have a huge increase in the number of non-work activities, the addition being almost six different activities per day. In the case of females it is less than one.

So the number of non-work activities for a childless male with basic education is estimated to be on average 9.7; in contrast an academic woman with two children has 13.2 activities during a day. The difference is almost three and half activities or 36 percent more.

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[26] We use the indicator of feeling time-pressure as an explanatory variable in our preliminary estimations. It is subsequently dropped because it did not turn out to be significant in any of the estimations. Therefore the increase in the number of activities cannot be explained by people being in a hurry and therefore being economical with their time. As the feeling of haste is correlated to the educational level, it is also possible that a part of the effect of time-pressure is captured by educational variables.

Table 16 Effect of Different Demographic Factors on Number of Non-Work Activities

	Number of Non Work Activities	
	Male	**Female**
Average number of activities	9.7	10.6
Secondary schooling	+0.5	+1.3
University	+0.8	+1.4
Each child	+0.2	+0.6
Weekend	+1.1	+1.0
Unemployed	+1.2	-
Housekeeper	+5.5	0.8
Disabled	+0.5	+0.7

To look at the total variety, which includes both non-work and work activities, we estimate the model with total variety as a dependent variable. The results are presented at appendix 1. The results change, in that the net wage rate now becomes positively statistically significant and only secondary education is statistically significant for both genders. The reason for this is that work-related activities, where income has a stronger effect, start to influence the amount of variety.

We estimate the same model using variety in non-work, with both primary and secondary activities included as a dependent variable. The estimation results are shown in appendix 2. The inclusion of secondary activities makes the net wage rates statistically significant. The effect of educational variables is still significantly positive. And moreover, all age-cohort variables for females turn out to be significant when secondary activities are included in the estimation.

In order to determine whether the educational level affects the amount of unspecified time use, we estimate a Tobit model, identifying unspecified time use in minutes at an hourly wage rate, non-labour income, educational level, age cohorts, and a set of other demographic variables. Estimation results by gender are presented in appendix 3. The Tobit model needs to be used because over 70 percent of the respondents have no unspecified time use recorded. We then test to determine

whether income variables, educational variables or age-cohort variables are significant in explaining the differences in unspecified time use. It is interesting to note that educational variables are jointly significant in explaining unspecified time use in case of men, while in case of women, the age-cohort variables are jointly significant. In both cases, however, the effect is positive: better educated men record more unspecific time use, not less as could have been expected. In the case of age-cohorts, older women record more unspecified time use. Therefore, it can be said that the coding does not bias the results in favour of those with higher educational level.

9 Conclusions

This study investigates the relationship between the levels of education and the number of activities people engage in. The amount of education is taken in this context to be a proxy for an amount of human capital. The theory advanced by Gronau and Hamermesh (2001) is that people with higher amounts of human capital are better able to switch from one activity to another and are thus more efficient in doing different activities. Furthermore, because their leisure time activities have a high opportunity cost, they prefer activities that are goods-intensive rather than time-intensive, thus also increasing the number of different activities done.

We note that in Finland the number of activities people participate in raises with the level of education. This is also the case in almost all the other countries studied. The only exception noted thus far is the case of the men in Sweden, and in this respect the Finnish men differ from their Swedish counterparts.

Although people with higher education have less leisure in total than those with lower education, the higher educated still enjoy more variety in their time use. This increase in variety is present both in work and non-work activities. Women have more variety than men and this fact cannot be explained solely by child-care activities. The presence of children increases the number of activities only marginally vis-à-vis to the effects from other demographic factors.

One part of the Gronau and Hamermesh's theory is the role of wage rate and non-labour income in increasing the time-costs of time-intensive non-work activities. Both should increase variety. When we

examine non-work variety with the net hourly wage rate and non-labour income, we observe that the income variables have no role in the determination of activities. It is the educational variables that have an impact. However, when we look at the total number of activities, both work and non-work related activities included, the net wage rate turns out to be statistically significant.

The variety in time-use is decomposed into variety according to routine and non-routine activities. It is the non-routine activities that increase the most. We also study to see whether time pressure as measured by experiencing haste explains the variety in time use, but time pressure is not significant in this regard.

Multitasking, or doing many activities at the same time, does not affect our results. Multitasking increases variety by a fifth, but this happens across the sample. Also the place of residence or seasonality has no affect on the number of activities people engage in.

We also test to determine whether the increase in variety can be explained by the possibility that the more educated are better able to give a detailed reporting of their activities. Our results show that this is not the case. In contrast, men with a higher educational level report more unspecific activities in their time-use diaries.

Appendix 1 Estimation Results for Variety in Total Activities by Gender

	Male	*Female*
Net wage rate	0.005** (0.020)	**0.005**** **(0.017)**
Non-labour income	-0.001 (0.125)	**-0.001*** **(0.081)**
Age 35-44	-0.058* (0.056)	**-0.059*** **(0.054)**
Age 45-54	-0.053 (0.196)	**-0.053** **(0.203)**
Age 55-64	-0.103* (0.055)	**-0.104*** **(0.058)**
Secondary education	0.069*** (0.001)	**0.070***** **(0.001)**
University education	0.017 (0.573)	**0.015** **(0.635)**
Number of children	0.043*** (0.000)	**0.044***** **(0.000)**
Semi-rural	-0.003 (0.852)	**-0.004** **(0.828)**
Countryside	-0.011 (0.575)	**-0.009** **(0.657)**
Unemployed	0.005 (0.863)	**0.003** **(0.909)**
Homekeeper	0.039* (0.098)	**0.040** **(0.100)**
Disabled	0.031* (0.066)	**0.031*** **(0.064)**
Weekend	-0.022** (0.028)	**-0.021**** **(0.037)**
Winter	0.015 (0.474)	**0.015** **(0.451)**

Summer	0.038* (0.069)	**0.039*** **(0.063)**
Fall	0.009 (0.661)	**0.008** **(0.698)**
Constant	2.535*** (0.000)	**2.519***** **(0.000)**
Observations	1568	**1568**
McFadden R^2	0.035	**0.028**
Pregibon's link test	P>|z| 0.900	**P>|z| 0.464**
Sfrancia test with	Z = -3.39	**Z = 0.783**
Anscombe residuals	**Prob> z 0.996**	**Prob> z 0.217**

Robust p values in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix 2 Estimation Results for Variety in Non-Work Activities for both Primary and Secondary Activity Combined

	Male	Female
Net wage rate	0.001** (0.012)	0.001* (0.051)
Non-labour income	0.001 (0.244)	-0.001 (0.201)
Age 35-44	-0.033 (0.232)	-0.062*** (0.007)
Age 45-54	-0.033 (0.234)	-0.065** (0.011)
Age 55-64	-0.091*** (0.009)	-0.107*** (0.001)
Secondary education	0.061** (0.015)	0.107*** (0.000)
University education	0.094*** (0.001)	0.113*** (0.000)
Number of children	0.018** (0.047)	0.050*** (0.000)
Semi-rural	-0.030 (0.215)	-0.015 (0.487)
Countryside	-0.049* (0.056)	-0.013 (0.563)
Unemployed	0.086** (0.032)	0.023 (0.551)
Homekeeper	0.384*** (0.000)	0.041 (0.109)
Disabled	0.047** (0.017)	0.055*** (0.003)
Weekend	0.086*** (0.000)	0.062*** (0.000)

Winter	-0.012 (0.618)	0.004 (0.867)
Summer	0.019 (0.497)	0.030 (0.197)
Fall	-0.044* (0.071)	-0.001 (0.955)
Constant	2.385*** (0.000)	2.435*** (0.000)
Observations	1574	1574
Log pseudo likelihood	-2 183 245	**-2 242 774**
McFadden R^2	0.029	**0.035**
Pregibon's link test	P>|z| 0.948	**P>|z| 0.848**
Sfrancia test with	z = -0.190	**z = 0.074**
Anscombe residuals	**Prob> z 0.575**	**Prob> z 0.470**

Robust p values in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix 3 Tobit Estimation Results for Unspecified Time Use

	Male	Female
Net wage rate	0.080 (0.924)	**-0.435** **(0.565)**
Non-labour income	0.067 (0.657)	**0.010** **(0.952)**
35-44	5.705 (0.672)	**1.993** **(0.850)**
45-54	15.746 (0.366)	**26.562*** **(0.059)**
55-64	12.227 (0.566)	**3.707** **(0.837)**
Secondary level	2.773 (0.729)	**11.049*** **(0.090)**
University level	29.274** (0.046)	**7.750** **(0.477)**
Number of children	2.651 (0.370)	**3.991** **(0.115)**
Semi rural	2.983 (0.711)	**5.202** **(0.407)**
Countryside	-11.044 (0.164)	**-0.510** **(0.935)**
Unemployed	17.971 (0.244)	**5.123** **(0.564)**
Homekeeper	11.896 (0.778)	**14.586*** **(0.072)**
Disabled	4.395 (0.486)	**4.815** **(0.327)**
Weekend	0.798 (0.888)	**-5.592** **(0.216)**
Winter	18.391** (0.020)	**1.116** **(0.860)**

Summer	-9.890 (0.234)	**-4.386** **(0.499)**
Fall	0.513 (0.948)	**-1.714** **(0.784)**
Constant	-84.170* (0.053)	**-37.985** **(0.230)**
Observations	1568	1568

p values in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 1. The Total Number of Activities versus Poisson Prediction

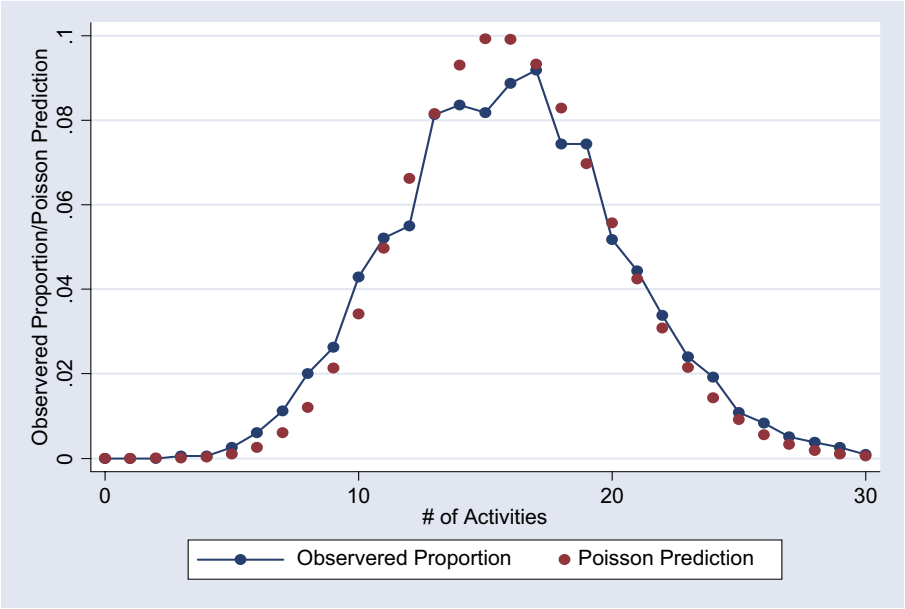
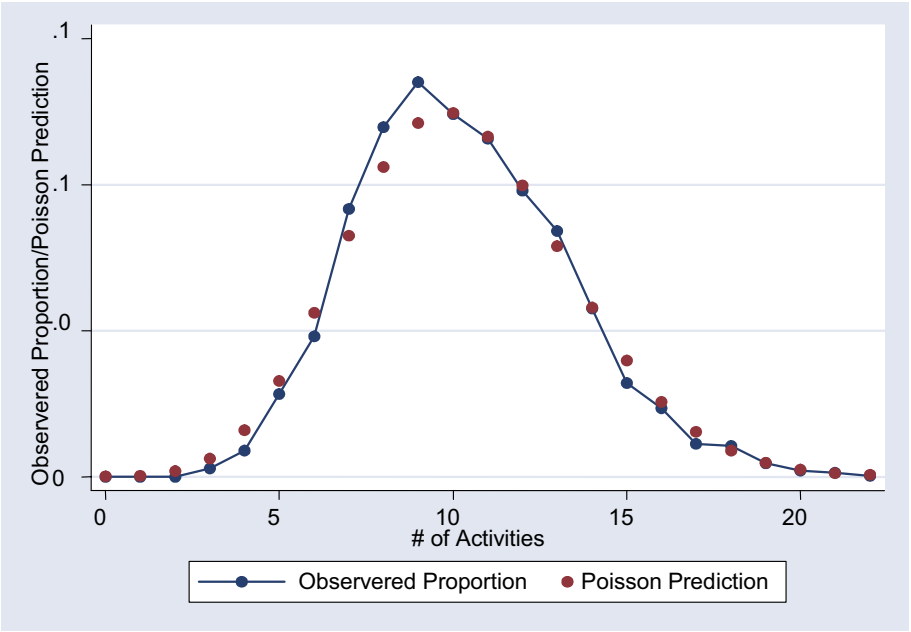


Figure 2. The Distribution of Non-Work Activities versus Poisson Prediction



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ESSAY 3.

Active Life during Leisure Time – Are the Winners Taking it All?

Abstract:

We look at the composition of leisure activities by investigating whether education affects the time spent on active versus passive leisure, using Finnish Time Use Survey from 1999/2000. Tobit and multivariate probit are used to investigate the composition of leisure time. We get strong evidence that education reduces the time spent on passive leisure but increases the time spent on active leisure. Within active leisure, the highly educated have a higher propensity to participate in cultural activities and women have a higher propensity for sports.

1 Introduction

In the labour economics literature the increase in human capital that is achieved by educating oneself is rewarded with higher wages. Therefore people are ready to forgo immediate rewards of working for pay to study and reap the benefits of high wages later. But is human capital increased just by going to school? Why would markets not reward other productivity-enhancing characteristics of the person, like good physical condition, polite manners, or language skills? If an active lifestyle is rewarded in the market, then there should be an incentive for people to spend more time in these activities.

This would mean that the choices between the different activities that people engage in during their leisure time are partly dictated by economic rewards. If human capital has an effect on the choice of different leisure activities and if the level of education is taken as a proxy for human capital, then there would be differing leisure activities between people with elementary education and those with higher education.

This difference has been noticed in sociological literature. For example there are some contributions (Robinson and Godbey 1997, Gershuny 2000 and Toivonen 2003) on the widening gap of the amount of time spent by different socio-economics groups watching television.

The choice between different leisure activities has typically been modelled as arising from the economic costs rather than the benefits of different activities. In general, the demand for leisure can be perceived as similar to the demand for any other commodity. Different leisure activities have different explicit prices and given the preferences and income, utility maximization leads to a choice of some of these activities. People with higher education usually have higher income and can thus afford more expensive leisure activities (like opera-tickets). The difference in disposable income leads to different leisure allocation. This kind of approach is employed by Kooreman and Kapteyn (1987) in their study of time allocation.

This type of demand system analysis concentrates on the explicit price of different leisure activities. In human capital literature, it is the productivity-enhancing aspects of different activities that are used to motivate economic investigations. Recently Fahr (2004) has argued that the more educated people spend their leisure time on informal education which further increases their human capital, thus enabling them to command higher wages. Furthermore, a higher market wage rate induces people do more market work, which reduces leisure. The result of this is a greater propensity of people to spend time out of the total leisure in pursuing informal education.

However, informal education need not be the only productivity enhancing activity. An earlier contribution by Biddle and Hamermesh (1990) uses similar logic to analyse the allocation of sleep.

If informal education, which can be mentally very demanding, and sleep, which is not demanding at all, both have a positive effect on wage rates by increasing productivity, then the issue is that all leisure, whether active or passive, can be said to have a similar effect. This fact is also commented on by Klevmarken (1998) in his survey of time use studies. Some kind of distinction between the different components of leisure should be constructed.

In addition to differences in incentives caused by different wage rates, people with higher educational level might have a preference for more active leisure than people with basic education. For example Fahr (2004) gets a result that preferences are more important in explaining the demand for informal education than increase in productivity. This is also

noted by Jenkins et al. (2002) who in their study of lifelong learning observe that people with longer education participate in more courses. People with higher education seem to like to read technical manuals during their free time.

The purpose of this paper is to study further the effects of human capital on the choice of leisure. We concentrate on the decision to participate in active versus passive leisure. We divide leisure to two different groups. One encompasses all leisure activities with an active element such as sports, organizational activities, volunteer work etc. The other group includes all passive leisure, like watching TV and resting. To check the robustness of our results, we also employ a narrower set of active leisure categories which excludes social activities, outdoor activities or those cultural activities that can be viewed on TV.

First we determine whether education has an impact on the amount of active and passive leisure. Then we specify whether education has an effect on the probability of participating in different types of active leisure. In our investigation we use the Finnish Time Use Survey from the year 1999/2000 with matched income and taxation records, which has two useful sets of data for this type of study. First, it has time diary data, which can be used to calculate the time spent in different activities. Second, it includes an interview part, where the respondents have indicated a number of activities the have done over the last 12 months. This can be used to study further the composition of leisure.

It is interesting to examine whether the educational variables or income variables can explain the allocation of time into these activities. A natural problem in using income and education is that they are correlated. Better educated people tend to have higher wages. However, it is interesting to see which variables are driving the results.

The use of leisure has important ramifications for the whole society. If people with basic education are disadvantaged also in their leisure choices the polarization of the society will increase with regard to those who have high education, better incomes, good health and more rewarding past-time and to those who do manual work, have poor health and passive leisure. The risk of health problems, like poor physical shape and overweight, increases with passiveness. These health problems impose a cost to the society because of lowered productivity in the marketplace and increased health costs to society.

This raises the question of the nature of leisure. Should leisure be viewed as utility or productivity enhancing? If a person gets the most utility by choosing to watch TV, who should bear the consequences of

the negative externatility like overweight and poor physical condition. If some people prefer to read complicated technical manuals during their spare time, should this positive externatility be rewarded?

By studying the factors that affect the quality of leisure, it might be possible to construct measures to counter the negative trends and enforce positive ones.

2 Previous Empirical Literature

If human capital affects the amount of education chosen, does human capital also have an effect on the quality of the activities chosen during leisure? Is it the case that people with human capital tend to allocate time to activities which are demanding both mentally and physically or does human capital that is overused in market work result an increase in passive leisure activities?

Gershuny (2000) points out, that in passive leisure there is a clear divergence between people with high and low education.[1] Gershuny defines passive leisure as viewing television or videos or listening to music. The amount of time spent in these activities has grown in all socio-economic groups but the increase has been substantial in individuals with limited education but quite moderate in highly educated people. This has led to a marked difference between educational groups. Toivonen's (2003) study on the determinants of the increase in the TV-viewing in Finland gives similar evidence.

In their book, Robinson and Godbey (1997) study the change in time use in the United States from 1965 to present. As an example of passive

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1 Analysing multinational time use data Gershuny (2000) finds three major convergences in time use in developed countries since the 1960's. The first one is the convergence in time use between different countries. The reduction in the hours of market work and increase in leisure have resulted in quite constant shares being devoted to these activities in developed countries. The second convergence is between genders. As women have started to participate in labour force, time use between men and women has become similar. The third convergence is between socio-economic groups. The time use between those in upper layers of society is starting to resemble those in the lower deciles. But, according to Gershuny, there has been a reversal. Previously those in the upper deciles of society had more leisure and less work but now they have more work and less leisure than those in the lower deciles of the society.

leisure, they examine the amount of television viewing and find strong negative effect of education on the time allocated to TV viewing. In the United States high school educated people watch twice as much television as those with a university degree.

It is understandable that the interest in these research studies concentrate on watching TV, because it stands out among leisure activities. Almost 40 percent of the time devoted to leisure is used to watch television as a primary activity in Finnish households. If television viewing as a secondary activity is taken into account, this figure increases by 20 percent to 48 percent. According to Niemi and Pääkkönen (2002) the increase of the share of TV constitutes the biggest change in leisure during the 1990's. This observation mirrors more or less the other developed countries as well. Therefore the active/passive time use depends quite heavily on the development of TV viewing.

At the same time as TV viewing has increased its share of time use, there has been a reduction in the time used for reading and socialising. However, leisure activities have not changed solely towards passive forms of leisure. Interestingly, the time used for sports and outdoor activities has increased during the 1990's. Another new activity that has increased especially among adolescents is the computer.[2]

In applied econometrics literature, a demand system based approach for choice of leisure is employed by Kooreman and Kapteyn (1987). They construct a flexible form specification for the demand system with seven different time use categories: three housework activities, three leisure activities and market work. They model this choice at a household level having both male and female wage rate as the price of time. They concentrate on the effect of wage rates on the amount of time spent in these different time categories. Their sample include 242 households from the Panel Study of Income Dynamics from year 1975/76 in their data.

The effects of education on time use obtained by Kooreman and Kapteyn (1987) are interesting. The education of the male has a positive effect on the time spent on watching TV, listening to a radio and reading books. Male education decreases time for entertainment and social activities. Female education had an opposite effect: the time uses for entertainment and social activities increased and TV watching, radio listening and reading books decreased.

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[2] Niemi and Pääkkönen (2002) note that Finnish children aged 10-14 years spend a third of their free time with computers.

As to income variables, Kooreman and Kapteyn note that male time use is very inelastic but female time use is elastic to changes in wage rates.

Biddle and Hamermesh's (1990) paper on sleep and the allocation of time concentrates on a narrower set of activities than Kooreman and Kapteyn. Building on the household production modelling framework, they show that wage rate has a negative impact on the amount of sleep. People with high opportunity cost of time tend to economize on sleep.

In their study on the demand for sleep Biddle and Hamermesh (1990) use three general categories. The first is simply sleep, second includes sleep, naps and resting and the third includes sleep, naps, resting and a category 'labelled miscellaneous personal activities' which includes sexual activities and affection. If sleeping, napping and resting can be termed as passive leisure, then Biddle and Hamermesh show that education reduces the time spent on these activities. However, they do not include market work hours in their estimation, so the decrease in sleep can be the effect of increased time in market work. Biddle and Hamermesh used 706 households from the Panel Study of Income Dynamics from year 1975/76.

Their main empirical estimation has two demand equations: one for sleep, naps and resting and one for remaining leisure and housework combined. They do not include educational variables, but use wage rate, which can be considered to reflect also human capital factors. They note that the higher wage rate decreases the time used for sleeping. Interestingly for the whole sample, the wage rate has the same effect also on the remaining leisure and housework combined. The hypothesis that the effects are equal can not be rejected. With men the increase in wages does not change hours of work but does increase other leisure and reduces sleep. With women the increase in wages does not reduce sleep but increases market work and decreases other leisure.

Biddle and Hamermesh's (1990) conjecture that the amount of sleep reacts to economic incentives is corroborated with Finnish time use data. Finnish time use data show that during an economic upturn in the late 1980's, the hours spent sleeping decreased from the earlier decade but rebounded during the recession in the 1990's. Women usually sleep longer than men. The variance in sleep times has also increased in Finland. There are more people who sleep less than 7 hours than those who sleep more than 11 hours. Interestingly, Niemi and Pääkkönen (1992) note that the length of sleep does not react to seasonality. People who sleep longer, sleep longer regardless of whether it is a dark winter day or a sunny summer day. Looking at the time use of retired Finns,

Niemi (2003) finds out that retired people sleep one hour longer than those who are still in the labour force.

Fahr (2004) concentrates on the time investment in productive leisure activities. He has two definitions for this kind of productive leisure. The narrower definition includes educational activities after-work and after-work courses, while wider set also includes reading newspapers, journals, hobby literature, working with computer and participating in work-related activities after work.

He offers two hypotheses concerning the demand for productive leisure. The other is that time spent on productive leisure increases wage rates and thus has the lowest opportunity cost among all different leisure activities. Therefore people with high education, who face higher wage offers, substitute non-productive leisure for productive. On the other hand there is a preference factor operating, which makes higher educated people demand more productive leisure activities.

Fahr (2004) uses Biddle and Hamermesh's model on the demand for sleep which he modifies to have a preference parameter within utility function, to take into account a possible inclination effect in addition to productivity effects.

Fahr notes that better educated people spend more time in informal educational activities, but this seemed to reflect the effect of preferences more than wage. He tests this further by using a control group of retired men, who were economically inactive. Here again he finds a strong indication of the taste effect instead of wage effect. He also conducts another test, where he uses information from a the sample between respondents with two working days as their time use collection days and those that had either one or two weekend days as their time use collection days. Here he finds evidence that there is substitution from other leisure to productive leisure. However there is no indication whether this is caused by the effect of wage or preferences.

The study by Biddle and Hamermesh as well as Fahr concentrates on a narrow set of activities selected out of a very broad spectrum leisure and housework activities. Not much evidence has been collected on the effect of human capital on the larger composition of out of work activities like housework and leisure.[3] Instead of taking only a limited set of activities

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[3] A notable exception is Gronau and Hamermesh's (2001) paper on the effects of education on the variety in time use. However they are interested in determining how the number of activities changes with the level of education.

under study, we are trying to find larger set of leisure activities which could be termed active. A similar set of passive activities is also investigated.

3 Model

We adopt Biddle and Hamermesh's (1990) model. It is derived from the Beckerian household production model which assumes that sleep enhances productivity at work. Like sleep, but unlike passive leisure, active leisure can be considered of as enhancing productivity in the market as well as also being desirable for its own sake. Passive leisure lacks both of the productivity increasing aspects: it does not refresh like sleep nor does it develop individual capabilities like active leisure.

The utility function of an individual is

$$U = U(Z, T_a)$$

where Z represents the Beckerian commodity, which is produced with time $T_z=bZ$ and market goods $X=cZ$. T_a represents time used in active leisure. Time use in active leisure is thus directly desired for its own sake. Fahr (2004) describes this in his own model as a 'taste' factor. The total time endowment is $T = T_z + T_a + T_w$. Time allocation is thus divided between consumption time T_z, time in active leisure T_a and time used in market work T_w.

Besides direct utility time spent on active leisure also increases the wage rate W by enhancing human capital. This is modelled as an additional parameter W_2 in the wage equation, which depends on the time allocation on active leisure:

$$W=W_1+W_2T_a$$

Individual budget constraint with P as a price of market goods and I as a non-labour income is

$$PX = WT_w+I$$

The full budget constraint, which incorporates time constraints, is

$$(W_1 + W_2T_a)(T - T_a - T_z) + I = cPZ$$

The maximization of the utility function with full income constraint results in maximization condition:

$$\frac{U_1}{U_2} = \frac{cP + bW}{W_1 + W_2(T_a - T_w)}$$

The effect of wage rate on the demand for active leisure has two components. First there is the direct effect W_1 and the indirect effect W_2 via productivity effects:

$$\frac{\partial T_a}{\partial W_1} = \left[(U_1 - bU_2)(cP + bW)\right]D^{-1} + T_w \frac{\partial T_a}{\partial I}$$

and

$$\frac{\partial T_a}{\partial W_2} = T_a \frac{\partial T_a}{\partial W_1} - (cP + bW)U_1 T_w D^{-1}.$$

The D in the equations is the second order derivate of the utility function evaluated at the maximization point and it is negative by definition of the utility function.

The first equation is the Slutsky equation for the effect of change in wage rate unaffected by productivity factors. It can be shown that the first part of the equation, the substitution effect, is positive. The second part, which is the income effect, is ambiguous.

The second equation describes the effect of the change in the effectiveness of the human capital enhancing part of the wage equation. Again the total effect is ambiguous.

The effect of non labour income on the demand for active leisure is

$$\frac{\partial T_a}{\partial I} = \left[(U_{11}\left[W_1 + W_2(T_a - T_w)\right] - U_{12}(cP + bW)) + bU_1 W_2\right]D^{-1}$$

where $U_{12} = \frac{\partial U}{\partial Z}\frac{\partial Z}{\partial T_a}$ and $U_{11} = \frac{\partial^2 U}{\partial Z^2}$. The effect of non labour income on the demand for active leisure is positive.

Thus Biddle and Hamermesh's (1990) model provides ambiguous behavioural responses. Although the demand for active leisure should response positively to change in non labour income, the effect of wage rate turns out to be an empirical question. Fahr's (2004) similar

model does not give univocal behavioural responses either, because the overall effects depend on the strength of the income effect. As the theoretical models do not give clear behavioural response, it is important to test this empirically.

4 Defining Active versus Passive Leisure

We have created passive and active categories of time use to be as extensive as possible. In our definition passive leisure includes television and video viewing, listening to music, resting and other inactivity. Active leisure includes volunteer work, activity in organizations, socializing, cultural events, sports, art hobbies, reading books, free time study, playing computer games or gambling, collecting stamps and coins etc. We exclude travel time and sleeping from the analysis. The division is represented in table 2.

Table 1 Division of Leisure into Active and Passive Components

Active leisure	Passive leisure
Volunteer work and participatory activities	**Resting and inactivity**
Social life, entertainment and culture	**Watching TV and video**
Sports and outdoor activities	**Listening radio**
Arts and hobbies	
Reading	
Free time study	
Computer games and gambling	

The problem is how to categorize leisure activities to the active or passive category, as no universally accepted categorization system is available. Additional problems are caused by the fact that same activity can be passive or active depending on the content of that activity.[4] This kind of cate-

[4] Watching TV is categorized as passive leisure. However, one can watch language programs or other educational programs on TV. Indeed, TV can be a source of increased productivity at work. Another example, suggested by a referee, is a stockbroker following profit warnings on TV versus a stock broker spending time at the Opera. As mentioned these are problems of categorization which cannot be avoided.

gorization is prone to subjectivism, where high-status activities are easily labelled as "active" leisure and low-status activities are labelled as "passive" leisure. The classification we propose later in the paper is prone to all this criticism.

As these divisions are arbitrary and subject to criticism, we form two subgroups. The first subgroup can be called narrow active leisure, and include those activities that clearly require effort on the part of the performer. Included are outdoor activities, organizational activities, free time study, entertainment and cultural activities, but excluding those which could also be watched on TV. The difference between the narrow and broad set of definitions of active leisure is that the broad set includes social and voluntary interactions within and between families, semi-passive past time like reading and computing and all cultural activities which can be also watched on TV. The second subgroup includes two of the most common passive leisure categories: watching television and listening to radio.

There have been other types of classifications in studying leisure choice. A classical sociological division is offered by Bourdieu (1984) where time use is said to create different sorts of capital. With regard to leisure, he considers it to encompass cultural, physical, social and passive capital. According to Bourdieu, cultural capital is increased by voluntary work, hobbies, and neighbourhood help, whereas physical capital includes all kinds of sports. And in his definition social capital is socialising and passive capital is resting.

Gershuny (2000) terms television or video viewing and listening to music as passive leisure. Other leisure activities are divided between categories of other home leisure and out-of-home leisure. Robinson and Godbey (1997) divide leisure time use into media time and social capital. Media time includes reading as well as TV watching and radio listening. Social capital contains socializing, communicating with others, sports/exercises, hobbies, religious and other organizations, events and adult education.

Kooreman and Kapteyn (1987) employ three classes of leisure activity in their demand system. The first is organizational activities, hobbies and sports. The second is entertainment and social activities. The third includes watching TV, listening to radio, and reading. In terms of active and passive leisure, the two first ones can be termed as active but the third classification has both active and passive elements. Reading a book can be termed as an active leisure while TV and radio can be categorized as passive.

Our definition was created to encompass as wide a range of active leisure categories as possible. We hope that with these large groups, we can focus on the aggregate development in active and passive leisure.

5 Sample

The dataset used in this study is the Finnish Time Use Survey 1999/2000 by Statistics Finland. The data were collected between 1 March 1999 and 29 April 2000 according to the Eurostat guidelines for harmonized European Time Use Surveys.[5] The dataset includes 5224 individuals, who had both answered the background interview and kept a diary for two days: one weekday and one day in weekend. Information on yearly incomes, transfers and taxes paid by the individuals are merged into this background information file from administrative files.

From the set of 5224 individuals we selected those in households where the spouses are aged between 18 and 65 years and who are either married or living in consensual union. At least one adult member of the household has to be employed. The other adult is allowed to be either employed, unemployed or taking care of the household.[6] The final sample had 1544 persons living in 772 households.

Table 2 gives the descriptive statistics for the sample used in this study. The average age for men in this sample is 43 years and for women 41 years. The households have, on average, only one child. The imputed hourly wage rate is calculated by Heckman's method.[7] The imputed hourly net wage rate for males is 9.4 euros and 8.1 euros for females. The men have on average an annual non labour income of 1 190 euros and females had 870 euros per year. In the sample, 96 percent of males and 83 percent of females are employed. Just 3.4 percent of the males are unemployed and 7.0 percent of the females. Only 0.4 of males and 9.6 percent of the women are homekeepers.

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5 For a more detailed description of the dataset see introductory chapter in this thesis.

6 Some technical deletions are also made: these include households with missing diaries, with two adults of same sex, or who were married but living separately, who reported to be were working full-time but did not have fixed working schedule and people who had two jobs or whose children were working. Also some households were excluded because of missing income variables, or the reported hourly wage-rates or yearly incomes were clearly outliers and households where members had negative work experience. Households where some children were also working were excluded as well. Furthermore in this essay some clear outliners were deleted from the dataset. Observations where active or passive leisure was over 750 minutes per day were excluded. This excluded 19 households.

7 See the introductory chapter in this thesis.

Table 2 Descriptive Statistic for the Sample

	Male	Female
Net hourly wage rate (euro)	**9.4**	**8.1**
Non-labour income (euro)	**1 190**	**870**
Age	**43**	**41**
Number of Children	**1**	**1**
Basic education	**24.2 %**	**20.2 %**
Secondary education	**41.6 %**	**39.9 %**
University education	**34.2 %**	**39.9 %**
% employed	**96.2 %**	**83.4 %**
% unemployed	**3.4 %**	**7.0 %**
% homekeepers	**0.4 %**	**9.6 %**
	n=772	**N=772**

The educational categories used follow Unesco's International Standard Classification of Education from the 1997. Elementary education is the lowest category. Upper secondary education constitutes the middle category. The highest category, university level education, also includes vocational university degrees.

5.1 Active and Passive Leisure in Total

First we examine to see how well our definitions of active and passive leisure capture the time use in Finnish households. Leisure according to time use is defined as excluding housework and personal care. Table 3 presents the percentage of zero observations for each category by gender and educational level. We see that with both types of active leisure the share of those who have not spent any time in these activities decreases with educational level.[8] However, passive leisure seems to be more invariant to educational level.

[8] A small exception which can be also seen in the table is active leisure by university educated women.

Table 3 **Percentage of Respondents who Haven't Spent Any Time in Given Aggregate Category during Diary Days by Educational Level**

	Men			Women		
	Basic	**Secondary**	**University**	**Basic**	**Secondary**	**University**
Active leisure (narrow)	**89 %**	**93 %**	**83 %**	**83 %**	**71 %**	**79 %**
Active leisure	**12 %**	**6 %**	**9 %**	**3 %**	**5 %**	**4 %**
Passive leisure	**6 %**	**5 %**	**8 %**	**8 %**	**7 %**	**8 %**

Table 4 shows the average time of different activities for both men and women. We see that women have on average 43 minutes less leisure than men. Of the total amount of leisure both genders spend greater part on active leisure. However, men use over 40 percent of their leisure time watching television or video, while women use less than 40 percent of their leisure time for watching TV.[9]

Table 4 **Time Use in Passive versus Active Leisure by Gender (in minutes)**

	Male	%	Female	%
Television and video	**138**	**41.1 %**	**111**	**37.8 %**
Other passive leisure	**24**	**7.1 %**	**21**	**7.1 %**
Total passive leisure	162	48.2 %	132	44.9 %
Active leisure narrow	**19**	**0.6 %**	**12**	**0.4 %**
Total active leisure	174	51.8 %	162	55.1 %
Total leisure	336	100.0 %	294	100.0 %

There is surprisingly little change in the share of active versus passive leisure over the weekdays and weekends. This is shown in table 5. Although the absolute amount of leisure increases by 62 percent during

[9] An attempt to model watching television is done by Corneo (2001). He uses a model to describe time-allocation into three categories: market work, watching TV and socializing. He gets multiple equilibria. In one equilibrium there is lot of market work combined with lot of television viewing. In the other equilibrium there is lot of television viewing with lots of socializing and very little market work. He uses these results to explain different trends in TV-viewing in different OECD countries.

Table 5 Time Spent on Active versus Passive Leisure during Weekdays and Weekends (in minutes)

	Weekday				Weekend			
	Male	**%**	**Female**	**%**	**Male**	**%**	**Female**	**%**
Television and video	107	42.6 %	98	40.9 %	168	40.3 %	123	35.8 %
Other passive leisure	19	7.4 %	16	6.6 %	31	7.5 %	27	7.8 %
Total passive leisure	**126**	**50.4 %**	**114**	**47.5 %**	**199**	**47.8 %**	**150**	**43.4 %**
Active leisure narrow	19	7.4 %	11	4.6 %	20	4.8 %	12	3.5 %
Total active leisure	**130**	**50.6 %**	**127**	**52.9 %**	**217**	**52.2 %**	**196**	**56.6 %**
Total leisure (min)	**257**		**241**		**416**		**346**	

weekends in the case of the men and by 44 percent in the case of women, there are only slight shifts in its composition. The share of active leisure increases only little over 2.3 percent for men and 4.4 percent for women. Men use 40 percent of the additional leisure time during weekends to watch TV, but women use only 25 percent.

If we look at the narrowly defined active leisure, we see that men spend more time both absolutely and relatively on these activities. This indicates that leisure activities of women are more socially oriented interactions within and between families than men.[10]

In contrast the share of the narrowly defined active leisure decreases both absolutely and relatively during weekends. This means that social part of active leisure increases during weekends.

Next we present the allocation of time by educational status and by gender in table 6 and in figures 1 and 2. Looking at the impact of education on the composition of leisure, we see that on average passive leisure decreases both absolutely and relatively with education regard

[10] This same phenomenon is noted for Canadian couples by Harvey and Pentland (1999).

Table 6 **Average Daily Time Use in Passive versus Active Leisure According to Educational Level and Gender (in minutes)**

	Male Basic	%	Secondary	%	University	%
Television and video	150	44.4 %	136	41.2 %	132	38.5 %
Other passive leisure	33	9.7 %	36	10.9 %	22	6.4 %
Total passive leisure	183	54.1 %	172	52.1 %	154	44.9 %
Active leisure narrow	13	3.9 %	18	5.4 %	26	7.9 %
Total active leisure	155	45.9 %	158	47.9 %	189	55.1 %
Total leisure	338	100.0 %	330	100.0 %	343	100.0 %
	Female Basic	**%**	**Secondary**	**%**	**University**	**%**
Television and video	130	43.0 %	111	37.5 %	101	35.2 %
Other passive leisure	27	8.9 %	20	6.8 %	2	7.0 %
Total passive leisure	157	52.0 %	131	44.6 %	121	42.2 %
Active leisure narrow	4	1.0 %	14	3.8 %	14	4.9 %
Total active leisure	145	48.0 %	165	55.7 %	167	57.8 %
Total leisure	302	100.0 %	296	100.0 %	287	100.0 %

Figure 1 **Decomposition of Male Leisure Time According to Educational Categories**

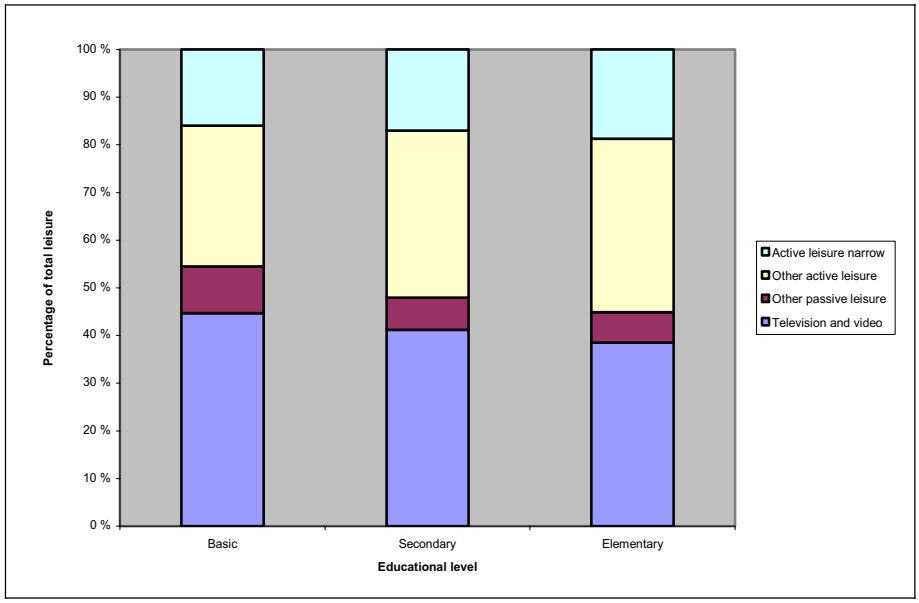
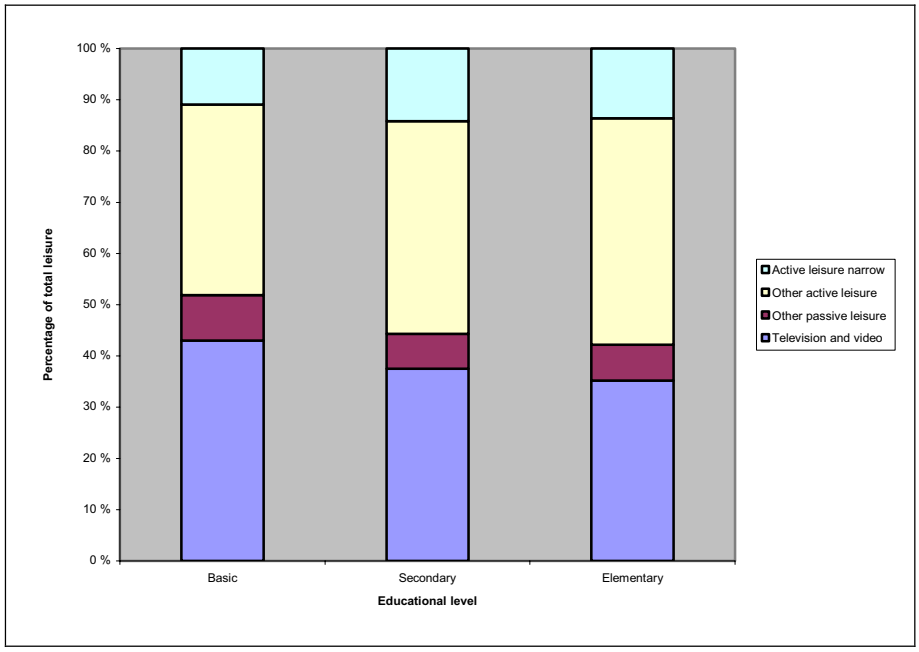


Figure 2 Decomposition of Female Leisure Time by Educational Categories



less of gender. In contrast the time used for active leisure increases both absolutely and relatively for men and women. The absolute increase in the amount of leisure for higher educated men, indicated that although they do more market work, less personal care activities or housework are pursued.

5.2 Distribution within Active Leisure

A second source of information on the choice between active and passive leisure is provided in the interview part of the time use survey. The problem with time diary data is that the data describe the time allocation of a short period only, usually two days. This introduces bias on the data, in as much as daily activities are recorded but infrequent activities may not be recorded.

In order to capture time use in activities with a high probability of not being captured in the diaries, additional questions are introduced during a background interview. The respondents were asked whether they had participated in a given group of activities during the previous 12 months. If the response was yes, they were asked to specify the number of times they had participated in the given activity during the past four weeks.

Table 7 Categorization of Active Leisure among Four Aggregate Categories

Sports	*Cultural activities*	*Organizational activities*	*Volunteer work*
Walking	Movies	Sports organization	Nursing
Running or jogging	Theatre	Student organization	Cooking
Cycling	Dance performance	Social or health organization	Cleaning
Swimming	Concert	Voluntary nongovermental	Gardening
Exercising	Opera	Religious organization	Shopping
Exercising in home	Art exhibition / museum	Housing board	Helping elderly
Body building	Other museum	School/Parents organization	Repairing houses
Dancing	Library	Political party/ labour union	Repairing cars/motorcycles
Field sports	Sports fair	Feminist organization	Snow removal
Ball games	Reading literature	Pensionars organization	Cutting trees and branches
Skiing, Skating or Slalom	Creative writing	Agricultural organization	Kept neighbours pets
	Playing an instrument	Nature club	Helping somebody to move
	Singing solo/choir	Cultural or art club	Helping in some other way
	Amateur acting	Other club	Helping parents
	Painting	Other organization	Helping kids
	Photography		Helping sister/brothers
	Video filming		Helping grandchildren
	Home computing		Helping neighbours/friends
			Helping strangers

The activities in question represent four aggregate categories: cultural activities, sports activities, organizational activities and volunteer work activities. Overall there were 153 questions on participation in different activities, including 15 different voluntary organizational types, 20 volunteer work situations, 19 cultural activities and 12 different types of sports. These are given in table 7.

As can be seen, the questions capture a wide scope of activities. For example culture encompasses both intellectual activities, like opera, as well as not so intellectual such as going to movies. Organizational activities have range from nature club to labour union. Voluntary work includes activities from helping grandchildren to nursing. Therefore, it cannot be said that some of these categories have a bias towards elite uses of leisure. These activities are classified as active leisure in our earlier categorization, and we use this extra information to study whether there is variability according to educational groups within the active leisure.[11]

Although the data provide information on the number of times a given activity is performed, we concentrate on the choice of doing a given activity rather than the number of times a given activity is done during the last 12 months. This segregates more clearly those who do not participate in an activity at all and those that participate regardless of the intensity of participation.

Table 8 summarizes information about the percentage of people in a given educational group who recorded a given activity in a leisure category at least once during the last 12 months. As can be seen both organizational and cultural activities increase steeply for both males and females with a rise in the educational level. There is almost no variability by educational category in volunteer work and sports for females, while for men, even these categories show a difference between the highly educated and the less educated groups.

Looking at the data there seems to be a strong relationship between education and the time spent on active versus passive activities during a

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[11] There have not been a lot of studies concerning the choice of active leisure choice. In their study of early retirement Huovinen and Piekkola (2001) divide active leisure and resting into two components: High activity level leisure and high time intensity leisure. High activity level includes cultural activities, voluntary work, hunting and fishing and holiday travelling. High time intensity leisure includes visiting friends, visiting library, walking, jogging, and resting. According to their evidence, men who spend time in high activity level leisure are more likely to retire early. For women no such indicators are noted.

Table 8 **Percentage Distribution of People Who Have Done a Given Activity at Least Once During 12 Months by Educational Categories**

	Males			Females		
	Basic	Secondary	University	Basic	Secondary	University
Organizational activities	**26.6 %**	**33.9 %**	**44.5 %**	**22.8 %**	**30.6 %**	**36.9 %**
Volunteer work	**56.3 %**	**63.9 %**	**63.0 %**	**66.5 %**	**64.0 %**	**66.0 %**
Cultural Activities	**76.0 %**	**86.5 %**	**92.1 %**	**87.3 %**	**92.1 %**	**98.4 %**
Sports	**75.5 %**	**82.6 %**	**87.5 %**	**93.0 %**	**94.6 %**	**95.8 %**

leisure time, which also manifests on the participation of different activities over previous 12 months.

One should note that there can be serious misreporting in the amount of different activities. With such a long time period the problems of recall are present. Robinson (1999) notes, for example, that when respondents in the United States were questioned about the frequency of tennis at a particular club or swimming at a particular pool over the last 12 months and the responses compared with the actual attendance data, twice as many visits were indicated than what the records actually showed. Also Niemi (1993) observes the problems in the estimates of participating in different leisure activities.

In our case, we attempt to correct this potential misreporting by only considering whether or not a person had done a given activity at all. Thus frequency of a given activity does not have an effect in our estimation.

6 Econometric Methods

We use two different econometric estimation methods to determine whether education has an impact on the quality of leisure. First we estimate a Tobit model for time spent on active and passive leisure.

This estimation uses the information collected in the time-use diaries. The next analysis is conducted utilizing interview information given in the time use data set. We use a multivariate probit model to examine whether the probabilities of having participated in cultural activities, sports, volunteer work and organizational activities differ by educational level.

6.1 Tobit

There are individuals who have not participated in active leisure at all and those who have not done passive leisure during the recording period. Therefore these zero observations need to be corrected in the data. The Tobit model was developed to take into account the problem of zero observations. In Tobit model the same parameters are used to describe the selection and outcome. This feature has been criticised for example by Maddala (1993) as not being suitable way for modelling zero observations. A more advanced method should be used, such as Heckman's (1979) method and a Double Hurdle method presented for example by Jones (1992).

However, using Swedish time use data Flood and Gråsjö (1999) and Flood and Gråsjö (2001) compare the suitability of different sample selection models. According to their results, the suitability of different estimation methods depends on how well the selection equation can be specified. Given the special nature of time use data they point out that it is not obvious that more refined methods would be superior to the simpler Tobit model. In case the zero generating process is unknown, an attempt to model it with ad hoc selection equations can lead to serious biases.

Tobit model is more suitable in this instance of active and passive leisure as it is unclear which factors generate non-participation. We proceed with Tobit data, preferring not to use the more advanced methods that could provide more accurate but misleading results.

The Tobit formulation used is

$$y_i^* = \mathbf{x}_i'\boldsymbol{\beta} + e_i$$

$$y_i = 0 \quad if \; y_i^* \leq 0,$$

$$y_i = y_i^* \quad if \; y_i^* > 0,$$

where y_i is the time use in active or passive activities by the person *i.* and e_i is the normally distributed error term with mean 0 and standard error σ. The exogenous variables in $\mathbf{x}_i$ include the imputed net wage rate, non labour income, the number of children, imputed hours of market work, age-cohort dummies, dummies for the educational level, seasons and living area, weekend and disability.

The log-likelihood function for Tobit model can be simplified by reparametrising $\boldsymbol{\gamma} = \boldsymbol{\beta} / \sigma$ and $\theta = 1/\sigma$

$$\ln L = \sum_{y_i>0} -\tfrac{1}{2}\left[\ln(2\pi) - \ln\theta^2 + \left(\theta y_i - \mathbf{x}_i'\boldsymbol{\gamma}\right)^2 \right] + \sum_{y_i=0} \ln\left[1 - \Phi\left(\mathbf{x}_i'\boldsymbol{\gamma}\right)\right]$$

where Φ is the distribution function for standard normal distribution. With this reformulation Newton's method for finding a maximum can be used easily and an asymptotic covariance matrix obtained.

A number of diagnostic tests have been developed to assess the Tobit model. Pagan and Vella (1999) suggest a conditional moment test for determining the normality of residuals in Tobit model. We use a bootstrap method to calculate the moments of activity and use these to test the normality assumption in Tobit models. This makes it possible to circumvent the potential asymptotic distributional problems found in this test.

Pregibon's (1980) link test is suitable for assessing potential misspecification in Tobit's functional specifications. In it fitted values of the estimation are squared and the function is re-estimated with the squared residuals. If there is no misspecification, then the squared residuals should have no explanatory power.

Smith and Blundell (1986) propose a test of exogeneity for one or more explanatory variables. The residuals from each first-stage instrument regression are included in the model, after which it is possible to test for the joint hypothesis that each of the coefficients on the residual series is zero. Under the null hypothesis, the models are appropriately specified with all explanatory variables as exogenous.

6.2 Multivariate Probit

A number of alternatives are available for studying our second research question concerning the selection of a number of active leisure categories. These choices are structured to include multiple binary dependent

variables. The most popular models used in the estimations are the multinominal logit, multinominal probit, multivariate probit and mixed logit.

The de facto choice in similar studies is the multinominal logit, but it suffers from a number of shortcomings that make its use difficult. First, there is a need to normalize the system by expressing other equations in terms of the one used as a numeraire. Second, there is a need to impose a very restrictive 'independence of irrelevant alternatives'-assumption to the model.

Thus a more general multinominal probit model is suggested.[12] Greene (2003) notes that the advantage of multinominal probit over multinominal logit is that the multinominal probit allows an unrestricted correlation structure, therefore eliminating the need to normalize one equation like in multinominal logit, where only comparisons are feasible. The second advantage is that one does not need to assume the irrelevance of independent alternatives.

However, the fact that different activities are not mutually exclusive makes even the multinominal probit difficult to use. In our case a person can choose simultaneously different combinations of leisure activities, not just one. The selection could be expanded to include different combinations of simultaneous choices as a single choice and preserve the structure needed in multinominal probit. However, this would create a large number of categories and the interpretation of these would be difficult.

When there is simultaneity of choices, then a suitable model is multivariate probit, which is a special case of the multinominal probit. In multivariate probit restrictions are placed on the correlation matrix between different simultaneous choice activities. Because we have a cross-sectional sample of the multiple simultaneous choices where the independence of irrelevant alternatives-assumption is clearly too stringent restriction, we resort to multivariate probit.

It is difficult to build a tractable multivariate probit model when the number of dependent variables is large, for the reason that accurate functions for the evaluation of higher order normal distributions, as required by these higher-order probit models, are very hard to derive and are computationally burdensome. This led to a search for a suitable

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[12] A recent alternative is a random parameters logit, which is also called mixed logit model. It gives a more general specification than multinominal logit and is especially suitable for panel data models. However, we choose to use multivariate probit instead.

simulation based method for deriving the necessary parameter estimates. Indeed, as Stern (1997) notes in his survey of simulation based estimation, multivariate Probit has been "…the leading problem in developing simulation methods."

One way to estimate a model with a number of simultaneous choices is to use simulated maximum likelihood estimation of the multivariate probit models. The pioneering application that uses simulation methods for these kinds of models is Börsch-Supan et al. (1992) paper. More theoretical derivation is introduced in Börsch-Supan and Hajivassiliou (1993).

In a recent contribution by Cappellari and Jenkins (2003) an algorithm for simulated maximum likelihood estimation of a multivariate probit regression is implemented to Stata, which is used in this study.

The multivariate probit is an enlargement of single equation probit to multiple equations *M*. A general formulation is:

$$y_{im} = \beta_m' X_{im} + e_{im}, \quad i = 1,....N, \quad m = 1,...,M$$

$$y_{im} = 1 \quad if \quad y_{im}^* > 0 \text{ and } 0 \text{ otherwise,}$$

where e_{im} are the error terms distributed as multivariate normal, with mean zero and variance-covariance matrix V, where V has values of 1 on the leading diagonal and correlations $\rho_{jk} = \rho_{kj}$ as off-diagonal elements.

For example, in the case of trivariate probit the likelihood function for a sample of N observations is

$$L = \sum_{i=1}^{N} w_i \log \Phi_3(\mu_i; \Omega)$$

where w_i is the optional weight for observation I and $\Phi_3(..)$ is the trivariate standard normal distribution with arguments μ and Ω where

$$\mu_i = \left(K_{i1}\beta_1' X_{i1}, K_{i2}\beta_2' X_{i2}, K_{i3}\beta_3' X_{i3}\right),$$

where $K_{ik} = 2y_{ik} - 1$, for each $i,k = 1,2,3$ and

$$\Omega_{jj} = 1, \text{ for } j = 1,2,3, \; \Omega_{21} = \Omega_{12} = K_{i1}K_{i2}\rho_{21},$$
$$\Omega_{31} = \Omega_{13} = K_{i3}K_{i1}\rho_{31}, \; \Omega_{32} = \Omega_{23} = K_{i3}K_{i2}\rho_{32}.$$

This kind of multivariate normal distribution can be evaluated by using Geweke-Hajivassiliou-Keane (GHK) smooth recursive conditioning

simulator.[13] The idea is that the multivariate normal distribution can be expressed as the product of sequentially conditioned univariate normal distributions, which then can be evaluated independently. Greene (2003) notes that the GHK simulator appears to be the most accurate simulator among the proposed alternatives.

Cappellari and Jenkins (2003) note that by applying Cholesky decomposition of covariance matrix to joint probabilities of each combination of outcomes, each of these decompositions is uncorrelated with each other, which can be used to compute overall multivariate probability. The estimated parameters in the covariate matrix are variances and covariances. The correlations calculated are the combinations of these two. The use of simulated maximum likelihood in this context produces an estimator that is asymptotically consistent.[14]

In the general case of multinominal models the question of the identification of the model is crucial. There has been a large and varied discussion on the identification of the multinominal models when used in choice situations. For example Ben-Akiva, Bolduc and Walker (2001) have show that many models presented in the literature have in fact not been identified.

Keane (1992) points out that there are two different notions of identification in the relevant literature. One is the question of formal identification and the question of the identification through maximization procedure.

As for formal identification, Weeks (1997) argues the key distinction in the identification debate should be between choice specific attributes and the characteristics of the individuals who make the choices. These form two clearly different subsets of potential exogenous variables.

Especially difficult are situations where different characteristics of the different objects of choice have been modelled and all the available choices are included in the system. As the parameters of these characteristics are same for the entire sample, it is a common practice to normalize the system by dropping one equation and to express the system as differences in utility.

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[13] As Cappellari and Jenksins (2003) point out, the GHK simulator has a number of properties which are desirable in this context. The simulated probabilities are unbiased and bounded within (0.1) interval. The simulator is continuous and differentiable function of the model's parameters. Moreover, it is also more efficient than a number of other simulators.

[14] In practice, a relatively small number of simulation draws is sufficient for well-behaving likelihoods.

One can argue that our case is different from the above mentioned scenario and there is no need to normalize the system. The reason is that we have implicitly already normalized the system by excluding other possible time use alternatives such as sleep. The 'utilities' in the choice are expressed vis-à-vis sleep.

Furthermore it can also be argued that the identification is not a problem in our model because all our exogenous variables vary between individuals but parameters differ. Take, for an example, a yearly non-labour income of a person: This is in contrast to modelling choice in multinominal framework, where x's vary but parameters stay the same. Indeed Heckman and Sedlacek (1985) show that a single regressor varies over individuals is sufficient for identification. This restriction guarantees the identification of the model.

For the method of obtaining identification through maximization, Walker (2001) points out that no general necessary and sufficient conditions for identification exist for discrete choice models. She notes that in many cases uncertainty regarding identification remains and even theoretically identified models can have multicollinearity problems. She recommends conducting some empirical verification tests like Monte Carlo experiments, using different starting values, looking at the stability properties, etc.

Train (2003) summarizes a number of conditions to be checked when using the GHK-simulator, which is used in our estimation. The most important of these is the positive definiteness of the covariance matrix. Cappellari and Jenkins (2003) note that the GHK-simulator relies on the Cholesky factorization, which requires that correlation matrix is positive definite in each iteration. This is checked each time during calculations.

Some, but only a few, tests are available in this estimation context. Hajivassiliou (2000) shows that especially Wald and likelihood ratio tests are applicable in the simulation based multivariate probit and they are computationally easy to derive. This makes it possible to resort to the standard hypotheses testing after the estimation of the model.

7 Results

We estimate a Tobit model for the time spent on active leisure and on passive leisure separately. With both specifications we correct for clustering in case of households. As Wooldridge (2003, 133) notes, the data at

hand have the simplest structure: a large population of relatively small clusters. In this study the effect of clustering is corrected by calculating modified sandwich estimators for variance.

For the unemployed and those taking care of the household the imputed wage rate is estimated by Heckman selection model. Also market hours of work are included in the estimation and they are imputed in order to correct potential endogeneity problems.[15]

The estimation results are given in table 9. Our main result indicates that there is a link between education and increased time in active leisure, accompanied by a decrease in the passive leisure.

Table 9 Tobit Estimation Results

	Male	*Female*	*Male*	*Female*
	Active Leisure	**Active leisure**	**Passive Leisure**	**Passive Leisure**
Net wage rate	0.562 (0.594)	0.897 (0.363)	0.692 (0.436)	-0.958 (0.245)
Yearly nonlabour income	-0.029 (0.879)	-0.351 (0.143)	-0.122 (0.447)	0.264 (0.189)
Age 35-44	-2.536 (0.877)	-1.869 (0.892)	4.357 (0.752)	29.164** (0.012)
Age 45-54	9.834 (0.649)	17.493 (0.348)	1.304 (0.943)	21.884 (0.161)
Age 55-64	-5.845 (0.825)	7.868 (0.737)	35.587 (0.110)	20.996 (0.285)
Secondary schooling	26.073*** (0.007)	30.378*** (0.000)	-19.462** (0.017)	-20.926*** (0.004)
University	40.287** (0.027)	24.903* (0.081)	-32.717** (0.032)	-20.284* (0.088)
Rural	10.945 (0.283)	7.567 (0.367)	5.522 (0.519)	11.779* (0.094)
Countryside	-13.773 (0.165)	-6.043 (0.463)	-2.472 (0.766)	4.323 (0.531)
Number of children	-10.288*** (0.005)	-10.694*** (0.002)	-6.408** (0.037)	-17.482*** (0.000)

[15] For details of the procedures please refer to the introductory chapter in this thesis.

Market hours	-1.226*** (0.000)	-0.382*** (0.000)	-0.737*** (0.000)	-0.431*** (0.000)
Weekend	91.049*** (0.000)	71.844*** (0.000)	75.218*** (0.000)	37.176*** (0.000)
Winter	0.759 (0.940)	-4.068 (0.632)	13.213 (0.116)	19.248*** (0.007)
Summer	-4.008 (0.696)	12.117 (0.154)	-25.906*** (0.003)	-15.134** (0.034)
Fall	8.122 (0.411)	-6.627 (0.428)	-13.662 (0.100)	-5.382 (0.443)
Disabled	-4.422 (0.602)	9.750 (0.149)	11.595 (0.104)	-8.402 (0.139)
Constant	80.024 (0.149)	48.098 (0.248)	102.763** (0.028)	173.726*** (0.000)
Observations	1544	1544	1544	1544
Log likelihood	-9143	-9230	-8978	-8723

p values in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

For both genders, the amount of active and passive leisure responds in completely opposite manner to changes in educational variables. The higher the educational level, the less time is spent on passive leisure and the more time is spent on active leisure. Interestingly, neither net wage rate nor non-labour income is significant in explaining the time allotted to active versus passive leisure. This could be taken as evidence that it is preference factors more than factors of productivity which affect the time spent on active versus passive leisure.[16]

The hours of market work diminish the time spent in both active and passive leisure. Also the number of children decreases the time spent on both active and passive leisure by both genders. Living in a rural area increases passive leisure for women. As expected there is a significant increase in the time spent in both active and passive leisure during a weekend.

[16] Indeed, there exists a potential endogenity problem. What if those who enjoy active leisure in the first place obtain a higher educational status. Then this same result would apply but the causality would be reversed.

Summer has a negative effect on passive leisure. However, seasons do not have an effect on the amount of active leisure. This means that active leisure categories do not exhibit seasonal variations and approximately same amount of active leisure is spent regardless of the time of the year.

We also estimate a Tobit model with a narrowly-defined active leisure as a dependent variable. This narrowly-defined active leisure excludes all social and sport activities and all those cultural activities that can be watched on TV. The estimation results are presented in Appendix 1. Our results do not change much with this definition of active leisure. Interestingly the number of children becomes significantly positive in explaining time use in this narrowly-defined active leisure.

Table 10 Summary of Diagnostic Tests for Tobit Estimations

		Pagan-Vella Conditional moment		Perigbon link test		Smith-Blundell Exogenity test	
		Test Value	Prob > Chi2	Hat^2	P-value|	Test Value	P-value|
Active	**Male**	74.844	0.000	-3.07	0.002	0.158	0.692
	Female	137.350	0.000	-0.79	0.463	3.072	0.080
Passive	**Male**	38.733	0.000	-0.83	0.404	5.046	0.025
	Female	48.849	0.000	0.28	0.782	6.115	0.014

Pagan and Vella's (1999) conditional moment test for the normality of errors in Tobit estimation is rejected in each case. This is normal because the test is quite sensitive to an increase in sample size. The Pregibon (1980) link test for functional form misspecification is passed in all other cases and in active leisure for males.[17] These tests are presented in Table 10 for active and passive leisure and in Appendix 2 for the active leisure. Smith-Blundell test of exogenity is conducted for net wage rate. Only in the case of male active leisure is exogenity test passed.

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[17] In most of the papers Ramsey's RESET-test is used instead of Pregibon's link test. However, this was not available after Tobit estimation.

Table 11 Change in Time Use by Different Demographic Factors (in minutes)

	Active leisure		Passive leisure	
	Male	Female	Male	Female
Mean time use in activity	**136**	**140**	**140**	**107**
Age 35-44	*	*	*	**+29**
Market work hour	**-20**	**-24**	**-42**	*
Secondary schooling	**+26**	**+30**	**-19**	**-21**
University	**+40**	**+25**	**-32**	**-20**
Each child	**-10**	**-11**	**-6**	**-17**
Weekend	**+91**	**+72**	**+75**	**+37**
Winter	*	*	*	**+19**
Summer	*	*	**-26**	**-15**

* = not statistically significant

Next we turn to Tobit marginal effects of different variables on the average time use in active leisure. These effects are calculated from the fitted values of *y* with sample mean values. The effect of some of the demographic variables is given in table 11. The predicted time per day in active leisure is 2 hours 16 minutes for a male with basic education. Having a university degree rises this time by 40 minutes, almost 30 percent more. A woman with basic education has daily active leisure time totalling 2 hours 20 minutes and university degree raises this figure by 25 minutes.

Passive leisure decreases with education. For university educated men, the daily decrease in passive leisure is little over 32 minutes and for women 20 minutes. Each child decreases their parents' time for both active and passive leisure on average 10 minutes per day.

Weekend has a strong effect on both active and passive leisure. Men increase active leisure by one and half hours during weekends and women by one hour and 12 minutes. Also passive leisure increases but more moderately.

Interestingly, seasons have a strong effect in Finland on the time devoted to passive leisure. In case of men, passive leisure decreases by 26 minutes as winter becomes summer and in case of women by 35 minutes.

The use of different and sometimes conflicting definitions in earlier studies makes the comparison of our findings difficult. In their demand system for time use Kooreman and Kapteyn (1987) use three leisure activity groups: organizational activities and hobbies and sports and entertainment and social activities. Activities that are clearly active. The third category had both passive elements like watching TV and listening radio, but also active elements like reading a book. However, as watching TV is the single biggest time use category, we consider Kooreman and Kapteyn's last category to represent passive leisure.

Our results on the effect of education on the demand for active leisure are partly at odds with Kooreman and Kapteyn. Their result indicates that the educational level of male increases passive leisure but decreases entertainment and social activities. The opposite effect is observed for the educational level of females. Male education also has no effect on the organizational activities, hobbies or sports, but female education does have a small positive effect on these as well. We obtain similar positive effects for active leisure in case of both females and males and negative effects for passive leisure.

Table 12 Simulated Multivariate Probit Estimates of Participation in Various Activities

	Culture		Sport		Organizations		Voluntary work	
Net wage rate	-0.019 (0.016)		0.013 (0.014)		0.030 (0.025)		-0.001 (0.011)	
Yearly non labour income	0.002 (0.025)		0.011 (0.006)	**	-0.250 (0.162)		0.002 (0.003)	
Age 35-44	-0.092 (0.237)		-0.089 (0.198)		-0.305 (0.214)		-0.135 (0.160)	
Age 45-54	-0.174 (0.304)		-0.370 (0.267)		-0.491 (0.270)	**	-0.224 (0.213)	
Age 55-64	-0.052 (0.390)		-0.136 (0.354)		0.160 (0.102)		-0.268 (0.274)	
Secondary schooling	0.213 (0.117)	**	0.158 (0.112)		0.079 (0.175)		0.007 (0.099)	
Academic degree	0.941 (0.247)	***	0.128 (0.206)		0.391 (0.123)		0.048 (0.182)	
Rural	-0.104 (0.147)		-0.126 (0.140)		-0.015 (0.111)		0.135 (0.112)	
Countryside	-0.277 (0.139	**	-0.228 (0.125)	*	0.158 (0.107)		-0.001 0.114	
Female	0.161 (0.211)		0.760 (0.181)	***	0.199 (0.150)		-0.041 (0.153)	

Number of Children	-0.010 (0.056)		-0.088 (0.055)		0.053 (0.041)		-0.071 (0.045)	
Winter	0.195 (0.133)		-0.094 (0.140)		-0.277 (0.110)	**	-0.053 (0.112)	
Summer	-0.080 (0.139)		0.077 (0.137)		-0.384 (0.110)	***	0.208 (0.115)	**
Fall	-0.026 (0.135)		-0.007 (0.132)		-0.361 (0.108)	**	0.119 (0.116)	
Hours of Market Work	0.001 (0.002)		0.001 (0.002)		0.012 (0.086)		-0.004 (0.001)	***
Health problems	0.121 (0.115)		0.190 (0.112)	*	0.060 (0.087)		0.209 (0.080)	**
Constant	2.155 (0.827)	***	0.216 (0.729)		-2.090 (-0.595)	**	0.635 (0.597)	
Obs.	1544		1544		1544		1544	
	σ21		*0.973*		*rho21*		*0.750*	
	σ31		*0.424*		*rho31*		*0.400*	
	σ41		*0.390*		*rho41*		*0.372*	
	σ32		*0.312*		*rho32*		*0.303*	
	σ42		*0.342*		*rho42*		*0.329*	
	σ43		*0.253*		*rho43*		*0.248*	
Log pseudo-likelihood	-1 507 080							

Likelihood test that all rho = 0: Chi2(6)= 300000 Prob > chi2 = 0.000

Also Biddle and Hamermesh's (1990) result for men on the reallocation of time from sleep to other leisure and housework, while market work hours stay the same, can be interpreted as an allocation from passive leisure towards active leisure. In the case of women, the market work hours respond more, so a clear comparison cannot be made. These effects have an impact only through wage rates as educational variables are not used in their estimation. Therefore, their results could be due to the correlation of wage rate with educational variables, which overlooked unobservables.

The next step in our investigation is to look for the composition of active leisure by using information on whether certain activities have been performed during the last 12 months. Multivariate probit model is estimated with simulated maximum likelihood. The estimation results are presented in table 12.

The only effect of educational variables is that educational level degrees have a very significant and positive effect on the probability of a person participating in cultural activities. Net wage rate has no effect and yearly non labour income affects only the propensity to engage in sports. Being female increases very significantly the probability of doing sports as does having health problems. Being between 45-54 years of age has a negative effect on participation on organizational activities.

Interestingly, hours of market work has no explanatory power in equations explaining participation in cultural activities, organizational activities or sports. However, it has a negative effect on the volunteer work. Organizational activities are sensitive to seasonal variations as all other seasons except spring had negative effect. Volunteer work increases during the summer period.

Additional information on the links between different activity groups can be inferred from the correlation coefficients between different equations. These correlations coefficients give an indication how the unmeasured background variables affect the probability to participate in different activities. The highest correlation, 0.75, is between culture and sport, implying that there is higher probability to observe same people engaged in sports and in cultural activities. The lowest correlation, 0.25, is between organizational activities and volunteer activities. These activities can be regarded as mutually exclusive so that highly educated people are more active in organizational activities and the lower-educated are more active in volunteer activities.

Using our estimations, we predict the various probabilities of participating in a given activity by educational groups. As a whole there is 16 percent probability of a person with basic education that he will participate at least once in all these activity groups: sports, cultural activity, volunteer work or organizational activity. For a person with university education the probability rises to 27 percent. There is a 6 percent probability for a person with basic education of not having done any of these activities. For a university educated person, the probability is merely 2 percent.

With regard to the individual activities, the probability of participating once in cultural activity during the last 12 months is 82 percent for a person with basic education and 95 percent for a person with university education. Corresponding probabilities on the part of sports are 83 and 91, respectively. For organizational activities probability increases from 26 percent to 39 percent with the move from the elementary educational

level to the university level. For volunteer work the increase in probability is a mere 1 percent: from 63 to 64.[18]

8 Conclusions

The finding of this study is that educational level, as a proxy for human capital, affects the choice of leisure more than economic factors. Looking at the impact of education on the quality of leisure, increased educational levels induce an increase in the time spent in active leisure. Moreover, the amount of time used in passive leisure decreases with the level education. However, income variables do not have a statistically significant effect on the amounts of time used in different activities.

This phenomenon can be explained by the fact that spending time in active leisure is driven more by educational factors than the quest for higher wages rewarded for increased productivity of a person. This result points to same direction as Fahr's (2004) observation that the amount of productive leisure is more a reflection of preferences than a matter of economics variables.

We conduct our empirical study by investigating the amounts of active and passive leisure and their determinants by using the Tobit model. There is very strong positive association between the level of education and the time spent doing active leisure and a strong negative association between level of education and passive leisure even when holding market work hours constant.

An additional attempt to study the effects of education on the time use in leisure is done with information resulting from the interview part of the time use survey. The probabilities of participating in cultural activities, volunteer work, organizational activities or doing sports are assessed by using a multivariate probit model. Even among these modes of

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[18] It is not possible to correct for clustering by household level with the multivariate probit estimation method. Therefore, we compare our multivariate probit estimates to individual probit estimates of each individual category corrected for clustering by households. There is very little change on the parameter estimates: the signs and significance of parameters stay the same. Only difference is that dummy for ages 45-54 is significant for individual probit estimates for volunteer work and cultural activities.

time use, which can be categorized as active, education plays a significant role along with gender. It is much more likely for a highly educated person to participate in these activities than for a person with basic education even when controlling for market work hours.

There are marked gender differences in the time spent in active leisure. Women spend proportionally more time in active leisure than men. Men spend more time in out-of-house active categories and women spend more time than men in social activities within and between households. Within active leisure women are likely to spend more time even in physical exercise than men.

It seems that an increase in human capital has quantitative and qualitative effects on time use. The more educated a person is, the more active in his time use vis-à-vis a person with a lower education. This can be interpreted to signify that the polarization to those who have and those who have not are also at work during the time for leisure.

Appendix 1 Estimation Results for Narrowly Defined Active Leisure by Gender

	Male	*Female*
Net wage rate	2.492 (0.205)	1.738 (0.315)
Yearly nonlabour income	0.542** (0.047)	-1.033 (0.335)
Age 35-44	-31.269 (0.302)	-19.633 (0.413)
Age 45-54	-10.840 (0.787)	-6.246 (0.849)
Age 55-64	-43.327 (0.389)	-6.655 (0.873)
Secondary schooling	38.348** (0.046)	79.947*** (0.000)
University	59.558* (0.082)	75.181*** (0.005)
Rural	-28.563 (0.129)	4.357 (0.761)
Countryside	-27.624 (0.132)	-6.774 (0.639)
Number of children	16.163** (0.012)	13.804** (0.045)
Market hours	-0.689*** (0.004)	0.062 (0.637)
Weekend	-4.210 (0.744)	4.570 (0.658)
Winter	24.210 (0.176)	6.496 (0.650)
Summer	-17.147 (0.367)	-32.071** (0.036)
Fall	-0.602 (0.973)	-4.673 (0.742)
Health problems	13.961 (0.361)	27.958** (0.016)
Constant	-361.170*** (0.001)	-306.631*** (0.000)
Observations	1544	1544

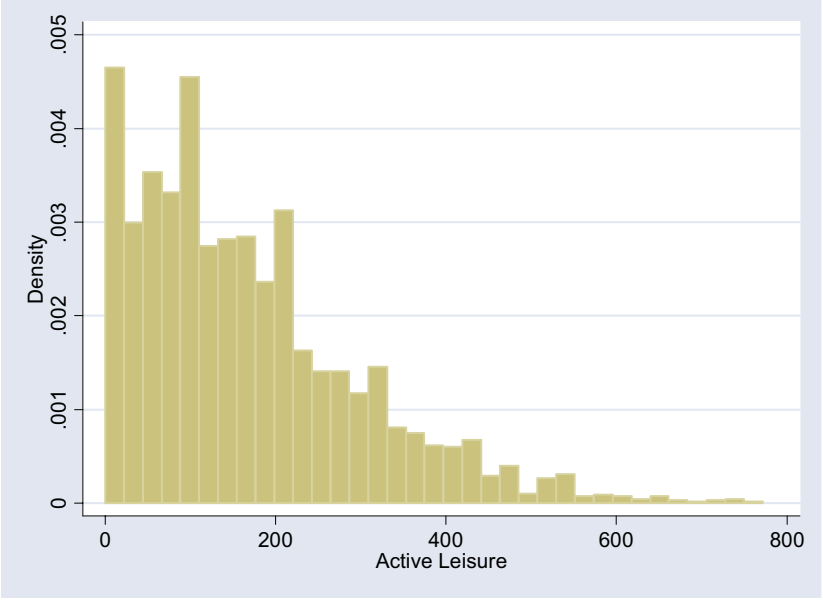
p values in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix 2 Summary of Diagnostic Tests for Narrowly Defined Active Leisure

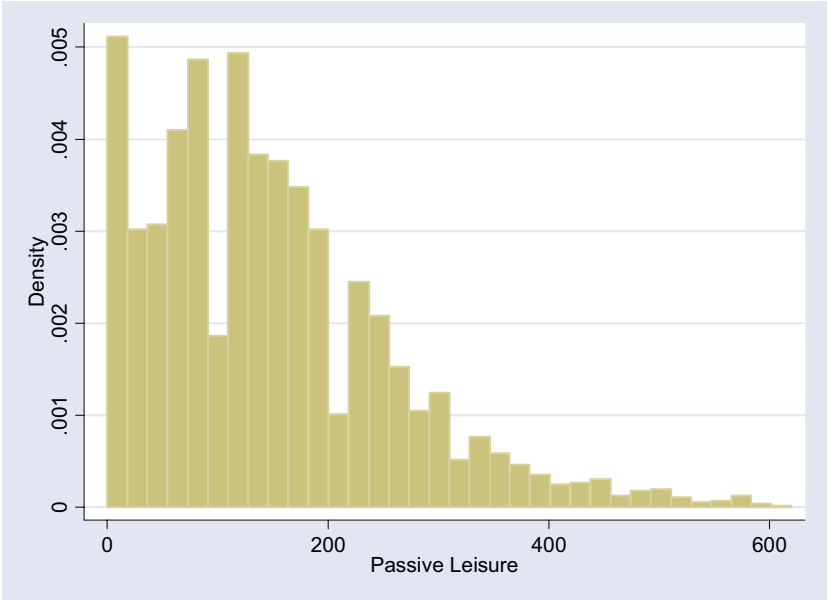
		Pagan-Vella Conditional moment		Pregibon link test		Smith-Blundell exogenity test	
		Test value	**Prob > Chi2**	**Hatsquar t**	**Prob>|t|**	**Test value**	**P-value**
Active narrow	**Male**	20.399	0.000	-0.73	0.463	3.719	0.054
	Female	9.537	0.008	-0.37	0.709	-3.096	0.789

Appendix 3 Distributional Plots of Active and Passive Leisure

Active Leisure



Passive leisure



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ESSAY 4.

More than Two Hands: Is Multitasking an Answer to Stress?

Abstract:

Time stress is the subjective experience of not being able to do all the desired or expected activities in a given time. Multitasking could be a response to the time stress experience. Concentrating on the multitasking in a housework and leisure, we investigate the factors that determine whether multitasking is done and the amount of it. The principal determinant for multitasking seems to be the amount of human capital. We look at the effect of rush on the incidence of multitasking. We find evidence that in some cases rush during a day has a negative impact on the amount of multitasking and experience of rush generally has a positive impact. Net wage rate, which is the shadow price of time, has a negative impact on the amount of multitasking, even when controlling for market work hours.

1 Introduction

Multitasking occurs when a person performs many activities at the same time. An example of this is a mother who cooks dinner while minding a child. Within time use surveys there exists extensive information about multitasking, and this information has been largely unexplored. In time use surveys a respondent usually records a secondary or even a tertiary activity in addition to a primary activity in the diary sheet. This information can be used to examine the extent of simultaneous time use within households. How often are the activities performed solitarily and how many times simultaneously? Is leisure mixed with housework and how much?

It is surprising to note that many of the standard treatises in time use merely mention secondary activities, but do not analyze them further.

When discussing time use trends in the United States, Robinson and Godbey (1997) hypothesize that Americans are better than people from rest of the world at doing many things simultaneously, but give no evidence on their claim. Gershuny (2000) mentions the recording of multiple activities, but does not analyze the data in his review of post-war time use.

One reason for this is the fact that even through many time use surveys have information on secondary activities, the variability is large. For example Gronau and Hamermesh (2001) report that there are great variations in different national datasets on the amount of multitasking. For example, the Australian Time Use Survey from 1992 reports secondary activity only in 5 percent of the time use records. The Swedish HUS data from years 1993-94 gives a secondary activity in less than third of the time-periods during the day. In Germany secondary activity is reported in 95 percent of the time-periods.

In contrast to multitasking, work-related stress has commanded a lot of attention from researches. In addition to the work place, lack of time and rush can cause stress during off-work hours. This is called time-stress. The adverse effects of a demanding market work and housework have been studied in the double burden literature. Other than that, economists have not studied time stress very much. A notable exception is the Hamermesh and Lee (2003) paper, where they try to determine whether people with higher education experience more stress.

Does multitasking mean that a person has a choice or is forced to do many things at the same time? In the double burden literature, for example Bittman and Wajcman (1999) argue that multitasking means that women have to do more tasks than men and that multitasking lowers the quality of women's time. In this paper we challenge their claim and argue that multitasking is a normal response to time pressure and most of the time multitasking introduces elements of leisure into the passage of time.

When a person experiences time stress, he/she responds in a number of ways. One possibility is to do activities in shorter period of time. The other response can be the attempt to do many activities at the same time.[1] This possible link between stress and the amount of multitasking has not been explored. Increased time pressure can cause people to economize their time use and by engaging in multitasking.

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[1] These two responses has been named time-deepening by Robinson and Godbey (1997).

There is some evidence to suggest that women do more multitasking than men. According to claims in the literature, taking multitasking into account when looking at housework and leisure gives a more negative picture of gender equality. As women do more multitasking during their leisure time, their leisure is in effect of lower quality than male leisure. Women also experience more interruptions during their leisure than men.

If multitasking is a method of coping with stress, then the greater amount of multitasking by women can be explained by their greater experiences of stress. If multitasking effectively solves the problem of the lack of time, then the gender question must be inspected in a new light. What seems to be an inequality problem can be interpreted as a rational response to different experiences of stress.

In this essay we estimate whether different measures of stress can explain the amount of multitasking done in the household during periods of housework and leisure. Our estimation is done using Finnish Time Use Survey from year 1999/2000 which has information on both the primary and secondary activities and also detailed income data that were merged into the original dataset. Because of the high recording rate for secondary activities, this information is especially suitable for studying multitasking.

Stress lowers the quality of life. Multitasking makes it possible to do many things at the same time. In this way it eases the time constraint, a primary cause of stress. By examining how multitasking is linked with stress, one can see more clearly the interaction of these two phenomena.

2 Defining Multitasking

It is difficult to define what multitasking means.[2] Usually it has been defined as doing many distinct activities in the same time period. There are two components in this definition: both the categorization of activities and the time frame used.

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[2] In this paper the word 'multitasking' is used to describe activities that are done at the same time. However, this phenomena has many names. Other terms found in the literature are 'overlapping activities', 'parallel activities', 'joint production', 'polychromic time use', 'concurrent activities' etc.

The estimates of the amount of multitasking depend on the level of aggregation used in categorization of activities. As Ironmonger (2003) points out, cooking and child care are two different activities that can be done at the same time. However, if these are recorded under 'household chores', then the incidences of multitasking become lost. The more detailed the list of separate activities, the more evident multitasking will be.

The time frame also has a bearing. If time use is looked at for very long time intervals, then more multitasking is recorded than in the case of short time intervals.

Juster and Stafford (1991) claim that different activities are usually performed sequentially rather than in parallel. According to them, if the measuring grid for time were fine enough, secondary activities would disappear. This assertion cannot be tested with our data. Although different time use surveys have used different lengths of basic periods, all of them have been adequately long as to give rise to multiple activities.

The nature of activities has also a bearing on multitasking. Pollak (1999) proposes the division of simultaneous activities into two different categories: parallel and on-call activities. Parallel activities are two independent activities done simultaneously, as for example driving a car and listening to radio. On-call activities are those with limited options for doing other things because the one activity constraints the other. Usually the other activity is related to the care of another person. An example is cooking while watching a sleeping child. On-call activities have a stochastic time demand not found in parallel activities. Pollak notes that parallel activities are easy to aggregate but on-call simultaneous activities are hard to define and measure sensibly.

All these aspects of defining multitasking introduce some vagueness to the resulting categorization. In this study, we follow Statistics Finland's survey schema. The list of activities is quite disaggregated: 158 different activities. This increases the likelihood of recording many activities at the same time. The list of possible activities has both parallel and on-call activities in the sense of Pollak. Therefore the range of activities is large and this further increases the possibility of multiple activities occurring. And finally, the ten minute interval used guarantees that there are episodes of multitasking in the diaries.

3 Defining Stress

In their survey of the development of stress research, Cooper and Dewe (2004) note that the study has been plagued by the confusing use of the term throughout its history. They note that there has been a wide variation in specific uses, definitions, and purposes to which the term "stress" has been applied.

Stress is usually connected to the lack of necessary means to accomplish a desired goal. The concept of stress has been historically linked to market work, and the study has its origins in the organizational health psychology.[3] Only lately has stress been connected with leisure as well.[4] The term has been associated with the time crunch and gender equality aspects of the time use during off-work hours.[5]

As we are interested in stress during leisure, the more suitable term would be 'time stress' to distinguish it from the work stress. 'Time stress' is the term used also by Hamermesh and Lee (2003). Naturally stress in the workplace and at home are linked. The length of day, the mental and physical demands from the job, and the pace in the workplace can spill over to leisure time.[6] However, this need not to be inevitable.

Time stress can be defined in various ways. Hamermesh and Lee (2003) define it as "physical, mental or emotional strain or tension." Piekkola (2003) gives an operational definition, defining stress as the simultaneity of three conditions: health problems, rush and double burden.

Piekkola (2003) notes from Finnish data that in younger age cohorts there is no correlation between indicators of stress and the length of the work day, but in older age groups there is a clear link between the two. Moreover, it seems that one cause of work stress is not the length of the day per se, but the difference between the desired hours and the actual hours of work. According to Piekkola (2003) there is a clear correlation of the feeling of rush and the disparency between desired and actual hours.

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3 Cooper and Dewe (2004) is an excellent survey of the development of the research field.

4 One can naturally question, whether the use of the concept of stress to describe feelings of anxiety and pressure during a leisure time is an appropriate use of the term.

5 An example is Bittman and Wajcman (1999).

6 For example Robinson and Godbey (1997) report on the National Center of Health Statistics survey where respondents were asked if they had experienced stress during last two weeks or a year. This question related not just to work but to the individual's overall life situation.

It should also be remembered that in Finland for example, work place surveys show that over 85 percent of workers are satisfied with their work and 80 percent think that their skills are sufficient in comparison to the demands of the job. This seems to imply, therefore, that there can be independent causes for off-work stress and the stress at work can coexist with unstressed leisure time or vice-versa.

As Cooper and Dewe (2004) note, it is possible to clinically measure stress by examining the level of the stress hormones, adrenaline and nonadrealine, in the urine. In social sciences, however, the subjective assessments are the base for measuring stress. In time use surveys, stress can be measured by looking how people have responded to a set of questions.

Time stress could be defined as the subjective experience of not being able to do all desired or expected activities in a given time. It has to do with the ability to cope with time pressure. Because time stress is difficult to measure, time use studies do not pose stress-related question directly. Instead, a set of questions usually asks about those aspects of time use that give rise to an experience of stress. In Eurostat guidelines for harmonised time use surveys (HETUS) three questions are used as proxies for stress: (i) How often does the respondent feel rushed. (ii) Does the respondent feel time pressure during weekdays, and (iii) does the respondent feel rushed during the diary day that he/she has completed. Whether these questions are able to indicate the presence of stress is, naturally, open to criticism.[7]

Even in an identical situation, two people can experience different levels of stress. Stress can also depend on age. Piekkola (2003), for example, notes that people aged 45-54 report more stress than other age groups. There can also be socially accepted conventions of complaining about stressful situations. For example Robinson and Godbey (1997) point out that in the United States the amount of leisure is usually regarded to be much less than what is revealed in time use studies.

There has been an indication that the feeling of stress has increased in most of the Western countries over the time it has been measured. This might be changing. Referring to the 1995 time use study follow-up

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[7] A question related to time stress, although not measuring it directly, asks a respondent to name the activity on which the respondent would like to spend more time, if possible. Pääkkönen and Niemi (2002) report the responses from working parents with children under seven years of age, who said that they suffered from lack of time. Slightly over 20 percent would like to do more sports and approximately 20 percent would do more housework. Reading more was the third most popular alternative.

Robinson and Godbey (1997) note that in the United States the share of those reporting stress has declined during the1990's. This is evident across all socio-economic groups. Women still experience more stress, but the gap in reporting stress between men and women has narrowed.

We use both the indictor for the general feeling of rush and the feeling of rush during the diary day as indicators of stress. Naturally, these are imperfect proxies for stress. However, with a positive response to these indicators, a respondent is stating that in his various life situations there are some symptoms which can be linked with stress.

4 Previous Literature

There are three strands of literature relevant for studying the link between multitasking and stress. The first concerns the incidence of stress, the second the determinants of multitasking and the third the related gender questions.

4.1 Stress Literature

Hamermesh and Lee (2003) propose a model on the determination of stress. However, they do not include the multitasking aspects of the stress. By constructing a Beckerian household production model, they argue that the feeling of stress is linked to the shadow price of time. As people have more income, they can buy more things. But consumption takes time, which people have in a fixed quantity. This creates time stress: inability to consume what money can buy. The increase in income raises the shadow price of time. They argue that that this increase in shadow price of time will add to the feeling of stress. In contrast, all the factors which decrease shadow price of time should decrease stress, such as an advanced efficiency in household production

In the empirical part of the Hamermesh and Lee paper data on income are linked to the respondents' declaration of stress. They used data from Australia, Canada, Germany, Korea and United States. The Australian, American and German data were household panels, which did not have information on the daily time allocation, while the Canadian and Korean data were time use surveys, which also had information about feelings of stress.

They found support for their hypotheses: people with higher income experience more stress. Moreover, women experience more stress than men and the presence of children increases stress. In addition, when one spouse is stressed so is the other.

Ehling (1999) studies the incidences of stress and time pressure using German Time Use Survey from the years 1991/92. Out of a set of questions describing the incidences of stress he constructs an index of stress, which is then linked to a set of explanatory variables using discriminant analysis. He observes that full-time employees, those aged between 30-45, and those with young children have the highest incidences of stress.

4.2 Literature on Multitasking

There is a surprising lack of literature on estimations of the time used in multitasking. In one of the few studies available Floro and Miles (2001) look at the determinants of housework, shopping and volunteer work as a secondary or tertiary activity utilizing the Australian National Time Use Survey from the year 1992.

Floro and Miles concentrate only at secondary and tertiary activities in connection to housework, shopping and voluntary work. Other secondary or tertiary activities, like leisure, are not investigated. This means that leisure as a secondary activity while doing some housework as primary activity is excluded from the analysis.

In Australian Time Use Survey over a third of all time periods had at least one other simultaneous activity reported by those that recorded some activity. In these cases, when the quantity of housework, shopping and voluntary work done as a secondary or tertiary activity is included in the time use of these activities as a primary activity, the total time use for these specific activities rises by 25 percent.

Floro and Miles note that twice as many women than men report doing additional housework, shopping or voluntary work as an extra activity. Also child care is done more by women both as a primary and secondary activity. Depending on the weight used for these additional activities, the time spent on child care by women becomes either twofold or threefold. For men the time spent with children increases four and half fold or doubles. The total hours spent by women doing more additional activities, if calculated mechanically, increases 44 percent. For men the increase is around 20 percent.

Floro and Miles (2001) estimate five different Tobit equations in order to explain the determinants of housework, shopping and volunteer work as secondary activities. In this framework the decision whether or not to engage in multitasking and how many hours involved cannot be separated: it is assumed that the same variables affect both decisions in a similar manner. Their basic model explained multitasking with gender, age, education, children and income. This basic model was subsequently enriched by a dummy for work at home, health condition of children, multiple jobs and employment status.

According to their result, the time used in these secondary activities is mostly gender related. Women do more housework, shopping and volunteer work than men. Age reduces while the number of children increases the time used in these activities. The level of education also increases time spent in these activities. However, income decreases the time used in housework, shopping and volunteer work, especially after a certain threshold. Interestingly the unemployed, part-time workers and people not in the labour force seem to do more of these activities than the fully employed.

The problem in Floro and Miles (2001) study is that the dataset did not match primary and secondary activities with each other. There is information on the aggregate amount of different activities but no details as to what secondary activity was done in connection with a given primary activity.

4.3 Gender Aspects

Multitasking can also be studied from the gender perspective. Bittman and Wajcman (1999) look at the gender equality implications of multitasking within households. They argued that there are qualitative differences between the leisure time of men and women. These differences are manifested in two factors: The amount of secondary activities done in addition to leisure and the length of uninterrupted leisure that spouses are able to enjoy.

Bittman and Wajcman concentrate on the leisure as the primary activity and divided secondary activities into leisure, market work, housework, and personal care. As indicators of the quality of leisure they use the duration of the longest leisure episode and the number of leisure activity periods within a day.

A third criterion is the presence or absence of children. The absence of children is considered to result in higher quality leisure. This is surprising

as most of the datasets with information on the enjoyment of different activities show that time spent with children is ranked very high.[8]

Their dataset is 1992 Australian Time Use Survey where they selected a sample of 9544 persons. A secondary activity was reported for half of the leisure time. A third of the secondary activities combined with leisure were also leisure related activities. When housework was a secondary activity, 70 percent of that housework constituted child care.

The data on time use showed that men had slightly more leisure without secondary activities than women. Women had more leisure which was combined with housework than men, and men had longer periods of unbroken leisure than women. In most cases the presence of children was the key determinant of the amount and structure of spousal leisure.

Piekkola (2003) investigates with data from the Finnish Time Use Survey from 1999/2000 Bittman and Wajcman's observation that there is discrimination in the time use between spouses. He shows that the total uninterrupted leisure is of the same duration for both males and females in Finland. Also the claim that women do more activities than men was not supported with Finnish data if only leisure is considered.

Another way to look at the gender inequalities in time use is employed by Phipps, Burton and Osberg (2001). Using self-reported satisfaction with time for oneself found in the Canadian General Social Survey from year 1990 as a dependent variable they explain the satisfaction measure with working hours, income, number of children, share of income, educational level, age and demographic variables.

Their results indicate that an individual's dissatisfaction with time for oneself increases with the market work hours for both genders. The presence of children lowers the satisfaction with own time for women and also for men but to less extent. Income, although significant, has a very limited impact on the satisfaction with time for oneself.

The results of Phipps, Burton and Osberg can be taken to measure the opposite element of stress, the satisfaction with time. Therefore their results could be interpreted to provide some indirect measures of the variables that decrease time stress. However, their result that the presence of children lowers the satisfaction with own time is surprising because there is evidence from Sullivan (1996) and Hallberg (2003) that time spent with children is usually rated very high.

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[8] See for example Sullivan (1996).

The literature thus points to varying conclusions. There seem to be a number of factors that increase the likelihood of stress and dissatisfaction with time, ie being a woman, having long working hours and having children. If full time employment brings high income, then Hamermesh and Lee's finding of the relationship between income and stress is not surprising. Interestingly, the same profile is at the centre of the double burden literature on the gender inequality. And indeed, this profile is the same for those that have a high incidence of multitasking. The connections between stress and multitasking will be studied next.

5 Model

In this paper multitasking is studied by adopting Hamermesh and Lee's (2003) model on the determination of stress. The model is as follows:

Household's utility function has two additively separable subutility functions: one for household consumption U and one for market work V.

$$U\left(Z_1, Z_2\right) + V\left(l_f, l_m\right)$$

where Z_i (i=1,2) are basic commodities and l_f and l_m are the hours of market work by the wife and husband, respectively. Basic commodities in a Beckerian sense are produced by household production function

$$Z_i = Z_i\left(T_i, X_i\right), \quad i = 1,2$$

where T_i is the time and X_i are the commodities used in producing basic commodities.

The household production process is assumed to be first order homogenous with fixed coefficients

$$T_i = t_i Z_i \text{ and } X_i = b_i Z_i \text{ for } i = 1,2.$$

The household faces a budget constraint $\sum p_i X_i = l_m w_m + l_f w_f + I$ where w_m is the wage rate of the husband, w_f is the wage rate of the wife, I is the non labour income, and p_i is the price of the commodity i.

Households also face time constraint $\sum T_i = T - l_m - l_f$.

The household maximization problem then becomes

$$U(.)+V(.)+\mu\left(w_m l_m + w_f l_f + I - p_1 b_1 Z_1 - p_2 b_2 Z_2\right)+\lambda\left(T - l_m - l_f - t_1 Z_1 - t_2 Z_2\right)$$

where μ is Lagrangian multiplier to the budget constraint and λ to the time constraint. Hamermesh and Lee concentrate their investigation on the Lagrangean multiplier λ of the time constraint, which can be taken as the shadow price of the time. In all cases:

$$\frac{\partial \lambda}{\partial T} < 0,$$

which means that an increase in time reduces the feeling of stress. It should be noted that as the day has a fixed number of hours, relaxation of the constraint is to be taken to mean any procedure that adds to the effective time available like growth of productivity achieved, for example, through multitasking.

The additional conditions in order for the following results to hold is that the value of home time must increase more in response to an increase in unearned income than the value of time in the market and one of the spouses has fixed market work hours.

This can be represented as:

$$w_f U_{11} U_{22} < V_{22}\left[p_2 b_2 t_2 U_{11} + p_1 b_1 t_1 U_{22}\right].$$

In this case

$$\frac{\partial \lambda}{\partial I} > 0,\ \frac{\partial \lambda}{\partial w_m} > 0 \text{ and } \frac{\partial \lambda}{\partial w_f} > 0,$$

which means that an increase in non-labour income or wage rates should increase the feeling of stress. When the assumption of fixed market work hours is relaxed for either spouse, the results turn ambiguous.

We propose to use the incidence of multitasking as a response to time constraint. People who experience a high shadow price of time should try to extend the time available by doing more things simultaneously. Therefore an increase in net wage rate, the feeling of rush and time-pressure should increase the occurrence of multitasking. Whether this is the case is studied next with Finnish data.

6 Sample

The dataset used in this study is the Finnish Time Use Survey 1999/ 2000 by Statistics Finland. The data were collected according to the Eurostat guidelines for harmonized European Time Use Surveys during years 1999-2000 and resulted in time use data for 10561 days. A sample taken included 15-year old Finns and every person over 10 years of age from the same household was interviewed and asked to keep time use diaries for two days consisting of one weekday and weekend day.

The final sample had 5224 individuals who had both responded to the interview and kept diary for two days. A subsample of households where adults were between 18 to 65 years of age is selected. Both adult members of the household have to be either employed, unemployed or taking care of the household.[9] This gives a sample of 784 households with 1568 adult members. The net wage rate for all the sample is derived by estimating Heckman selection model. An estimate of hours of work is imputed for each person.[10]

Table 1 gives descriptive statistics for the sample used in this study. The average age is 43 years for males and 41 years for females. The households have on average only one child. The imputed hourly wage rate is calculated by Heckman's method. The imputed hourly net wage rate is 9.5 euros for males and 8.1 euros for females. The males have on average annual non labour income of 1 183 euros and the females had 869 euros per year. In the sample 96.2 percent of males and 83.3 percent of females are employed. Just 3.4 percent of the males are unemployed and 7.0 percent of the females. Only 0.4 of males and 9.7 percent of the women are homemakers.

Some coding conventions were used by Statistics Finland when transferring primary and secondary activities into data records. If a subject

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9 Some technical deletions are made: these include households with missing diaries, with inconsistent information on the number of children, with two adults of same sex, or with married status but living separately. Also excluded are thos working full-time but having no fixed working schedule. Also households are excluded with missing income variables, which have hourly wage-rates clearly resulting outliers and households where members have negative work-experience. Also people who hold two jobs are excluded as well as households where some children are also working.

10 For detailed information see introductory essay in this theses.

Table 1 Descriptive Statistic for the Sample

	Male	Female
Net hourly wage rate (euro)	**9.5**	**8.1**
Non labour income (euro)	**1 183**	**869**
Age	**43**	**41**
Number of Children	**1**	**1**
Basic schooling	**24.5 %**	**20.0 %**
Secondary schooling	**41.6 %**	**40.6 %**
University level schooling	**33.9 %**	**39.4 %**
% employed	**96.2 %**	**83.3 %**
% unemployed	**3.4 %**	**7.0 %**
% homekeepers	**0.4 %**	**9.7 %**
	n=784	**n=784**

recorded two activities as a main activity, a selection was performed. If one activity seemed to result from the other then the primary activity was designed as the main activity. If two independent activities were given, the first mentioned was assigned as primary activity. If activities were sequential, then the longest was coded as the primary activity.

Each respondent recorded his/her primary and secondary activity for ten minute intervals for two diary dates. The recording of secondary activity was obligatory. Each household member recorded the same days.

Certain rules concerning the assignment of time use categories were also applied. Market work was always classified as primary activity, regardless of secondary activity. Lunch breaks during a work day were coded as secondary activity, if other activities were pursued. However, if no secondary activity was done during a lunch break, then it was classified as primary activity. There were a number of similar schemas. Awake in bed, sick in bed, resting and inactivity were coded as secondary activity, if other activities were done simultaneously. The same applied to visiting and receiving visitors, drinking alcohol and talking on the phone.

A number of questions regarding stress in the Finnish Time Use Survey were introduced.[11] The first question and the admissible answers

[11] The questions followed the recommendations of the Eurostat guidelines for harmonised time use.

were: "How often do you feel rushed? Would you say that you a) always feel rushed, b) only sometimes feel rushed, c) almost never feel rushed ". The second question looked at the time-pressure and it was targeted to those who had answered that they always or sometimes feel rushed. The question was "Consider the way you spend your time on weekdays. Do you often feel that time is too short for doing all the things you want to do?" The admissible answer was "yes" or "no".[12] The third question was recorded in a diary. After completing the diary the respondent was asked whether he/she felt rushed during the recording day.[13]

In this paper we concentrate on the primary time use categories of housework and leisure. Housework includes cooking, cleaning, shopping, caring for a child, gardening, repairing and managing the household. Leisure includes social life and entertainment, sports and outdoor activities, volunteer work and organizational activities, reading, watching TV and video, listening to music, hobbies and games.[14]

Housework and leisure can be combined with housework, leisure and personal care as secondary activities. Personal care includes eating, sleeping, resting, washing and dressing. We have categorized lunch breaks during a market work as personal care, although those are usually classified under market work time.

7 Some Preliminary Investigations on the Amount of Stress and Multitasking

The respondents were asked how often they felt rush. Three possible answers were: that they felt always rushed, only sometime or almost never. The other measure of the subjective feeling of the time pressure was whether or not respondents experienced lack of time. A third question concerned whether the respondent had been in a rush during diary day.

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12 There was also an additional question which tried to ascertain where the lack of time is experienced. It was "On which activity would you like to spend more time, if possible?" Only one activity was admitted as an answer.

13 The possible bias introduced by the interviewer could have been presented only for the first three questions. Due to the general nature of these questions, it is unlikely that interviewer could have had a significant impact on the answers.

14 For a more extensive list see Appendix 3 in the introductory chapter of this thesis.

Table 2 Rush and Gender

How often do you feel rushed		
	Men	Women
Always	27 %	27 %
Sometimes	58 %	62 %
Almost never	15 %	11 %
Do you feel time is too short during weekdays		
	Men	Women
Yes	62 %	67 %
No	38 %	33 %
Did you feel rushed during a diary date		
	Men	Women
Yes	28 %	29 %
No	72 %	71 %

Answers are presented in table 7. We see that there is surprisingly little variation between men and women. The same percentage of men and women answered they always felt rushed. Also feeling of rush during a diary day was almost the same. Regarding the question about the rush during weekdays, there was a five percentage point difference between women and men. These figures are at odds with data from other counties, where women usually report larger incidences of stress.[15]

Table 3 Rush and Educational Level

		Educational level		
		Basic	**Secondary**	**University**
Rushed	**All the time**	22.0 %	24.8 %	32.1 %
	Sometimes	62.4 %	59.9 %	58.9 %
	Never	15.6 %	15.4 %	9.0 %

Pearson chi2 (4) = 42.0119 Pr = 0.000
Kendall's tau-b = -0.1013 Asymp. Standard Error = 0.016
Gamma = -0.1695 Asymp. Standard Error = 0.027

15 See for example Robinson and Godbey (1997).

Table 3 gives the distribution of the feeling of rush according to the educational level. As can be seen more educated people responded to being more in a hurry than those with less education. We tested to determine if this effect was significant with Pearson's chi-square, Kendall's Tau-b, and Gamma-test and all tests indicated that there is association between education and time-pressure.

The feeling of lack of time also increased with educational level. Little over half of the people with basic education said they were suffering from time pressure, whereas three quarters of those with university education reported the same. A third measure concerned the feeling whether the respondent had been in a rush during the diary day. Interestingly a third of the respondents in all educational levels gave a positive answer, and there was no correlation between this and the educational level.

One conjuncture in the Hamermesh and Lee's (2003) paper is that there is a link between incidences of stress and educational level. Finnish data seem to support this with regard to general feelings of rush and time-pressure but not with regard to feeling rush in a particular day.

Table 4 gives information on the feeling of being rushed and employment. As expected, there is a clear difference between individuals who are unemployed and those who are not with respect to the experience of always being rushed

Table 4 Rush and Employment Status

	How often do you feel rushed?		
	Employed	**Housekeepers**	**Unemployed**
Always	29 %	23 %	2 %
Sometimes	60 %	53 %	61 %
Almost never	11 %	24 %	37 %

A common conjecture is that people with children experience more stress. We will look at this as a percentage of the male and the female respondents who report general rush or rush during the diary date by the number of children in the household. This is presented in table 5.

Table 5 Rush and the Number of Children

	Rush During Diary Day		General Rush	
Number of Children	**Female**	**Male**	**Female**	**Male**
0	30 %	26 %	86 %	78 %
1	26 %	27 %	83 %	70 %
2	28 %	28 %	90 %	84 %
3	33 %	32 %	92 %	80 %
4	50 %	42 %	100 %	75 %

We note an interesting fact that a higher percentage of people without children feel general rush or rush during the day than those with one child. Two and more children increase these figures further. A 10 percentage point difference exists between men and women regardless of the number of children in feeling general rush. However, there is virtually no difference between men and women in reporting rush during a diary day.[16]

Next we turn to the data on multitasking. Total housework and leisure time can be divided into time periods when only one activity is performed or periods when multiple activities are performed simultaneously. The percentage of people doing some multitasking is presented in table 6.

Table 6 Prevalence of Multitasking in the Households by Gender

	Total		**Housework**		**Leisure**	
	Male	Female	Male	Female	Male	Female
Weekday	91.9 %	95.7 %	47.4 %	76.4 %	90.4 %	93.4 %
Weekend	88.0 %	94.5 %	52.7 %	77.1 %	85.9 %	91.5 %

If we look at the housework and leisure together a majority of the interviewed people have recorded some multitasking during that period. Females do more multitasking than males. The clear difference between genders can be seen if we look at the percentage of persons who have recorded multitasking during housework or leisure. The low figure for

[16] The age of the children is also important factor in the parent's work load. We did not analyze the feeling of rush by the ages of children.

housework for males mirrors the fact that less housework is done by males. Also the higher figure for multitasking in housework during weekends reflects the higher overall time use in this activity.[17]

There can be various reasons for the lack of observations on multitasking. First a person might have done some multitasking activities, but has failed to record it. Second, the person has not done any multitasking during the diary day, but does multitasking on some other days, and third the person never does any multitasking.[18] In order to take the zero observations into account we use Heckman's selection model, which separately estimates the probability of observing multitasking.

Consistent with the Floro and Miles (2001) data on Australia on average a third of leisure and housework is spent on multiple activities by people, who have recorded some multitasking.[19] This is shown in table 7.

Table 7 **Multitasking in Housework and in Leisure, According to Gender** (of those that have reported some multitasking)

	Total	Male	Female
Total time in housework	226	174	274
of which multitasking	61	37	83
% of multitasking	27.0 %	21.3 %	30.3 %
Total time in leisure	449	474	425
of which multitasking	136	134	138
% of multitasking	30.3 %	28.3 %	32.5 %

If we look at the composition of housework we can see that out of the aggregate 3 hours 46 minutes approximately one hour is used for doing other activities besides housework. There are marked gender differences in the multitasking. In doing housework women engage over two times more often in multitasking than men. Men do less than 40 minutes of

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17 The reason why the total is higher than housework and leisure in separation. Is that there are some persons that have not reported any leisure during the day. Vice versa there is also persons that have not done any housework just leisure.

18 These same problems also occur in household expenditure surveys and other surveys where the recording period is short.

19 The difference between Australian and Finnish data is that in the Finnish data a greater number of people have indicated as having done multitasking.

multitasking per day while women do over 1 hour 20 minutes. This is explained partly by the fact that women on average do over one hour and forty minutes more housework.

It is interesting to note that both genders do secondary activities besides leisure almost the same absolute time 2 hours and 15 minutes. However, as males have more leisure as their primary activity, this reduces the share of multitasking of the total leisure time.

Table 8 **Multitasking during Weekdays and Weekends in Minutes and as a Share of Time Spent on Housework and Leisure** (of those that have reported some multitasking)

Minutes	Male	Female
Weekday	135	187
Weekend	200	252
%	Male	Female
Weekday	27 %	31 %
Weekend	26 %	32 %

Multitasking increases by more than an hour for both genders during a weekend day (table 8). This is a reflection of the increase in total time spent doing housework or in leisure. Interestingly the share of multitasking stays constant regardless of whether it is a weekend or a weekday. Men use slightly less than a third of their total time for multiple activities while women use a third.

By plotting time periods in sequential order, it is possible to find out when multitasking is most frequently done. These are presented in Figures 1 and 2, which show that more variation in multitasking occurs during weekdays. There are few periods of intensive multitasking. The highest point is reached around 7.30 AM and high points also occur at 5.30 AM, 10.30 AM, 2.00 PM, 3.30 PM and 5.30 PM. These time periods can be linked to the organization of work day. At 7.30 AM people get ready for work[20] At 10.30 AM is the first pause or coffee break. From around 12.30 PM to 6.00 PM, i.e. during the whole afternoon an increased amount of multitasking is done at the workplace. These most probably are leisure activities in addition to work, like listening to a radio.

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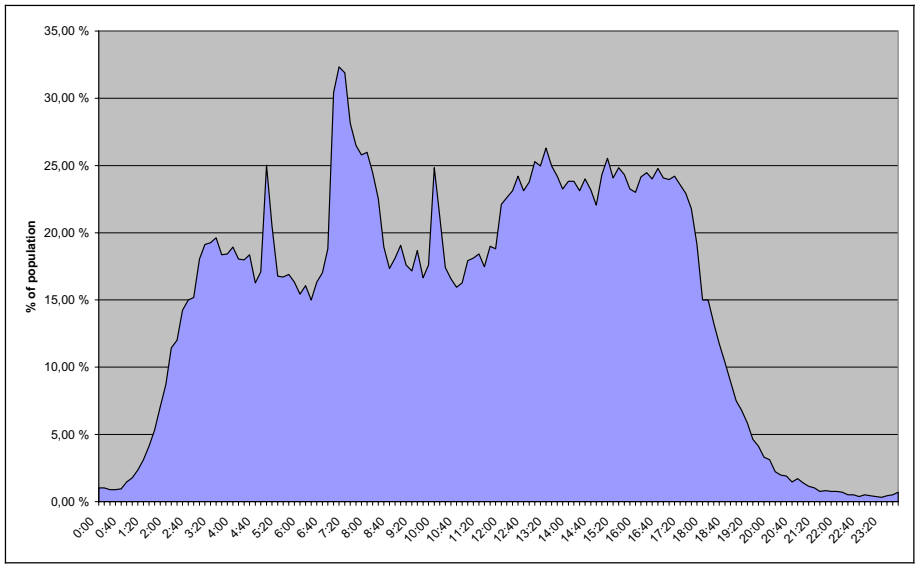
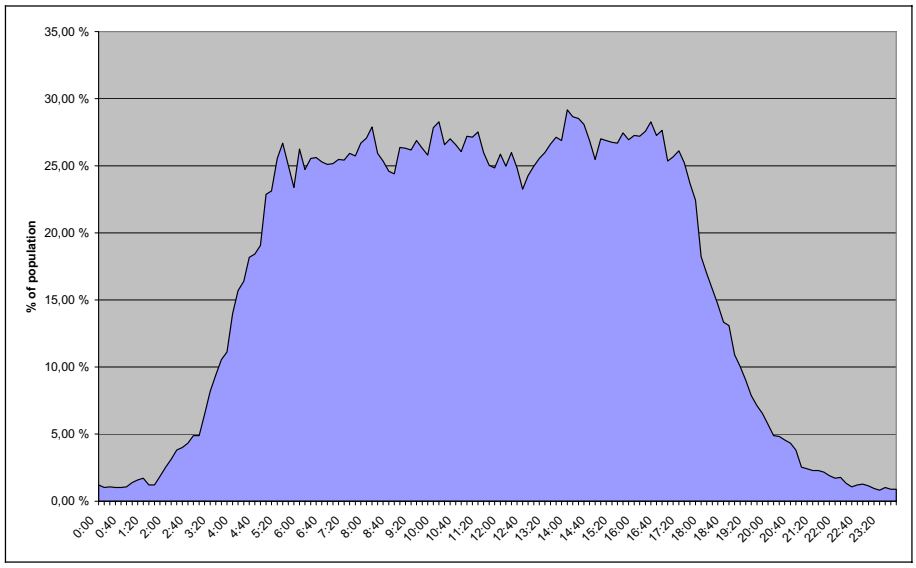
[20] Some even at 5.30 AM.

Figure 1 Multitasking During a Weekday from Morning to Midnight



Over the weekend multitasking is much more evenly spread over the entire day. The rise in multitasking occurs later than during a weekday and remains more stable, with no clear peaks or troughs in the data.

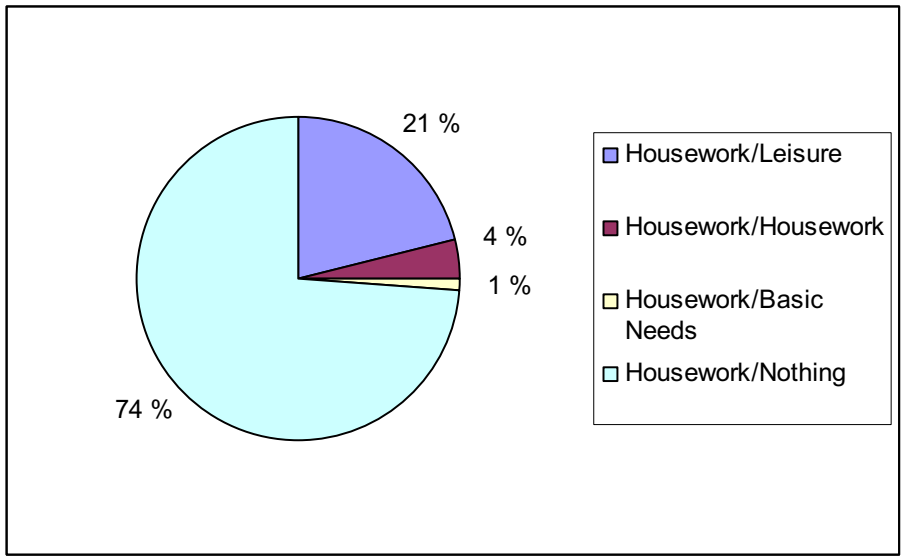
Figure 2 Multitasking During a Weekend from Morning to Midnight



It is interesting to see the types of activities performed when the primary activity is either housework or leisure. The largest secondary activity

while doing housework is leisure. This is shown in table 9 and in Figure 3. If we look at the total time used for housework, some leisure activity is done in little over 20 percent of that time besides housework. Of all secondary activities done besides housework, these leisure activities command over 80 percent of the total. This is the case for both males and females.

Figure 3 Multitasking during Housework



The second largest secondary activity is housework itself. This accounts, however, for only 4 percent of the time used in housework as primary activity. Basic needs are done in addition to housework in only 1 percent of the time used in housework.

If we look at the secondary activities carried out while leisure is a primary activity, leisure activities themselves stand out as the most common secondary activity. See figure 4. Of all time spent in leisure, exactly a fourth is spent on some other leisure activity at the same time. If we look just at the instances when multiple activities are done besides leisure, leisure activities as secondary activities command almost 80 percent. Women combine more housework with leisure as a primary activity than men. Both men and women have personal care activities as secondary activity in 3 to 4 percent of the cases.

Figure 4 Multitasking during Leisure

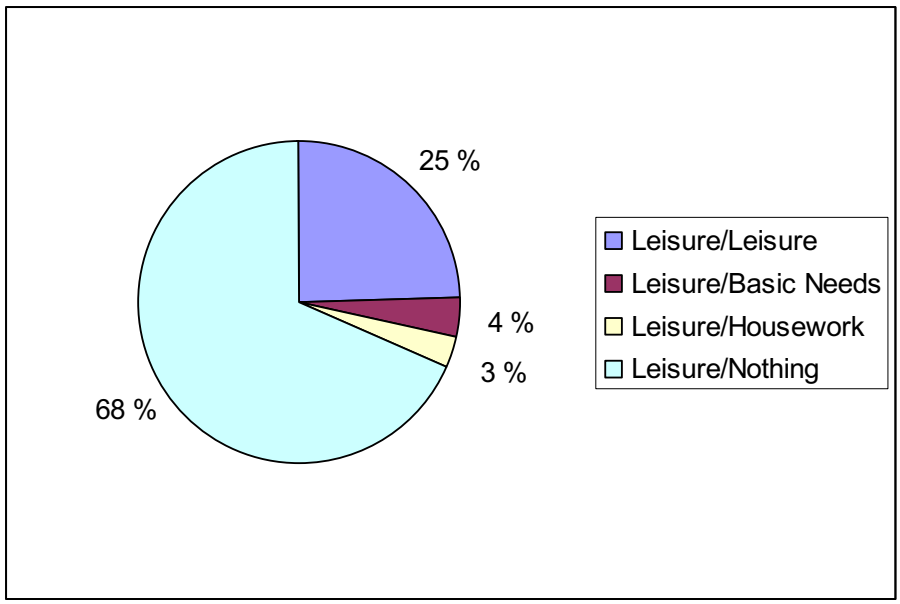


Table 9 Distribution of Secondary Activity When Primary Activity is Either Housework or Leisure (in percentages)

Activities Primary	Secondary	Total	Male	Female
Housework	**Housework**	4 %	3 %	5 %
Housework	**Leisure**	21 %	18 %	24 %
Housework	**Basic Needs**	1 %	1 %	1 %
Housework	**Nothing**	74 %	78 %	71 %
	n=	2963	1413	1550
Leisure	**Housework**	3 %	1 %	4 %
Leisure	**Leisure**	25 %	24 %	25 %
Leisure	**Basic Needs**	4 %	4 %	3 %
Leisure	**Nothing**	69 %	71 %	67 %
	n=	3138	1568	1570

These figures translate into variable lengths of time (table 10). For example, women combine housework with leisure activity as a secondary activity for over an hour per day. Men do the same for 30 minutes. Stating this the other way around; combining leisure with some secondary housework activity covers only 14 minutes per day in the case of women and six minutes in case of men. Both men and women do multiple leisure activities for almost 2 hours per day out of total leisure time of 7 hours.

Table 10 Duration of Secondary Activity When Primary Activity is Either Housework or Leisure (in minutes)

Activities Primary	Secondary	Total	Male	Female
Housework	**Housework**	11	5	17
Housework	**Leisure**	49	32	65
Housework	**Basic Needs**	1	1	1
Housework	**Nothing**	165	137	191
Total Housework		226	174	274
	n=	2968	1415	1553
Leisure	**Housework**	10	6	14
Leisure	**Leisure**	114	115	112
Leisure	**Basic Needs**	10	11	10
Leisure	**Nothing**	313	340	287
Total Leisure		449	474	425
	n=	3116	1548	1568

Bittman and Wajcman (1999) argue that men have longer genuine leisure times, if secondary activity is taken into account. We take pure leisure to include periods where leisure is the primary activity and no secondary activity is reported as well as those periods when both primary and secondary time period are reported to be leisure. Now our data show that men have 445 minutes of pure leisure while women have 399 minutes - a difference of 46 minutes per day. If we look at the shares of total leisure, then men and women have 94 percentage of pure leisure.

Based on these percentages Piekkola (2003) argues that Bittman and Wajcman's observation of gender inequality in leisure time is false. However, the result depends on whether one looks at leisure according to the percentage share or absolute time in minutes.

More serious criticism of Bittman and Wajcman's assertion is that they do not consider the type of secondary activity. As can be seen from the table 9 and figures 1 and 2 most of the secondary activities are leisure activities even when leisure is primary activity. In the case of women leisure is effectively interrupted by a simultaneous housework activity only in 4 percent of the time. This is clearly more then with men, where housework encroaches on leisure time only in 1 percent of the cases, which is hardly a serious hindrance to the enjoyment of leisure.

Moreover, Bittman and Wajcman do not consider housework. Women do more housework but they also have a greater share of the housework time during which a leisure activity is a secondary activity. The interpretation in this case cannot mean that if secondary activities are accounted for, this increases the amount of double burden for women. What the result indicates, is that there is an attempt to make housework more bearable by doing some leisure activity besides it.

There are gender differences between the most common secondary activities. These are presented in table 11. On average the most popular secondary activity for men is listening to the radio and watching TV. Socialising with family is ranked third. For women socialising with the family is the most popular secondary activity. This is followed by listening to a radio and talking with a child.

Table 11 Three Most Common Secondary Activities by Gender when Primary Activity is either Housework or Leisure

	Male	Female
1	Listening to Radio	Socialising with Family
2	Watching TV	Listening to Radio
3	Socialising with Family	Talking with a Child

In discussing the family care time, but without a specific reference to a country, Robinson (1999) notes that if one looks at the child care time, the inclusion of secondary activities adds nearly 50 percent to the total. Indeed, as Robinson and Godbey (1997) show, although the time used in child care as a primary activity has decreased, the overall time with chil-

dren which takes into account both primary and secondary activity has remained stable in the United States.

Doing many activities at the same time is an effective way to buy more time, when one is in a hurry. Therefore, it could be reasoned that individuals who report suffering from either lack of time or feeling hurry would try to do more multitasking. As the first test we look at the correlation between these measures and the amount of multitasking. The correlation coefficients for generally feeling rush and time pressure were just -0.01 and -0.04 and only the latter was significant. However, the correlation between multitasking in minutes and a dummy for feeling rush during a particular day was statistically significant and the correlation was 0.13.

8 Econometric Methods

We use Heckman's sample selection to estimate first the probability of engaging in multitasking and then to explain the determinants of the amount of multitasking. We believe that in using Heckman's model instead of some other method, like Tobit, we can capture the fact that the same variables have a different effect on the decision to do multitasking and the amount done.

Heckman's model allows the errors in selection equation and the errors in outcome equation to be correlated. This means that there are unobservable variables that affect both the probability to do multitasking and the amount done. If this is the case, then this correlation needs to be taken into account.

The Heckman (1979) model is based on the estimation of two simultaneous equations. We follow Puhani (2000) and name the first equation as an outcome equation. The second will be the selection equation.

The specification used will be:

$$H_j^* = x_j\beta + e_{1j}$$
$$M_j^* = z_j\gamma + e_{2j}$$

$$H_j^* = \begin{cases} H_j & if\ M_j^* > 0 \\ 0 & o.w. \end{cases}$$

where H_j is the daily amount of multitasking done by the person j if primary activity is either housework or leisure and the x_j are the exogenous variables and e_{1j} is the normally distributed error term. In the selection equation M_j for person j z_j stands for exogenous variables determining the selection and e_{2j} is the error term. These error terms have the following structure.

$$e_{1j} \text{ follows } N(0,\sigma),$$
$$e_{2j} \text{ follows } N(0,1),$$
$$\text{corr}(e_{1j}, e_{2j}) = \rho$$

If the estimates for Heckman model are calculated by using maximum likelihood estimation, then the log likelihood function is

$$l_j \begin{cases} \ln \Phi \left\{ \dfrac{z_j\gamma + \left(H_j^* - x_j\beta\right)\rho/\sigma}{\sqrt{1-p^2}} \right\} - \left(\dfrac{\left(H_j^* - x_j\beta\right)}{\sigma} \right)^2 - \ln\left(\sqrt{2\pi\sigma}\right), & \text{if } M^* \text{is observed} \\ \ln \Phi\left(-z_j\gamma\right), & \text{if } M^* \text{is not observed} \end{cases}$$

where Φ is a standard cumulative normal distribution.

In our model the exogenous variables in the outcome equation are the net wage rate and non labour income of the person, spouse's income, age-cohort dummies, dummies for educational level, the imputed market work hours, and the number of children. In addition to these the exogenous variables in the selection equation have a dummy for being unemployed or housekeeper and seasonal dummies.

In both equations we will include two measures of stress. The first is a dummy that indicates whether the respondent experiences rush all the time or sometimes. The second is the estimate whether the respondent had experienced rush during the recording day.

The third question in the survey is whether the respondent experiences the feeling of lack of time. This was not used, because the question was posed only to those that had answered positively to question of feel-

ing rush. This created the problem of some missing observations alongside with positive and negative answers. Therefore the question was dropped from the analysis.

An important qualification also concerns the fact that these questions come from different parts of the survey. The amount of general rush is asked during the interview part of the study, whereas the feeling of rush during the recording day is recorded in the diary.

There are two important practical aspects in Heckman's model: the normality assumption of error terms and the identification of the selection and outcome equations. The most serious problem concerns the underlying assumption that errors are normally distributed both in the selection equation and in the outcome equation.

As Pagan and Vella (1989), Vella (2000) and Puhani (2000) all note, there are very few tests constructed to test the normality assumption. We test this by using a procedure suggested by Pagan and Vella (1989, S51)[21]. First, the higher orders of linear predictions are multiplied by inverse of Mills' ratios and these are inserted into the outcome equation. Then the test for normality will be the joint test that the parameters of these terms are all zero.

The identification problem has to do with use of the same explanatory variables in both equations. If the explanatory variables are the same, there are no exclusion restrictions and the identification rests on the nonlinearity of Mills' ratio λ. This can create collinearity problems. In order to prevent this, we introduce variables in the outcome equation that are not contained in the selection equation or vice versa.

In Heckman's model the error terms in the selection and outcome equation can be correlated. If this is not the case, then both equations could be estimated separately and the resulting coefficients would be the same. When there is correlation between selection and outcome equation Heckman's model takes this correlation into account in estimating the coefficients and their standard errors. We employ a likelihood ratio test to determine whether the equations to be estimated are correlated.

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[21] This test is based on the mills-ratios. Another popular normality test of Pagan and Vella (1989), which is presented in the same article, relies on the score vector from the estimation.

9 Results

In order to get a general picture of the determinants of multitasking and the indicators of stress, we estimate a Heckman model separately for males and females as well as for weekdays and weekends. The estimation results are presented in table 13 for males and in table 14 for females.

A number of exogenous variables have a different impact on the decision to do multitasking and the amount done. This means that the Heckman's model reveals interactions which other less refined methods like ordinary least squares or Tobit, would have concealed. However, the test of no correlation between these equations could not be rejected for males and was rejected for females only during weekends. This means that most of these equations could have been estimated separately, if so desired. The fact that different variables behave differently in these equations justifies the use of Heckman's model.

For males during weekdays the dummies for both secondary and university education, indication of general rush and being a housekeeper have a statistically significant positive effect on the decision to do multitasking. Number of children has a negative effect on the multitasking decision.

As for the amount of multitasking done by men during weekdays, the dummy for university education has a significant positive effect. The higher the net wage rate and the more hours of market work done, the less multitasking is done by men during weekdays.

During weekends the age and season become significant in explaining the decision to carry out multitasking. Older age has a negative effect and winter and fall have a positive effect. Number of children has also a negative impact. As for the amount of multitasking done during weekends, the educational variables have a significantly positive effect on the amount of multitasking done.

With respect to indicators that affect the time constraint λ in Hamermesh and Lee's model net wage rate has a negative impact in case of men on the amount of multitasking. The indication of experiencing a general rush has a positive impact on the probability of multitasking. Rush during a day decreases the amount of multitasking over weekends. If high net wage rate or feeling or rush means that the shadow price of time is high and the answer to the high shadow price is multitasking, then the results from the data are in clear contrast to postulated behavioural implications. However, the positive association with the general feeling of rush over weekdays and the decision to do multitasking is in favour of the hypotheses.

Table 13 Determinants of Multitasking by Men During Weekdays and Weekends

	Weekday		Weekend	
	Outcome eq	*Selection eq*	*Outcome eq*	*Selection eq*
Net wage rate	-0.290*	-0.008	-0.381**	0.009
	(0.148)	(0.016)	(0.191)	(0.020)
Non labour income	0.001	0.002	0.051	0.014
	(0.015)	(0.003)	(0.051)	(0.010)
Age 35-44	1.716	-0.251	3.604	-0.714**
	(2.215)	(0.277)	(3.191)	(0.305)
Age 45-54	2.479	0.172	2.500	-0.734*
	(2.845)	(0.370)	(4.109)	(0.376)
Age 55-64	2.622	-0.377	1.793	-1.316***
	(3.459)	(0.431)	(4.875)	(0.445)
Secondary education	1.018	0.309*	4.089**	-0.034
	(1.322)	(0.172)	(1.928)	(0.163)
University education	7.024***	0.508*	13.278***	0.348
	(2.616)	(0.283)	(3.391)	(0.363)
Number of children	-0.039	-0.204***	-1.538*	-0.157**
	(0.578)	(0.071)	(0.789)	(0.067)
Market work hours	-0.083***	-0.004	0.010	-0.003
	(0.025)	(0.003)	(0.026)	(0.003)
Rush during a day	-1.538	-0.089	-5.796***	-0.139
	(1.052)	(0.153)	(2.037)	(0.172)
General rush	0.319	0.372**	0.241	0.015
	(1.219)	(0.170)	(1.726)	(0.142)
Spouse's income	0.011	-0.001	-0.013	-0.001
	(0.008)	(0.001)	(0.014)	(0.001)
Unemployed		-0.864**		-0.417
		(0.440)		(0.440)
Housekeeper		6.031***		5.680***
		(0.571)		(0.428)
Winter		0.275		0.333*
		(0.214)		(0.170)
Summer		-0.301		0.141
		(0.204)		(0.178)
Fall		0.163		0.363**
		(0.219)		(0.171)

Constant	30.881*** (8.187)	2.033** (0.884)	45.174*** (10.343)	1.266 (1.116)
Log pseudo likelihood	-1 680 428		-729 519	
Rho		-0.161		-0.175
Wald test of independent equations		chi2(1)=1.13 Prob > chi2 = 0.287		chi2(1)=1.58 Prob > chi2 = 0.210
Observations	784	784	784	784

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

The estimation results for females are represented in table 14. During weekdays, the dummies for having secondary or university education has a positive effect both on the decision to multitask and the amount done. Hours of market work have a significant negative effect on both the selection and the outcome equations. Being unemployed also decreases the amount of multitasking done. The amount is positively affected by being a 45-54 years of age.

As to the variables affecting time constraint, the amount of multitasking is negatively affected by the net wage rate. It is interesting to note also that the indication of having been in a rush during the day has a statistically significant negative effect on the amount of multitasking, while experiencing general rush has a positive effect.[22] Once again, it does not seem that multitasking is a response to the high price of time caused by high wage rate or rush. However the lack of time has a positive effect on the amount of multitasking during weekdays.

The estimation results for weekends indicate that the number of children has a negative effect on the decision to multitask, while feeling general rush, own non labour income and spouse's income increase the decision to multitask. The amount of multitasking done by females during weekends is positively affected by her university education and negatively by her net wage rate and number of working hours during weekends.

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[22] Estimations were also done using only either lack of time or rush variables in case of men and women. They did not change the results from the estimations that used both variables.

Table 14 Determinants of Multitasking by Women During Weekdays and Weekends

Women Multitasking	Weekday		Weekend	
	Outcome eq	*Selection eq*	*Outcome eq*	*Selection eq*
Net wage rate	-0.459*** (0.171)	-0.018 (0.022)	-0.432** (0.198)	0.006 (0.029)
Non labour income	-0.039 (0.039)	-0.006 (0.005)	-0.040 (0.044)	0.214*** (0.075)
Age 35-44	3.981 (2.597)	0.509 (0.369)	5.089* (3.084)	-0.328 (0.412)
Age 45-54	5.981* (3.237)	0.200 (0.465)	2.730 (3.813)	-0.455 (0.516)
Age 55-64	4.570 (3.747)	-0.323 (0.521)	3.141 (4.627)	-0.833 (0.580)
Secondary education	3.266* (1.797)	0.509** (0.218)	2.834 (1.972)	0.267 (0.191)
University education	7.851*** (2.625)	1.027*** (0.331)	8.561*** (2.835)	0.554 (0.402)
Number of children	0.680 (0.677)	-0.078 (0.101)	-1.160 (0.813)	-1.031*** (0.329)
Market work hours	-0.093*** (0.018)	-0.011** (0.005)	-0.063*** (0.018)	0.002 (0.003)
Rush during a day	-2.576** (1.250)	0.112 (0.182)	0.023 (2.134)	-0.260 (0.183)
General rush	3.508* (1.829)	-0.153 (0.254)	1.434 (2.042)	0.383* (0.217)
Spouse's income	-0.002 (0.007)	-0.000 (0.001)	-0.004 (0.008)	0.002* (0.001)
Unemployed		-1.186** (0.519)		-0.307 (0.379)
Housekeeper		-0.465 (0.685)		0.226 (0.475)
Winter		-0.050 (0.275)		0.331 (0.239)
Summer		-0.352 (0.246)		0.144 (0.212)
Fall		-0.271 (0.257)		0.259 (0.225)

Constant	34.439*** (7.542)	2.582** (1.027)	44.544*** (8.713)	0.881 (1.280)
Log pseudo likelihood	- 1 787 689		- 755 939	
Rho		-0.182		-0.230
Wald test of independent equations		chi2(1)=1.94 Prob > chi2 = 0.163		chi2(1)=3.80 Prob > chi2 = 0.051
Observations	784	784	784	784

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

The results of these models can be compared with the results from the Floro and Miles (2001) study with Australian time use data in analyzing the incidences of housework, shopping and volunteer work as secondary or tertiary activity. Unfortunately they did not use stress indicators in their estimations. Using a Tobit model they do not differentiate between the decision to do multitasking and the amount of multitasking done. Our results are similar with regard to the positive effect of education. However, the negative effect of age does not show in our estimation. Moreover, with the Australian data the number of children increases the amount of housework, shopping and volunteer work. In our data, which relate to all leisure and housework activities, children have a negative impact on the decision of the men to do multitasking and also decreases the amount of multitasking during weekends. For women, the only effect is the negative impact of children in the decision to multitask during weekends.

Floro and Miles (2001) have only seven annual income brackets to work with, so their income data are not as detailed as ours. They observe the result that an increase in annual income decreases multitasking, especially after a certain threshold. As we are able to disentangle the effects to wage and income effects, the net wage rate has a negative impact on the amount of multitasking done by males and females. Non labour income is not generally significant in explaining time-allocation. It had a positive effect on the decision to multitask during weekends only in case of females.

We test the normality in each model with the method proposed by Pagan and Vella (1989). These are presented in table 15. The assumption

of normality cannot be rejected in the case for men during weekdays and weekends. However, for women the normality assumption is rejected with 95 percent significance level during weekends and with 99 percent during weekdays.

Table 15 Pagan and Vella's Tests for Normality of Residuals

Men Weekday	F(3, 1392) = 1.29	Prob > F = 0.2750
Men Weekend	F(3, 1390) = 1.19	Prob > F = 0.3115
Women Weekday	F(3, 1473) = 4.01	Prob > F = 0.0074
Women Weekend	**F(3, 1473) = 3.63**	**Prob > F = 0.0125**

We can also calculate the marginal effects of a change in different variables on the amount of multitasking. These calculations are based on the sample averages for a person doing 35 hours of work per week (table 16). During weekdays men do slightly more than 2 hours and women 2 and half hours of multitasking. During weekdays both genders do approximately 4 hours of multitasking.

Table 16 Effects of Different Demographic Factors on the Amount of Multitasking (in minutes)

	Weekday		Weekend	
	Male	Female	Male	Female
Multitasking minutes	**130**	**150**	**239**	**241**
Euro raise in net wage	**-18**	**-30**	**-24**	**-24**
Secondary education	*	**37**	**41**	*
University education	**70**	**79**	**133**	**86**
One hour increase in work time	**-6**	**-6**	*	**-4**
Rush during the day	*	**-26**	**-58**	*
General rush	*	**35**	*	*
Age 45-54	*	**60**	*	*

* not statistically significant

The biggest increase is caused by a university education. This increases multitasking by over an hour during weekdays for both genders. The biggest increase is for university educated men, who do 2 ¼ hours more multitasking during weekends. For university educated females the increase is one and half hours. An increase in market work hours has a minor effect. Each hour decreases multitasking only six minutes during weekdays.

As to the indicators of rush, it is interesting to note that feeling of rush decreases the multitasking done by females during a weekday by half an hour. The feeling of general rush increases multitasking by little over half an hour. For males only rush during the day is statistically significant and this decreases multitasking by an hour during weekdays.

Our results of the link between multitasking and stress indicate that people who report having experienced rush during a day do less multitasking. This is the case for females during weekdays and men over weekends. In contrast, general rush increases the amount of multitasking by females and affected positively the decision to do multitasking in some of the cases for men and women.

One objection to be raised is that the feeling of stress and multitasking can be determined simultaneously. If this is the case, then we have a problem of endogenous dummy variables. In order to look at the determinants of the indicators of stress, we estimate separate probit models for both the probability of recording feeling rush during a reporting day and for the probability of reporting feeling of time pressure. They are presented in Appendix 1 and 2. We explain these variables with net hourly wage rate, non labour income, age-cohort dummies, educational level dummies, number of children, imputed hours of work, and dummies for being handicapped, unemployed or home keeper. The question on feeling of time pressure is posed by an interviewer before the start of the diaries so it is not associated to weekends/weekdays division. Therefore weekend dummy was not used in that estimation. Furthermore, as none of the males who were home indicated feeling rushed, it was dropped from the relevant estimates for males.

When looking at the probability of reporting a feeling rushed on the reporting day only a few variables turn out significant. A dummy for the weekend has a negative impact and market work hours has a positive impact on the reporting of rush at the same day for both genders. Furthermore, in the case of men the age 45-54 years and in the case of females being homekeeper have a positive effect. When looking at feeling time pressure, more variables turn out to be significant. In case of males having a university education increases the feeling of time pressure as

does dummy for being disabled. Interestingly, net wage rate has a negative impact on the feeling of time pressure, as does being a home keeper. In case of women, it is the number of children that increase the feeling of general rush while being unemployed decreases it.

10 Conclusions

Multitasking during off-work hours is widespread. In Finnish Time Use Survey 1999/2000 around 95 percent of women and 90 percent of men record doing a secondary activity simultaneously with housework and leisure. For those that have reported doing secondary activity, multitasking occurs in about third of the time. The share of multitasking stays the same regardless whether the recording day is a weekday or a weekend.

In 80 percent of the cases, a secondary activity done in connection with housework or leisure is leisure. The next is housework, but with just five percent. People thus combine housework routines with leisure and leisure routines with other leisure routines.

Hamermesh and Lee (2003) have recently suggested that stress is a reaction to the high shadow price of time. Therefore people with higher income should experience more stress. Their model implies that the relaxation of time constraint should decreases stress. We suggest that multitasking might be an attempt to make more time and to decrease stress.

We estimate a Heckman selection model to explain the determinants of multitasking. The net wage rate is significant in explaining the amount of multitasking. Its effect on the amount of multitasking done during a day is negative. Also the feeling of rush during the day has in most cases a negative effect on the amount of multitasking. These observations can be taken as evidence against the hypotheses that, in case of high shadow price of time, multitasking is an attempt to buy more time. However, the amount of multitasking is positively affected in some cases by the feeling of general rush. This is indication of the fact that multitasking could be used in the case of general rush to buy more "effective time".

There are gender differences in the amount of multitasking. Females do more multitasking than males. There are also clear differences according to educational level. Having a university level education has a positive effect on the multitasking decision and the amount of multitasking done in most of the cases. People of both genders with university education do almost a third more simultaneous activities than those with elemen-

tary education. It seems that multitasking is connected more to the amount of human capital then to stress.

There are number of additional questions that should be investigated. Our results show that in 25 percent of housework time simultaneous leisure activity performed. Also housework is done as a secondary activity during about 3 percent of leisure time. Calculations of the value of housework have usually only used information on the primary activity.[23] Taking into account the secondary activity would produce more accurate estimates of the value of housework in the society.

As the number of time use surveys that also record secondary activities increases, it becomes possible to compare different countries on the prevalence of multitasking and its links to stress in different societies.

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[23] For Finnish case look Vihavainen 1996.

Appendix 1 Probit Estimates for Feeling of General Rush by Gender

	Men	Women
Net wage rate	-0.022* (0.013)	-0.009 (0.018)
Non labour income	-0.000 (0.003)	-0.002 (0.004)
Age 35-44	0.125 (0.220)	-0.109 (0.266)
Age 45-54	0.042 (0.273)	-0.390 (0.344)
Age 55-64	-0.202 (0.336)	-0.099 (0.436)
Secondary education	0.014 (0.130)	-0.237 (0.171)
University education	0.655*** (0.225)	0.079 (0.276)
Number of children	0.007 (0.053)	0.168*** (0.065)
Hours of Work	0.000 (0.002)	0.003 (0.003)
Disabled	0.303** (0.123)	0.273* (0.144)
Unemployed	-0.481 (0.326)	-0.787*** (0.298)
Homekeeper	-1.426** (0.691)	-0.628* (0.344)
Spouses income	-0.000 (0.001)	0.000 (0.001)
Constant	2.024*** (0.688)	1.847** (0.801)
Observations	784	784

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix 2 Probit Estimates for Feeling Rush in Recording Day by Gender

	Men	Women
Net wage rate	-0.015 (0.010)	-0.002 (0.011)
Non labour income	0.001 (0.002)	-0.001 (0.002)
Age 35-44	0.139 (0.165)	0.028 (0.161)
Age 45-54	0.359* (0.208)	0.016 (0.218)
Age 55-64	0.164 (0.258)	0.323 (0.269)
Secondary education	0.015 (0.104)	-0.170 (0.106)
University education	0.269 (0.167)	-0.133 (0.170)
Number of children	0.050 (0.038)	0.065 (0.044)
Weekend	-0.712*** (0.063)	-0.738*** (0.065)
Market work hours	0.010*** (0.002)	0.008*** (0.002)
Disabled	-0.121 (0.089)	0.111 (0.083)
Unemployed	0.459 (0.315)	0.166 (0.237)
Spouses income	-0.000 (0.001)	-0.000 (0.000)
Homekeeper		0.740*** (0.244)
Constant	0.367 (0.520)	-0.084 (0.494)
Observations	1562	1568

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

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