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The Intra-household Allocation of Time

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The Intra-household Allocation of Time

ACADEMISCH PROEFSCHRIFT

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aan de Universiteit van Amsterdam
op gezag van de Rector Magnificus
Prof. Dr D.C. van den Boom
ten overstaan van een door het college voor promoties ingestelde
commissie, in het openbaar te verdedigen in de Agnietenkapel der Universiteit
op 2 juli 2009, te 16.00 uur

door

Chris van Klaveren

geboren te Zaanstad

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Faculteit der Economie en Bedrijfskunde

Dedicated to Julie & Lise.
You make my world so simple.

"Pure economics has a remarkable way of producing rabbits out of a hat – apparently a priori propositions which apparently refer to reality. It is fascinating to try to discover how the rabbits got in; for those of us who do not believe in magic must be convinced that they got in somehow."

(John R. Hicks, *Value and Capital*, 1939, p.23)

Acknowledgements

During my economics degree course and my one year experience as a consultant at the World Bank, I became fascinated by the passionate attempts of researchers to describe the individual decision-making process. After I finished my Master's thesis, Bernard van Praag and Henriette Maassen van den Brink asked me if I wanted to do research as a PhD student on the intra-household allocation of time. Since this topic is an interesting mixture of microeconomics, econometrics, and psychology, my decision problem on whether I wanted to become a PhD student was an easy one to solve.

In 2006, I started working for SEO Economic Research, under the assumption that I was about to finish my thesis. However, the final chapter had to be replaced by a new chapter, due to convergence problems and my lack of knowledge, and this caused a delay. This meant that my decision-making problem became how to divide my time optimally between working on my thesis, paid work, my family, and leisure. I never solved this decision-making problem. My thesis became somewhat of a struggle, but at the same time my own time allocation problem provided me with additional insights on the intra-household allocation of time. I could not have finished this thesis without the help and encouragement of others, whom I now wish to thank.

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ionship.

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For me, playing soccer is a great way to clear my mind after a day's work. But of course, playing soccer alone is not as much fun than playing it with others. Therefore, I want to thank Alexander, Arthur, Bas, Massimo, Piet, Theo, Massimo and all others with whom I played soccer in 'de Boekmanschool'. I also want to thank my futsal teammates Adam, Casper, Jaap Anne, Justin, Magiel, Marko, Rob and Tim, with whom I played in the USC futsal competition. We always had long (and useless) discussions on how soccer should be played, we performed great in the third half and talked about everything and nothing. Our friendship has been important to me.

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Chris van Klaveren

University of Amsterdam

Contents

Chapter 1

Introduction

The aim of this thesis is to obtain a better understanding of how persons, in multi-person households, decide to allocate their time to paid labor, leisure and household work. For this purpose we define a structural model where preferences are assumed to depend on the collective consumption of market goods and household production, and on the individual hours spent on leisure, paid labor and housework. It is important to take into account that the decisions of spouses concerning consumption, expenditures and the allocation of time are interdependent. If, for instance, we ignored the possibility of bargaining between household members, we would obtain a distorted image of relations that are of economic importance. A similar argument can be made if we do not take into consideration that spouses can have distinct preferences or that the timing of activities plays an important role in the household decision process.

The participation in paid labor by Dutch women has undergone rapid changes over the last 20 years. The labor participation rate of men, on the other hand, remains rather constant, and so there is convergence between men's and women's labor force participation rates. Similar patterns are also observed in other Western European countries.[1]

The Neo-classical economic explanation for why women participate less in paid labor than men is that men specialize in paid labor and women specialize in housework because the hourly wage rate of the male partner is higher. According to this explanation, the observed division of labor is the consequence of comparative advantage. Although this explanation is consistent with the observed labor supply patterns until the 1960s, it does not explain the convergence between men's and women's labor force participation rate.

An explanation for the convergence between men's and women's labor force participation

[1]See for example Henkens, Grift and Siegers (2002), Kaiser (2006) and OECD Employment Outlook (2007).

rate is that the gender roles or behavioral norms associated with men and women have changed over time. Traditionally, gender roles were such that the woman managed the household and took care of the children and the man provided the household with income. Second-wave feminism in the 1960s successfully addressed the inequalities between men and women, and as a consequence it became more and more accepted that men *and* women performed paid labor. Although the remaining difference in the participation rates between men and women may still be the result of gender role inequalities, there are also other explanations for this difference.

Labor supply choices are based on gender roles, but are also a matter of individual preferences and bargaining between the household members. On the one hand, performing more paid labor generates more money income and enables more consumption, but, on the other hand, performing more paid labor has as its opportunity cost potential leisure time. The optimal labor-leisure combination therefore relies on a person's preferences.

In multi-person households the question *who performs which activity* becomes important. There are, for example, several labor supply combinations that will generate the same amount of household income. However, household members may have different opinions about the optimal labor-leisure combination for both household members. They may also have different opinions on how the labor income should be divided between the household members. The observed labor supply outcomes therefore depend on the bargaining process between household members *and* on individual preferences. In this context, topics like child care, fertility, household formation/dissolution, and human capital investments are of economic importance because they are related to a person's time allocation decision, and consequently to a person's labor supply choice. Moreover, studies on the intra-household allocation of time and labor supply choices are relevant for policy makers because the household demand and labor supply may depend on who in the household is taxed or is subsidized.

There are several theoretical models that describe the behavior of households. Of these models, the collective model of household behavior gradually found acceptance in the family economics literature due to its appealing properties. In this thesis we use this model of household behavior as a theoretical foundation, and from there we move to the empirical analysis of household behavior. To show the advantages of the collective model, we now briefly review the leading theoretical models on household behavior.

Until the 1980s, household behavior was described by the unitary approach (Becker (1965)).[2] A good characterization of the unitary approach is given on the back cover of Becker's book *A treatise on the family*:

[2]Becker received the Nobel prize in 1992 for his contribution to the understanding of human behavior and interaction, including nonmarket behavior (www.nobel.se).

> Gary Becker sees the family as a kind of little factory – a multi-person unit producing meals, health, skills, children, and self-esteem from market goods and the time, skills and knowledge of its members (Becker (1991)).

Because, according to Becker, households are seen as *multi-person units*, each household is considered as a single unit even though it may consist of several household members. It follows that household members are only interested in maximizing the welfare of the household; the outcomes of the household decision process are entirely driven by comparative advantage. Because individual preferences and bargaining are not considered in the model, nothing can be said on the intra-household allocation of welfare. The latter is clearly a disadvantage from a welfare economic perspective. In addition, the unitary model restricts household behavior by assuming that household members pool their income, and that compensated wage changes of spouses have the same effect on each other's labor supply. These restrictions are often rejected in the empirical literature.[3]

Two alternative models of household behavior were developed in the 1980s and the 1990s to overcome the drawbacks of the unitary model. The first model is the cooperative bargaining model of household behavior and was developed by Manser and Brown (1980) and McElroy and Horney (1981). The second model is the collective model of household behavior and was developed by Chiappori (1988a, 1992, 1997). In addition, we mention the noncooperative model of household behavior, because it has been used since the 1960s by many authors.[4]

All three models explicitly define the individual preferences of the household members by means of their utility functions so that the intra-household allocation of welfare can be examined. This means that these models can be used to examine whether changes in women's labor participation rate are caused by changes in individual preferences or, in the cooperative and collective model of household behavior, by changes in the relative bargaining position of the spouses.

The question that remains is which model has the more appealing properties: the cooperative bargaining model, the collective model, or the noncooperative model of household behavior? The cooperative bargaining model and the collective model both assume Pareto efficiency, which means that household decisions are assumed to be efficient, so that it is not possible to make one of the household members better-off without making another household

[3]The literature that empirically rejects the unitary model is substantial, see, among others, Ashworth and Ulph (1981), Kooreman and Kapteyn (1986), Thomas (1990), Browning and Costas (1991), Browning, F, Bourguignon, Chiappori and Lechene (1994), Kawaguchi (1994), Fortin and Lacroix (1997), Lundberg, Pollak and Wales (1997), Browning and Chiappori (1998), Ward-Batts (2002).

[4]See, for example, Leuthold (1968), Ashworth and Ulph (1981), Kooreman and Kapteyn (1990), Browning (2000) and Cheng and Woolley (2001).

member worse-off. A disadvantage of the cooperative bargaining model is that it is based on a game theoretical setting, and hence the predicted bargaining outcome depends crucially on the equilibrium concept that is chosen, while there is no consensus on the appropriateness of this concept. The result is that the particular solution concept that is chosen immediately pinpoints the position on the utility possibility frontier, and consequently each solution concept predicts a different Pareto efficient outcome.[5] Because the collective model merely assumes Pareto efficiency it allows for all Pareto-efficient outcomes that are possible, and hence each Pareto-efficient outcome predicted by the cooperative bargaining model can also be predicted by the collective model. In conclusion, the collective model is a more general model than the cooperative bargaining model and imposes less restrictions on the behavior of households. The collective model is therefore the most suitable model to describe household behavior.

Furthermore, the collective model restricts household behavior by assuming that households behave efficiently. Noncooperative models of household behavior, for example, allow for inefficient outcomes and assume that both spouses optimize their own utility function, taking the behavior of the partner as given. However, it seems more natural to assume that household members act, at least to a certain extent, cooperatively, and Pareto efficiency then implies that (eventually) efficient outcomes emerge from the repeated interactions between the spouses.[6]

According to the collective model, the equilibrium outcome of the household decision process can be described as if the household maximizes a weighted sum of the individual utility functions, where the positive weights are assumed to add up to 1. The individual utility functions represent the individual preferences of the spouses, and the utility weights show how the individual utility functions are weighted in the household utility function. An intuitive interpretation of these weights is, therefore, that they represent the division of bargaining power between the spouses.

We formulate a public good version of the collective model where household behavior is described as if the household chooses an optimal time allocation 'bundle'. This is convenient as usually there is information on time use, wage rates, and on factors that may influence the bargaining position and preferences of both spouses. We consider consumption as a good that is publicly consumed in the household, and the value of this good is approximated by the household income. As household production is usually not observed, we define it as the

[5]We note that the utility possibility frontier or Pareto frontier is a curve that represents all possible efficient utility combinations of the spouses.

[6]Donni (2007) argues that noncooperative models are counterintuitive because in the noncooperative equilibrium, the household members themselves can benefit by behaving more cooperatively.

sum of hours spent on housework weighted by a parameter that represents the marginal productivity of the woman relative to that of the man. It follows that the arguments of the individual utility functions are the choice variables leisure, housework and paid labor. We use this particular collective household model throughout this thesis. By estimating this model, we obtain information on the preferences of men and women, and on how the bargaining power is divided between them. Moreover, we are able to examine how individual preferences and the division of bargaining power varies for different household types.

One contribution of this thesis to the literature is that we differentiate between the individual effort spent on housework and the fruits of those efforts from both partners in creating a specific level of household production. Moreover, note that in this 'public good' version we do not need information on the individual consumption of the spouses in order to identify their individual utility functions.

To estimate the model empirically, we developed an iterative two-step procedure. According to this procedure, we first use the method of Seemingly Unrelated Regression followed by a non-linear Maximum Likelihood procedure. We show that applying these estimation methods iteratively is sufficient to estimate and identify the model. The estimation procedure allows us to estimate the individual (ordinal) utility functions and the utility weights. Conditional on these estimates, we can assess the (cross-)wage, child and non-labor income elasticities on the different time expenditures of individuals. These cross-effects are usually not considered (or discussed) in the current economic labor supply literature, because the man's labor supply is considered to be inelastic. By treating the man's labor supply as endogenous we allow for the fact that an increase in the woman's wage rate can affect the time that the woman *and* the man spend on leisure, housework, and labor and this is relevant for policies concerning child care subsidies, fertility rates, income taxes, social benefits, etc.

By choosing an empirical approach where we treat men's labor supply as endogenous, and where we consider housework and household production in the model, we aim to contribute to a better understanding of the household decision process and the intra-household bargaining process between the household members.

Work Timing Behavior

Usually, two dimensions of household labor supply are distinguished, namely, the paid labor supply of the man and the woman. A third dimension, that is often not considered is the degree to which working times per day, or per week, overlap. Obviously, partners can influence their own working times to a certain extent, but in most jobs there are common job hours, which cannot be changed at will. Hence, we assume that part of the observed overlap may

be involuntary, and that part of the work time overlap is the result of decisions by the partners themselves. Because the labor participation rate of women has increased enormously over time, the number of two-earner households must also have grown enormously over time. For these two-earner households, the coordination of family time is more difficult than in a traditional one-earner household. We could say that the members of a two-earner household face an additional work timing problem. It is therefore important that we consider not only the labor hours of the spouses, but also the timing of these labor hours by the spouses.

The timing of work hours is an intriguing topic. First of all, this is because heterogeneity in working schedule arrangements and restrictions in choosing an optimal work schedule are normally not part of the traditional time allocation model. As a result, neglecting the work timing between the spouses may cause biased estimates of the economic incentives for the volume of labor supply and when it is performed (Hallberg (2003)). Second, parents who can more easily time their work hours may have different public child care demands and this is important for policy that is related to child care subsidy and female labor participation. Third, the work timing behavior of spouses may be the result of a togetherness preference. In this case, spouses time their work hours such that the amount of leisure time that can be spent together is increased.

By 'work timing', we mean the amount of paid labor that spouses supply at the same time, and that cannot be explained by factors other than the partners' potential to communicate on the timing of their paid work. It follows that we measure work timing by the hours of paid work that spouses perform at the same moment, i.e. the work time overlap.

It is difficult to disentangle which part of the observed work time overlap is caused by the (non-observed) timing behavior of the spouses, and which part is caused by the fact that persons with certain characteristics end up in certain jobs with accompanying working times. In order to identify the observed work time overlap that is caused by the (non-observed) timing behavior of the spouses, we simulate how the amount of work time overlap would vary if spouses do not have the possibility to time their work hours. By comparing the work time overlap with the simulated outcomes, we can identify the amount of work time overlap that is the result of work timing behavior. First, we match couples to other identical couples in the sample and let them switch partners. The average work time overlap of the couples that remains after the partner switch represents the control situation where spouses have similar characteristic but cannot time their work hours. Comparing this control outcome with the observed work time overlap of the spouses provides us with a work timing estimate.

Besides measuring whether spouses time their work hours, it is also interesting to find

out what is the reason for this work timing behavior. Therefore, we examine how the work timing behavior of the spouses is related to the time that spouses spend on various joint activities and is related to the demand for child care.

Outline of this thesis

Chapter 2. In Chapter 2, we discuss the principles and theory of the collective model and point out the advantages of this model compared with other existing models of household behavior. Since there is usually no information on the individual expenditures by the man and the woman, we also discuss a collective model where household behavior can be described as if the household chooses an optimal time allocation 'bundle'. In this model, consumption goods are assumed to be publicly consumed within the household, in the sense that the good is always financed out of the common purse although it may be that one of the spouses is the sole consumer. Furthermore, each spouse's leisure is assumed to be a private good, i.e. the husband does not benefit from the wife's leisure, and conversely. We refer to this model as a public good version of the collective model and this model is used throughout Chapters 3, 4 and 5 of this thesis.

Chapter 3. In Chapter 3, we develop an estimation procedure that allows us to empirically estimate the public good version of the collective model. Using this procedure we estimate: (1) the (ordinal) utility functions; (2) the utility weight function; and (3) the (cross-)wage, child and non-labor income effects.[7]

By estimating the individual utility functions, we obtain information on the preferences of the household members, and on how these preferences can be different between the household members. By estimating the utility weight function, we obtain information on how the individual utility functions are weighted in the household utility function, and so we obtain information on the division of bargaining power between the spouses. On the basis of these estimation results, we can link the observed time allocation outcomes to the individual preferences and the division of bargaining power so that we obtain more insights into the household decision process itself. The elasticities that are derived from the model then show how the time that spouses spend on housework, leisure, and paid labor react to changes in individual wages, non-labor incomes, and the number of children. In this way we can predict how these changes affect the choices of the household members conditional on the underlying household decision process.

[7]This chapter is based on Van Klaveren, van Praag and Maassen van den Brink (2008), published in *Review of Economics of the Household*.

To estimate the model, we make use of the British Household Panel Survey (BHPS) and, more specifically, of a restricted data set of British households where both partners have a paid job. This data source is widely known and used in sociological, psychological, and economic research.[8]

Chapter 4. In Chapter 4 we estimate the model of Chapter 3 for two-earner households, where we distinguish between Dutch, Turkish, Surinamese and Antillean households. Because the empirical model of Chapter 4 is equivalent to that of Chapter 3, we test the robustness of the estimation model by using a different sample. A similar argument can be made for the (cross-) wage and child effects on the different time expenditures of individuals.

Research on household labor supply in the Netherlands tends to neglect the time allocation choices of immigrant households. The main reason for this is that immigrant households do not often participate in surveys, and so they are either lumped together with the main population of Dutch descent or are not considered at all. In this chapter we consider the household decision process of Dutch, Turkish, Surinamese and Antillean households, and consequently we may find interesting differences between the time allocation choices of these households due to differences in ethnic background.

The data used in this chapter were collected between September and November 2001 by DESAN, a Dutch organization for market research. The aim was to create a balanced sample with as many Dutch households as Turkish and Surinamese/Antillean households. The Dutch sub-sample is randomly drawn from the total pool of phone numbers of the Royal Dutch Mail (KPN). The immigrant sub-sample is drawn from a register owned by DESAN.

Chapter 5. In Chapter 5, we extend the empirical model and allow for the possibility that household members do not participate in paid labor. It is important to allow for the non-participation decision because it may be different for different household types, and it may depend on the level of the individual wages. Exclusion of households where household members do not participate in paid labor could potentially result in a selectivity bias.

In this chapter we assume for one-earner households that household behavior can be described as if the household maximizes a household utility function, conditional on the zero job-hour choice of the woman. It implies that the non-participation decision may not be optimal for the household, as the zero job-hour choice may not be optimal but forced upon the woman by external circumstances. In addition we define a model where we assume that the labor supply choice may be non-optimal for *both* one- and two-earner households. By

[8]More information on the validity of the data can be found on http://www.iser.essex.ac.uk/ulsc/bhps

estimating the various models, we obtain more insights into how the individual preferences and the bargaining process between the spouses differ between one- and two-earner households. Furthermore, we obtain information on how individual utility and household utility is influenced by working an additional hour of paid labor. This is interesting as it gives more information about why women do or do not participate.

The data used in Chapter 5 are from the same source as in Chapter 3. Because of the limited number of observations of the one-earner households where the man does not supply a positive amount of labor, we can only analyze the behavior of one-earner households where the woman does not supply a positive amount of paid labor.

Chapter 6. In Chapter 6 we examine how the spouses of Dutch two-earner households *time* their work hours.[9] In this way we not only consider the quantities of time that spouses allocate to paid labor but also take into account that spouses have the ability to *time* these work hours. The timing of work hours is measured by the existing overlap in work times of the two spouses.

The first contribution of this chapter is that we propose a method by which we can disentangle which part of the observed work time overlap is caused by the (non-observed) timing behavior of the spouses and which part is caused by the fact that persons with certain characteristics end up in certain jobs with associated working times.

The second contribution of this chapter is that we examine how work timing behavior is related to the demand for child care, and is related to the time that spouses spend jointly on leisure, housework and child care. In this way we examine not only whether spouses time their work hours but also what might have caused this timing behavior, which increases our understanding of why spouses time their work hours.

For this purpose, we have asked questions in what is called the Post Initial Schooling Survey. The data were collected in December 2005 by the Dutch Institute for Public Opinion and Market Research ($NIPO$).

[9]This chapter is a continuation of the work of Van Klaveren and Maassen van den Brink (2007) that was published in *Social Indicators Research*. Furthermore, this chapter refers to the results of Carriero, Ghysels and Van Klaveren (2009) that is forthcoming in *European Sociological Review*.

Chapter 2

The Collective Model of Household Behavior

2.1 Introduction

In this chapter we discuss the principles and theory of the collective model of household behavior and point out some of the advantages of this model compared with other existing models of household behavior. In addition, we discuss a particular version of this model, where the behavior of the household is described as if the household chooses an optimal time allocation 'bundle'. Since there is usually no information in data sets on the individual expenditures of the family, we assume that consumption goods are public within the household in this model.

Normally a good is considered to be public if consumption of the good by one individual does not reduce the amount of the good available for consumption by others, and no one can be effectively excluded from using that good. A public good in our model is somewhat differently defined. As we do not observe individual expenditures, we represent the total household consumption as a Hicksian composite good. The value of this good is equivalent to the value of the total household income. The expenditures on this Hicksian consumption good are subject to a public decision, although the consumption of this good may be private. For example, if a man goes to a soccer match without his wife, the ticket is financed from the entire household income. On the contrary, each spouse's leisure time is assumed to be a private good, i.e. the husband does not benefit from the wife's leisure, and conversely. This public good version of the collective model is used in Chapters 3, 4 and 5 of this thesis.

This chapter proceeds as follows. In Section 2.2, the principles and theory of the collective model are explained. In Section 2.3, we discuss the public good version of the collective

model. Finally, Section 2.4 summarizes.

2.2 The Collective Household Model: Principles and Theory

In this chapter we focus on two-earner households only. In the collective model, both spouses, say A and B, are characterized by their own preferences. More specifically, the preferences of spouse s ($s = A, B$) can be represented by the following direct utility function:

$$U^s = v^s(\mathbf{x}^A, \mathbf{x}^B, \mathbf{X}, t_c^A, t_c^B) \tag{2.1}$$

where $v^s(\cdot)$ is twice continuously differentiable and a strongly concave utility function.

The arguments of the utility function represent the total amount of consumption, where $\mathbf{x}^s$ represents the n-vector[1] of private consumption goods of spouse s; $\mathbf{X}$ represents the n-vector of public consumption goods[2]; and t_c^s represents leisure time of spouse s.

The inclusion of private consumption and leisure of the partner in the utility function of the spouse allows for spillover effects in consumption, i.e. the interdependence of preferences. These spillover effects may affect the partners' utility positively (e.g. clothing) as well as negatively (e.g. cigarettes). In the literature this is also referred to as household members having 'caring preferences'. Preferences are referred to as egoistic if the utility function of the spouse does not contain partner variables.

The next step is to model the household decision process based on the individual preferences in (2.1). Following the collective model, the outcome of the household decision process should yield a Pareto-efficient outcome. The intuition for this Pareto-efficient outcome is that spouses interact repeatedly with each other and that efficient outcomes emerge due to these interactions. The Pareto-optimal outcome of the household decision process is a

[1]The convention is that $\mathbf{x}^s = (x_1^s, ..., x_n^s)$ is a row vector and, consequently, $\mathbf{x}^{s\prime}$ is a column vector.

[2]A consumption good n is purely public if $x_n^A + x_n^B = 0$ and $X_n \neq 0$, and purely private if $x_n^A + x_n^B \neq 0$ and $X_n = 0$. Furthermore, we have for the consumption vectors that $\mathbf{x}^s \in R_+^n$ and $t_c^s \in R_+$.

solution to the following problem:

$$\max_{\mathbf{x}^A,\mathbf{x}^B,\mathbf{X},t_c^A,t_c^B} v^A(\mathbf{x}^A,\mathbf{x}^B,\mathbf{X},t_c^A,t_c^B)$$

subject to

$$\begin{aligned}
&(1) \quad \mathbf{p}'\mathbf{x} + w^A t_c^A + w^B t_c^B \leq y + (w^A + w^B)T \\
&(2) \quad v^B(\mathbf{x}, t_c^A, t_c^B) > \overline{U}^B \\
&(3) \quad 0 \leq t_c^A, t_c^B \leq T
\end{aligned} \tag{2.2}$$

For convenience, we introduce $\mathbf{x} = (\mathbf{x}^{A\prime} + \mathbf{x}^{B\prime} + \mathbf{X}')$ that represents the consumption vector of commodities; and the accompanying price vector is indicated by $\mathbf{p} = (p_1, ..., p_n)$. The wage rate of spouse s is indicated by w^s; and $\overline{U}^B$ stands for the minimal utility that partner B needs. Non-labor income consists of three parts, and y is a shorthand notation for $y^A + y^B + Y$. y^s represents the non-labor income that is received by spouse s (e.g. social benefits); and Y represents the non-labor income that is received by the entire household (e.g. a rent subsidy).

The first constraint in (2.2) is the full budget constraint and the right-hand side represents the maximum amount of money that the household can spend on consumption goods and leisure, i.e. the full household income. The second constraint in (2.2) shows that there is a minimal level of utility ($\overline{U}^B$) that spouse B requires. It holds that all conceivable efficient utility combinations $(U^A; U^B)$ can be obtained by choosing different values of $\overline{U}^B$. The set of possible efficient utility combinations is usually referred to as the Pareto-frontier or the utility possibility frontier.

We may rewrite the first line and the second constraint of (2.2) in the Lagrangean form such that we have the following maximization problem:

$$\max_{\mathbf{x}^A,\mathbf{x}^B,\mathbf{X},t_c^A,t_c^B} v^A(\mathbf{x}^A,\mathbf{x}^B,\mathbf{X},t_c^A,t_c^B) + \lambda \cdot (v^B(\mathbf{x}^A,\mathbf{x}^B,\mathbf{X},t_c^A,t_c^B) - \overline{U}^B)$$

subject to

$$\begin{aligned}
&(1) \quad \mathbf{p}'\mathbf{x} + w^A t_c^A + w^B t_c^B \leq y + (w^A + w^B)T \\
&(2) \quad 0 \leq t_c^A, t_c^B \leq T
\end{aligned} \tag{2.3}$$

We may multiply (2.3) with $\frac{1}{1+\lambda}$ and drop the constant $\overline{U}^B$, such that household behavior can be viewed as if the household chooses the optimal bundle $(\mathbf{x}, t_c^A, t_c^B)$ that maximizes:

$$\pi v^A(\mathbf{x}^A, \mathbf{x}^B, \mathbf{X}, t_c^A, t_c^B) + (1-\pi)v^B(\mathbf{x}^A, \mathbf{x}^B, \mathbf{X}, t_c^A, t_c^B)$$

$$\text{subject to} \tag{2.4}$$

$$\mathbf{px} + w^A t_c^A + w^B t_c^B \leq y + (w^A + w^B)T$$

where $\pi = \frac{1}{1+\lambda}$ is a normalized Lagrangean multiplier. Equation (2.4) is often presented directly as the collective household model, where the household decision problem can be described as if the household maximizes a π-weighted sum of the individual utility functions subject to the full budget constraint and two time constraints.

The weight that is given to the utility function of spouse A increases when π increases. An intuitive interpretation of π is, therefore, that it reflects the division of bargaining power between the household members. Vermeulen (2002) observes that this setting allows us to characterize *all* Pareto allocations as stationary points of a linear 'social welfare function', assuming that the budget constraint is strongly convex and the individual utility functions are strongly concave.

At this point, we would like to point out an advantage of the collective model compared to cooperative bargaining models of household behavior. Cooperative bargaining models are based on a game-theoretical setting and the predicted bargaining outcome depends crucially on the chosen equilibrium concept. However, there is no consensus on the concept that is most appropriate.[3] The choice of a particular solution concept pinpoints the position on the utility possibility frontier and therefore each solution concept predicts a different Pareto-efficient outcome. Since the collective model allows for all Pareto-efficient outcomes it holds that each efficient outcome predicted by a cooperative bargaining model can also be predicted by the collective model. Vermeulen (2002) observes that a rejection of the empirical implications of a cooperative bargaining model does not clarify whether the underlying equilibrium choice is rejected or that the bargaining setting in general is rejected. The collective model does not suffer from such an ambiguity.[4]

Browning, Chiappori and Lechene (2006) point out that, although generally π is con-

[3]Different equilibrium concepts are: the dictatorial solution (Manser and Brown, 1980), the Nash-bargaining solution (Nash, 1950), and the Kalai-Smorodinsky solution (Kalai and Smorodinsky, 1975).

[4]For more elaborate discussions on the collective model and cooperative bargaining models, we refer to Chiappori (1988b), Thompson (1994), Vermeulen (2002) and Donni (2007).

sidered as a function, there has been confusion about what the arguments of this function should be. They show that when π is 'misspecified' it is possible that the model collapses into the conventional unitary model. In order to understand the conditions under which this happens, we will briefly describe the unitary model.

The unitary model considers each household as one decision unit with its own utility function and preferences. During the late 1960s, the unitary model provided economic theory with a theoretical foundation of household behavior based on traditional consumer theory. According to this theory, the household decision process can be viewed as a household utility maximization problem where individuals specialize in certain activities because of comparative advantages. Because men's wage rates are higher than those of women the model predicts for two-earner households that men specialize in paid labor and women specialize in household tasks (see Becker (1965, 1991)).

A drawback of the unitary approach is that it imposes two restrictions on household behavior that are often rejected in the empirical literature. The first restriction is referred to as *income pooling* and means that it does not matter which member of the household generates household income. The second restriction is referred to as *Slutsky symmetry* and means that marginal compensated wage changes of the spouses have the same effect on each other's labor supply. The empirical literature that rejects the unitary model is substantial (see, among others, Ashworth and Ulph (1981), Kooreman and Kapteyn (1986), Thomas (1990), Browning and Costas (1991), Browning et al. (1994), Kawaguchi (1994), Fortin and Lacroix (1997), Lundberg et al. (1997), Browning and Chiappori (1998), Ward-Batts (2002)). Another disadvantage of the unitary approach is that differences in preferences between the household members are not taken into account and as a consequence nothing can be said about the intra-household allocation of welfare.

Whether the model collapses into a unitary model depends on the arguments of the utility weight $\pi(\cdot)$. The utility weight is generally represented as a function that may depend on prices ($\mathbf{p}$), wages ($\mathbf{w} = (w^A, w^B)$), non-labor income ($\mathbf{y} = (y^A, y^B, Y)$), *and* on variables that do not enter the individual preferences directly but influence the utility weight distribution. The latter are called distribution factors ($\mathbf{d}$).[5] More formally, π can be represented by the following function:

$$\pi = \pi(\mathbf{p}, \mathbf{w}, \mathbf{y}, \mathbf{d}) \tag{2.5}$$

with

$$\pi \in [0, 1]$$

[5]Similarly to the collective model, cooperative bargaining models define a threat point. In these models the terminology 'extra-environmental parameters' is used instead of 'distribution factors' (see McElroy (1990)).

Different specifications of π restrict household behavior differently. As the non-labor income may be seen as a distribution factor we include it in the vector $\mathbf{d}$. We assume here, without loss of generality, that there is only one distribution factor, z. Browning et al. (2006) show that there are four relevant specifications of $\pi(\cdot)$. Conditional, on these different specifications of π, they show when the model satisfies income pooling and Slutsky symmetry. Moreover, they show whether the model collapses into a model that is more restrictive than the model described in (2.4) with π specified as in (2.5).

Table 2.1 shows the various specifications of π and their theoretical consequences.[6] Before we focus on the formal derivations, we will first discuss the implications of Table 2.1.

Table 2.1: The collective model given alternative utility weight specifications

		Model restriction:		
Case:	π	Pooling	Slutsky Symmetry	Type of model
I	$\pi(\mathbf{p}, \mathbf{w}, \mathbf{z})$	No	No	Collective
II	$\pi(\mathbf{p}, \mathbf{w})$	Yes	No	DFI Collective
III	$\pi(\mathbf{z})$	No	Yes	DFD Unitary
IV	c	Yes	Yes	Unitary

The second column shows how the utility weight, $\pi(\cdot)$, is specified. The third and fourth column indicate whether the particular type of model satisfies income pooling and Slutsky symmetry. The fifth column shows how Browning et al. (2006) characterize the different types of models conditionally on the specification of π. The abbreviations DFI and DFD stand for, respectively, Distribution Factor Independent and Distribution Factor Dependent, and this corresponds to whether the utility weight does or does not depend on at least one z.

We conclude from Table 2.1 that a collective model collapses into a unitary model if the utility weight does not depend on prices or wages, and in these cases Slutsky symmetry is imposed. Furthermore, income pooling is assumed if the utility weight does not depend on a distribution factor, z.

Below we formally derive under what conditions the Slutsky matrix is not necessarily symmetrical and show that a necessary condition is that the utility weight depends on wages

[6] As Browning et al. (2006) mention, it is difficult to imagine models where the corresponding specification of π is $\pi(\mathbf{p}, \mathbf{w})$ or $\pi(\mathbf{p})$. In the discussion of π we follow Browning et al. (2006).

or prices. Furthermore, we show that income pooling is not imposed if the utility weight depends on non-labor income.

The Collective Model and Slutsky Symmetry

For simplicity, we assume that we can not distinguish between public and private goods so that $\mathbf{x}$ represents the total amount of consumption goods, i.e. $\mathbf{x} = (\mathbf{x}^{A\prime}+\mathbf{x}^{B\prime}+\mathbf{X}')$. The total household consumption bundle of goods that represents household demand can be denoted by:[7]

$$\tilde{\mathbf{x}} = (\mathbf{x}, t_c^A, t_c^B)' \tag{2.6}$$

The corresponding price vector is:

$$\tilde{\mathbf{p}} = (\mathbf{p}, w^A, w^B) \tag{2.7}$$

We consider the utility weight specification of case II. According to Table 2.1 Slutsky symmetry does not depend on the presence of a distribution factor. Using (2.6) and (2.7), it follows that the Pareto-efficient solution equals a set of $n+2$ uncompensated demand functions:[8]

$$\tilde{\mathbf{x}} = f(y + (w^A + w^B)T, \tilde{\mathbf{p}}) \tag{2.8}$$

However, the demands in (2.8) are not directly observed because we do not observe $\pi(\cdot)$. We observe $f(\cdot)$ for a particular π, such that the uncompensated demand functions can be written as:

$$\tilde{\mathbf{x}} = g(y + (w^A + w^B)T, \tilde{\mathbf{p}}, \pi(\tilde{\mathbf{p}})) \tag{2.9}$$

Using the demand functions in (2.9), we determine how a marginal increase in the price of commodity k results in the substitution to or from commodity l, given that wealth is adjusted so that the household can afford the same consumption bundle. This substitution effect is better known as the 'Slutsky effect':

$$\begin{aligned} s_{lk} = \frac{\partial g_l}{\partial p_k} + \frac{\partial g_l}{\partial (y + (w^A + w^B)T)} \cdot x_k + \\ \frac{\partial g_l}{\partial \pi} \cdot [\frac{\partial \pi}{\partial p_k} + \frac{\partial \pi}{\partial (y + (w^A + w^B)T)} \cdot x_k] \end{aligned} \tag{2.10}$$

In (2.10) we can distinguish the direct substitution effect (first two elements) and an addi-

[7] The derivation of the Slutsky matrix in inspired by Browning and Chiappori (1998) and Vermeulen (2002).

[8] This is shown in Appendix A.

tional price effect (last two elements). The additional price effect reflects bargaining, and a change in bargaining position due to a marginal price change can shift the household indifference curve. Similarly, a marginal increase in the hourly wage rate may induce a shift in the indifference curve, which can be tested empirically.[9]

Using the notation of Browning and Chiappori (1998) the Slutsky matrix can be denoted as:

$$\mathbf{S} = \mathbf{\Gamma} + \mathbf{u}\mathbf{v}' \tag{2.11}$$

where $\mathbf{\Gamma}$ is a $(n+2) \times (n+2)$ matrix that is symmetric and does not contain the bargaining effect. This matrix is similar to the Slutsky matrix in a unitary setting. The $(n+2)$ vectors $\mathbf{u}$ and $\mathbf{v}$ represent the part of the Slutsky matrix due to bargaining. Browning and Chiappori (1998) show that the product of these vectors has at most rank 1. Furthermore they show that a model can be referred to as a collective model if the Slutsky matrix is the sum of a symmetric matrix and a rank 1 matrix. This is referred to as the symmetry plus rank 1 condition or, in short, the $SR1$ condition.

Many empirical studies have examined the Slutsky symmetry condition and it is almost always rejected (see, among others, Ashworth and Ulph (1981), Kooreman and Kapteyn (1986), Browning and Costas (1991), Kawaguchi (1994), Fortin and Lacroix (1997)).

The Collective Model and Income Pooling

Income pooling means that the household demand is not influenced by a redistribution of income. To test the income pooling assumption we should test whether an exogenous redistribution of the household income affects the household demand. It follows that we cannot test income pooling by measuring the effect that a change in labor income has on the household demand as labor income depends on wages, which is a price in the model. Because non-labor income does not depend on wages, we can test income pooling by testing if the household demand is affected by a redistribution of the unearned income. When households pool their non-labor income it should hold that: $\frac{\partial g}{\partial y^A} = \frac{\partial g}{\partial y^B} = \frac{\partial g}{\partial Y}$. It can be seen from the demand functions in (2.9) that a 1 euro increase of y affects the household demand, but that it does not matter if this increase happens through y^A, y^B, or Y.

We now consider Case I and assume that the distribution factor (z) is defined as the ratio of non-labor income, i.e. $\frac{y^A}{y^B}$. The choice of this fraction is convenient because we then have one term that includes the non-labor incomes of both spouses. Of course we could also use alternative specifications as long as the non-labor incomes of both spouses are included.

[9] If the model is estimated and wage rates turn out to be significant in the utility weight, then it follows that Slutsky symmetry is rejected.

The utility weight depends positively on the ratio of non-labor income because an increase of $\frac{y^A}{y^B}$ is to the advantage of spouse A. In this case, the utility function of A is weighted more heavily in the household utility function. We can rewrite (2.9) as:

$$\tilde{\mathbf{x}} = g(y + (w^A + w^B)T, \tilde{\mathbf{p}}, \pi(\tilde{\mathbf{p}}, \frac{y^A}{y^B})) \tag{2.12}$$

If there is income pooling we should have that:

$$\frac{\partial g}{\partial y^A} = \frac{\partial g}{\partial y^B} = \frac{\partial g}{\partial Y}$$

Using (2.12), we have:

$$\frac{\partial g}{\partial y^A} + \frac{\partial g}{\partial \pi} \cdot \frac{\partial \pi}{\partial y^A} = \frac{\partial g}{\partial y^B} + \frac{\partial g}{\partial \pi} \cdot \frac{\partial \pi}{\partial y^B} = \frac{\partial g}{\partial Y}$$

and it follows that income pooling is satisfied if:

$$\frac{\partial g}{\partial \pi} \cdot \frac{\partial \pi}{\partial y^A} = \frac{\partial g}{\partial \pi} \cdot \frac{\partial \pi}{\partial y^B} = 0 \tag{2.13}$$

Clearly a redistribution in $\frac{y^A}{y^B}$ can affect household demand and income pooling is not imposed. Empirically, income pooling can be tested by including the individual unearned incomes in the utility weight and testing if these non-labor incomes are significantly different from zero. Income pooling is rejected if the individual non-labor income influences the household demand differently. Empirical studies that reject income pooling are, for example, Thomas (1990), Browning et al. (1994), Lundberg et al. (1997), Fortin and Lacroix (1997), Browning and Chiappori (1998) and Ward-Batts (2002). There are also studies that do not reject income pooling, such as Ashenfelter and Heckman (1974), Horney and McElroy (1980), Aronsson, Daunfeldt and Wikstrom (2001), Lancaster and Ray (2002), and Nyman (2002).

The utility weight may also depend on distribution factors other than non-labor income, such as divorce laws, differences in education level, age differences and the ratio of single (wo)men to non-single (wo)men. As we mentioned earlier, the distribution factors may also contain preference factors as long as these preference factors do not appear in the utility function directly. Examples of these preference factors are age and education level.

Using the terminology of Browning et al. (2006), we refer to the Case II model as a Distribution Factor Independent collective model, since the utility weight function is not

dependent on distribution factors. For Case III the utility weight function is dependent on a distribution factor and so we can refer to this model as a Distribution Factor Dependent unitary model.

We end this section by showing in Table 2.2 the uncompensated demand functions that may vary over the various utility weight specifications. For the utility weight definition in Table 2.2, we do not assume that there is one distribution factor or that y is captured by $\mathbf{d}$.

Table 2.2: Utility weight definitions and the uncompensated demand functions

Case:	π	Demand functions
I	$\pi(\mathbf{p}, \mathbf{w}, \mathbf{y}, \mathbf{d})$	$\tilde{\mathbf{x}} = (\mathbf{p}, \mathbf{w}, \mathbf{y}, \mathbf{d})$
II	$\pi(\mathbf{p}, \mathbf{w})$	$\tilde{\mathbf{x}} = (\mathbf{p}, \mathbf{w}, \mathbf{y})$
III	$\pi(\mathbf{y}, \mathbf{d})$	$\tilde{\mathbf{x}} = (\mathbf{p}, \mathbf{w}, \mathbf{y}, \mathbf{d})$
IV	c	$\tilde{\mathbf{x}} = (\mathbf{p}, \mathbf{w}, \mathbf{y})$

Table 2.2 shows that, although demand functions can be similar in their arguments, the underlying theoretical implications can be rather different. This is exactly the point that Browning et al. (2006) make.

2.3 A Public Good Version of the Collective Model

The model used in this thesis finds its origin in the household labor supply model that was initially introduced by Chiappori (1988a; 1992), in the sense that households are viewed as a two-group making Pareto-efficient decisions concerning their labor supply and consumption (see Chiappori and Ekeland (2006)). Chiappori and Ekeland (2006) showed that the individual preferences of a collective model, as in Chiappori (1988a; 1992), are identifiable if:

1. Leisure is an exclusive good; or
2. Leisure is a public good, and there is one private consumption good per member; or
3. Leisure is an exclusive good with household production; or
4. Leisure is a public good, and there is one private consumption good per member, with household production.

Most of the available data sets do not contain information on the individual expenditures of the family and, as a consequence, the uncompensated demand functions in Section 2.2 cannot be estimated. Since there is usually information available on time use, wage rates, distribution factors, and preference factors, we formulate a model that is in line with the third alternative.

According to this alternative, consumption goods are always financed from the total household income, although it may be that one of the spouses is the only consumer of this good. Furthermore, each spouse's leisure is assumed to be a private good, i.e. the husband does not benefit from the wife's leisure, and conversely. The individual preferences of this particular model are identifiable by assuming that the spouses' leisure is a private good (see Chiappori and Ekeland (2006)).

The preferences of spouse s ($s = A, B$) are represented by the following direct utility function:

$$U^s = v^s(x, h(t_h^A, t_h^B), t_c^s, t_h^s) \tag{2.14}$$

The utility function of spouse s depends on leisure time (t_c^s) and on housework time (t_h^s). By including the latter we allow for the possibility that the household production process itself can affect utility negatively or positively. The utility function $v^s(\cdot)$ is assumed to be twice continuously differentiable and strictly concave.

Consumption is represented by a Hicksian composite good. This composite good represents the money value of the total household consumption which is taken to equal the total household income. Since we use cross-section data throughout this thesis, we assume a static model with no savings, such that total expenditures equal household consumption.

Household production goods are generally not observed in data sets either. Therefore, we represent household production by the household technology $h(t_h^A, t_h^B)$, where the arguments represent the household production hours of both spouses. We assume for the household production function the following linear form:

$$h(t_h^A, t_h^B) = t_h^A + \gamma t_h^B \tag{2.15}$$

where γ represents the marginal productivity of spouse B relative to that of spouse A. In other words, by specifying household production as the weighted sum of the housework performed by both spouses, the model allows for differences in the spouses' marginal productivity. Given the linear specification of household production we can write the utility function in (2.16) as:

$$U^s = v^s(x, t_h^A, t_h^B, t_c^s; \gamma) \tag{2.16}$$

In Section 2.1 it was shown that household preferences can be described as if a household maximizes a π-weighted sum of the individual utility functions subject to a budget constraint. Households choose the optimal bundle $(t_c^A, t_h^A, t_c^B, t_h^B)$ and maximize:

$$\begin{aligned} & \pi(\mathbf{w}, \mathbf{d}) v^A[x, t_h^A, t_h^B, t_c^A; \gamma] + (1 - \pi(\mathbf{w}, \mathbf{d})) v^B[x, t_h^A, t_h^B, t_c^B; \gamma] \\ & \text{subject to} \\ (1) \quad & x \leq y + w^A(T - t_c^A - t_h^A) + w^B(T - t_c^B - t_h^B) \\ (2) \quad & 0 \leq t_c^A, t_c^B, t_h^A, t_h^B \leq T \end{aligned} \tag{2.17}$$

where we assume, without loss of generality, that the price of the Hicksian composite good equals 1.

As shown in Section 2.2, it is crucial that the utility weight function depends on prices and/or wages, since otherwise the model collapses into a unitary model. Although we do not observe prices of consumption goods, we do observe wage rates, $\mathbf{w} = (w^A, w^B)$, and therefore the utility weight must depend on $\mathbf{w}$. Similar to Section 2.2, the utility weight is assumed to depend on variables that do not enter the individual preferences directly but influence the utility weight distribution. These variables are known as distribution factors $\mathbf{d}$.

The optimal time allocation 'bundle' that represents the household demand is denoted by:

$$\mathbf{t} = (t_c^A, t_h^A, t_c^B, t_h^B)' \tag{2.18}$$

The optimal solution to the problem in (2.17) yields a system of four demand functions:[10]

$$\mathbf{t} = \tilde{f}(\mathbf{w}, \mathbf{d}, \mathbf{y}, \gamma) \tag{2.19}$$

Below we derive the Slutsky effects in order to examine if the utility weight should depend on wages. Furthermore, it may seem that we assume income pooling because consumption goods are financed from the total household income.

However, Table 2.1 shows that income pooling is not assumed if the utility weight depends on non-labor income. Therefore, we examine whether income pooling is assumed in this particular model when the utility weight depends on the non-labor incomes.

Slutsky Symmetry in the Public Good Version of the Collective Model

The demands in (2.19) are not directly observed because we do not observe $\pi(\cdot)$. Instead, we observe $\tilde{f}(\cdot)$ for a particular π, such that the uncompensated demand functions can be

[10] Optimal labor supply follows directly from the optimal amount of leisure, household production hours, and the time constraint.

written as:

$$\mathbf{t} = \tilde{g}(\mathbf{w}, \pi(\mathbf{w}, \mathbf{d}), \mathbf{y}, \gamma) \tag{2.20}$$

It should be noted that distribution factors enter the demand functions only through $\pi(\cdot)$. In equation (2.21) we show how a marginal price increase in t_h^A results in the substitution to or from t_h^B, given that wealth is adjusted so that the household can afford the same consumption bundle:

$$\begin{aligned} s_{t_h^A, t_h^B} = \frac{\partial \tilde{g}_{t_h^A}}{\partial w_B} + \frac{\partial \tilde{g}_{t_h^A}}{\partial (y + (w^A + w^B)T)} \cdot t_h^B + \\ \frac{\partial \tilde{g}_{t_h^A}}{\partial \pi} \cdot [\frac{\partial \pi}{\partial w_B} + \frac{\partial \pi}{\partial (y + (w^A + w^B)T)} \cdot t_h^B] \end{aligned} \tag{2.21}$$

The first two elements represent a direct substitution effect, and the last two elements represent an additional wage effect. The substitution effect corresponds to a shift *along* the utility possibility frontier, while the additional price effect corresponds to a shift *of* the utility possibility frontier itself.

The wage rate w^s is the price of one leisure hour and one household production hour for spouse s. This is because the consumption of one leisure hour or the supply of one hour of domestic work implies that no paid labor is performed at a cost of w^s. As a result we can determine, for example, $s_{t_c^A, t_h^B}$ or $s_{t_c^A, t_c^B}$.

A marginal wage increase of spouse B can influence the leisure consumption of spouse A through the utility weight function. Intuitively, this means that the marginal increase in wage rate affects the bargaining position of spouse A, presumably negatively, and hence spouse A will demand less leisure. Slutsky symmetry is therefore not imposed and the Slutsky symmetry condition can be tested by including wage rates in the utility weight and testing whether these wages are significantly different from zero.[11]

Income Pooling in the Public Good Version of the Collective Model

In Section 2.2 we explain that in labor supply models we should have $\frac{\partial \tilde{g}}{\partial y^A} = \frac{\partial \tilde{g}}{\partial y^B} = \frac{\partial \tilde{g}}{\partial Y}$ if income pooling applies. If we assume that $\frac{y^A}{y^B}$ is the only distribution factor in equation (2.20), then we have:

$$\frac{\partial \tilde{g}}{\partial y^A} + \frac{\partial \tilde{g}}{\partial \pi} \cdot \frac{\partial \pi}{\partial y^A} = \frac{\partial \tilde{g}}{\partial y^B} + \frac{\partial \tilde{g}}{\partial \pi} \cdot \frac{\partial \pi}{\partial y^B} = \frac{\partial \tilde{g}}{\partial Y}$$

[11] The entire Slutsky matrix can be determined as in Section 2.1. We will not derive it in this section, as it does not add anything to the discussion.

and thus income pooling is assured if:

$$\frac{\partial \tilde{g}}{\partial \pi} \cdot \frac{\partial \pi}{\partial y^A} = \frac{\partial \tilde{g}}{\partial \pi} \cdot \frac{\partial \pi}{\partial y^B} = 0 \tag{2.22}$$

Clearly, when the utility weight depends on non-labor income (2.22) will not hold and thus the income pooling assumption is not satisfied. Although we could have chosen different specification than $\frac{y^A}{y^B}$, this would not change the conclusion above. This result may seem remarkable given that consumption goods are public goods that are financed from the household income. However, from the perspective of bargaining between the spouses this result is rather intuitive because a redistribution of the non-labor incomes can influence the labor supply choice of the spouses through a change in the distribution of bargaining power.

Studies that reject income pooling usually test the assumptions of the unitary approach. The rejection is based on the observation that household demands change when there is a redistribution of non-labor income (see, for example, Lundberg et al. (1997)). We would like to add to this discussion that it is possible that it is not income pooling that is rejected, but that the unitary model is rejected because bargaining between the spouses is not incorporated in the model.

We conclude that the more restricted public good version of the collective model neither imposes income pooling, in the unitary sense, nor Slutsky symmetry.

2.4 Summary

In this chapter we have discussed the principles and theory of the collective model of household behavior and pointed out the advantages of this model compared with other existing models of household behavior.

The main competitors of the collective model are the unitary model and the cooperative bargaining model. The advantage of the collective model compared with the cooperative bargaining model is that the predicted outcome of the household decision process is not based on a game theoretical equilibrium concept. Instead, the main assumption is that the outcome of a household decision process should yield a Pareto-efficient outcome, and no assumptions are made about the household decision process itself. Because the collective model allows for all Pareto-efficient outcomes, it holds that each efficient outcome predicted by a cooperative bargaining model can also be predicted by the collective model.

According to the unitary model the household can be viewed as one decision unit (one person) with its own utility function and preferences. Spouses maximize the household utility

function and the efficient outcomes of the household decision process are driven entirely by comparative advantages. Because household members maximize the same a household utility function so that individual preferences are not considered nothing can be said on the intra-household allocation of welfare. In addition the unitary model restricts household behavior by assuming that the household income is pooled and that marginal compensated wage changes of the spouses have a similar effect on each other labor supply. The latter is also known as the Slutsky symmetry assumption. The restrictions of the unitary model can be empirically tested and are almost always rejected in the empirical literature. The collective model does not impose the unitary restrictions on the household behavior and because individual preferences are explicitly defined it is possible to examine the intra-household allocation of welfare.

The collective model describes the household decision problem as if the household maximizes a weighted sum of the individual utility functions. This utility weight represents the division of bargaining power between the household members. A necessary condition is that the utility weight is a function that depends on the prices of consumption goods and/or wage rates, or else the model will collapse into a unitary model.

Since there is often no information on the expenditures of the family members it is not possible to estimate the collective model because the optimal uncompensated demand functions have consumption goods as endogenous choice variables. Therefore, we formulate a public good version of the collective model where household behavior is described as if the household chooses an optimal time allocation 'bundle', which is convenient as there usually is data on time use, wage rates, distribution factors and preference factors. In particular, consumption goods are assumed to be public within the household and where each spouse's leisure is assumed to be a private good, i.e. the husband does not benefit from the wife's leisure, and conversely. We also include household production by considering the time that spouses devote to housework and assuming for household production goods that they are public goods within the household. Throughout this thesis we refer to this particular model as the public good version of the collective model. The individual preferences of this model are identifiable by assuming that spouses' leisure is a private good (see Chiappori and Ekeland (2006)). This model is used in Chapters 3, 4 and 5.

In the public good version of the collective model Slutsky symmetry is not assumed if the utility weight function depends on wages. Moreover, a redistribution of the non-labor incomes can influence the labor supply choice of the spouses even though we assume that consumption is financed from the pooled household income. We conclude that, besides the public good assumption, the main principles of the public good version of the collective

model are similar to those of the collective model.

Appendix 2.A

In this Appendix we show how the Pareto-efficient solution in (2.8) is obtained using equations (2.6) and (2.7), where we define total household consumption and the corresponding price vector. When we assume that the utility weight is of the form $\pi(\mathbf{p}, \mathbf{w})$, we can write the household maximization process as:

$$\max_{\tilde{\mathbf{x}}} \quad \pi(\tilde{\mathbf{p}})v^A(\tilde{\mathbf{x}}) + (1 - \pi(\tilde{\mathbf{p}}))v^B(\tilde{\mathbf{x}})$$

subject to

$$\tilde{\mathbf{p}}'\tilde{\mathbf{x}} \leq y + (w^A + w^B)T$$

Obviously the optimal solution to this problem is a system of demand functions $\tilde{\mathbf{x}}$ that depend on prices ($\tilde{\mathbf{p}}$), wage rates ($\mathbf{w}$) and non-labor income (y), or:

$$\tilde{\mathbf{x}} = f(y + (w^A + w^B)T, \tilde{\mathbf{p}})$$

Since we have n consumption goods and the consumption of leisure of both spouses, we have n+2 demand functions.

Chapter 3

A Public Good Version of the Collective Household Model: An Empirical Approach with an Application to British Household Data[1]

3.1 Introduction

The labor choice of the female affects not only the consumption level of the female but also that of the husband. The household income is a kind of public good (Y) within the household.[2] This does not imply that out of the household income no commodities are bought that can only be consumed by one of the two spouses, e.g. clothing, the barber, etc., but it does imply that even then a purchase by one of them needs the explicit or implicit approval of the other partner. It is an issue of the power distribution between the two partners who in the end gets most of the pie. Actually, we may discern two sides of the coin with respect to the male's (and the female's) paid labor supply. His direct labor effort (or enjoyment) is his own, but the ensuing money outcome of his labor is shared with his partner and hence also affects the partner's utility function through the household income.

[1]This chapter is based on Van Klaveren, van Praag & Maassen van den Brink (2008). Furthermore, we are grateful to Pierre Andre Chiappori and Frederic Vermeulen for their valuable comments.

[2]See also Browning et al. (2006), who show that income pooling is neither necessary nor sufficient to describe a household as a unitary household.

The second public good that we can distinguish in the household is what we refer to as the level of household care (H), defined as the sum of hours spent by both partners on what they call 'household tasks'. These tasks include cooking, cleaning, doing the laundry and other such activities. Of course, the distinction between housework and leisure may be ambiguous, and therefore we leave the empirical definition to the respondents themselves. Some love cooking and see it as a leisure activity; others hate cooking and see it as house*work*. Here again the direct effort (or enjoyment) linked to housework is experienced by the individual who spends his or her time on it, but the ensuing product is a public good H that also affects the partner's utility function through H.

In this chapter we develop a structural collective household model of time allocation, assuming that internally produced household services and externally purchased market goods are public goods in the household, while the direct time expenditures by each partner (paid work, housework and leisure) affect only the utility of the individual time spender. A public good is usually understood to be a good where the consumption by one person does not exclude the consumption of the same good by another person. Here we stretch the concept somewhat, as the consumption of, for instance, going to the barber, although financed out of the common purse, can only be for one partner. In the present situation the public good is characterized by the fact that personal 'inputs' do not automatically equal personal 'outputs'. For instance, when considering the traditional household model where only the male earns labor income, then part of that money is spent by the female in favor of herself. Similarly, the housework performed by the female is also enjoyed by the male.

In the 1980s Chiappori (1988a, 1992, 1997) introduced the collective model (CM) of household behavior and, as we explained in Chapter 2, the CM is currently the obvious setting in which to study the joint labor supply of both spouses. For an elaborate and more formal discussion we refer to Chapter 2.[3] According to this model, spouses are living together, so to speak, in a Pareto-equilibrium. In the Pareto-equilibrium of the collective model, the equilibrium may be described as the result of optimizing the household utility function, which is defined as a weighted sum of the male's and the female's utility function. The weight is generally referred to as the Pareto-weight and an intuitive interpretation of this weight is that it represents the division of bargaining power between the spouses. A crucial and necessary assumption in the CM is that the Pareto-weight depends on, among other exogenous variable(s), the wage rates of both household members, because otherwise the model coincides with the unitary model. It then implies that the marginal compensated wage changes of the two partners must have the same effect on each other's labor supply,

[3]For other discussions see Bergstrom (1997), Pollak (2002), Vermeulen (2002), Ermish (2003), Chiappori & Ekeland (2006) and Donni (2007).

which is clearly a disadvantage.

In Chapter 2 we formulated a Public Good Version of the Collective Model (PGVCM) where the endogenous choice variables are time use variables rather then bundles of consumption goods. Choosing time-use variables as choice variables is convenient because usually family expenditures are not observed in the data, whereas, information on the time use of the spouses is usually available. The empirical model is similar to the theoretical model described in a recent paper by Chiappori and Ekeland (2006). There they derive theoretically when collective household models are non-parametrically identifiable. One of the specific identifiable cases they refer to is a model where at least one consumption good of each household member is an exclusive good. Since we do not observe consumption goods, as in market goods and household production goods, we consider each spouse's leisure as a private good and assume that consumption goods are public.[4]

In this chapter, we propose an iterative estimation method, by which it is possible to estimate: (1) the (ordinal) utility functions; (2) the utility weight function that necessarily depends on the individual wage rates; and (3) the wage, child and non-labor income effects.

For this purpose we use data from the British Household Panel Survey (BHPS). The PGVCM is estimated on a restricted sample of British households where both spouses perform paid work and this may induce a selectivity bias. In Chapter 5, we will address this problem and extend the PGVCM, such that the non-participation decision of household members can be examined.

This chapter proceeds as follows. In Section 3.2 we develop an empirical model of the PGVCM version. In Section 3.3 the two-step iterative estimation procedure is explained by which the model can be estimated. In Section 3.4 we describe the data that are used and present the estimation results. In Section 3.5 we discuss the wage, child and non-labor income effects and finally, Section 3.6 concludes.

3.2 The Model

Before introducing the PGVCM it is useful to make a digression to the literature of individual labor supply. In the theory of individual labor supply the individual utility function is:

$$U = U(q, t)$$

[4]We note that in Chiappori 1988a; 1992 consumption goods are assumed to be purely private, while in our paper they are considered as public goods.

where q stands for a consumption bundle of market goods and t for a vector of time expenditures, say (t_1, t_2, t_3), denoting leisure, housework and job hours, respectively. Utility is maximized under the budget constraint $w \cdot t_3 = p\,'q$ and the time budget constraint $t_1 + t_2 + t_3 = T$, where w stands for hourly wage.

If we have no information about consumption q, we assume a Hicksian composite commodity, the value of which is income y $(= w \cdot t_3)$. Then we may write the utility function as:

$$U = U(y(t_3), t_1, t_2, t_3)$$

This is not an indirect utility function, since here y stands for a composite commodity. This somewhat unusual expression demonstrates that spending time t_3 on paid work has *two* effects on utility. The first is positive as working generates income, i.e. consumption. The second effect is mostly assumed to be negative as the working effort is thought to reduce utility.[5] In a similar way we might split the household effort t_2 into two effects: a positive effect with respect to the level of household care $H = H\,(t_2)$, where $H(t_2)$ stands for the household production function, and a negative effect because most people do not like the effort identified with housework t_2.[6] Including H we may write in a similar way:

$$U = U(y(t_3), H(t_2), t_1, t_2, t_3)$$

$H(t_2)$ represents the positive effect of household production. The direct effect of household time t_2 is ambiguous as well. On the one hand individuals may dislike the effort of working in the household, but on the other hand the process of participating in household production may yield utility.

In the utility function above, both t_2 and t_3 figure twice, once in their 'input' role, and once in their 'output' role. Obviously, these formulations look a bit like hair-splitting in the individual case. However, in the collective case this distinction makes sense as the input effort may fall on one partner while both partners or even, exclusively, the other partner, may enjoy the output.

More precisely, we may write the utility function of household member i as[7]

$$U_i = U_i(Y(t_{3m}, t_{3f}), H(t_{2m}, t_{2f}), t_{1i}, t_i, t_{3i}), \quad i = (m, f)$$

[5]It may be, as many psychologists and sociologists claim, that participation as such is welfare increasing. Then we have two positive effects.

[6]Note that some men and women like household work as a way of self-realization, that is, it is utility increasing. In that case, the effort effect would be positive.

[7]For a similar argument see also Grossbard, 2005, 217.

Let us now rename our variables in a more familiar way. We assume that both partners i $(= m, f)$ have a log-additive utility function in the individual variables: leisure le_i, housework hours wh_i, job hours jh_i $(= T - le_i - wh_i)$, and the public goods household income (Y) and household care level (H). We specify the household production function as the productivity weighted sum of the hours that both partners spend on household activities, i.e. $H = (wh_m + \gamma \cdot wh_f)$. As a result of the inclusion of the variable H, we are able to make a distinction between the effect of the individual's household input effort (wh) and the effect of the provision level of the public good H on the individual. Moreover, we assume a utility effect of H that depends on the family size. More precisely, the spouse spending 20 hours on household production for a two-person family may derive less (or more) satisfaction from that effort than the spouse who spends 20 hours for a family with two children in addition to her husband. Therefore, we add an interaction term between family size and household hours. The ordinal utility functions of household members $i = m$(ale), f(emale) are then written as:

$$\begin{aligned} U_i = {} & \alpha_{i,1} \ln(Y) + [\alpha_{i,2} + \alpha_{i,2I} \ln(fs + 1)] \cdot \ln(H) + \alpha_{i,3} \ln(le_i) \\ & + \alpha_{i,4} \ln(wh_i) + \alpha_{i,5} \ln(jh_i) \end{aligned} \tag{3.1}$$

The fs-term in equation (3.1), referred to as family size, stands for the number of children living in the household. In order to avoid taking a logarithm of zero we add 1 to the number of children. By including family size we account for the fact that, the larger the family size, the same amount of hours spent on household work will yield less household care. The utility functions describe a net of indifference curves and the analysis does not change if we apply a monotonic transformation on utility or normalize by requiring the coefficients to add up 1 or another non-zero constant.

As is shown in Chapter 2, the behavior of household n may be viewed as the outcome of maximizing a household utility function of the following type:

$$U_{n,h} = \pi_n U_{n,m} + (1 - \pi_n) U_{n,f} \tag{3.2}$$

with respect to le_m, wh_m, le_f and wh_f. The individual preferences are represented by $U_{n,i}$ and the utility weight is represented by π_n and is assumed to be situated on the interval (0,1). Furthermore, π varies over households as a function of wages and possibly other variables that influence bargaining within the household. In addition, household members face the

following constraints:

$$
\begin{aligned}
&le_i + wh_i + jh_i = T, \quad i = m, f \\
&Y = w_m \cdot jh_m + w_f \cdot jh_f + y_u \\
&H = wh_m + \gamma \cdot wh_f
\end{aligned}
$$

The parameter γ stands for the productivity of the female in terms of male hours. The total weekly time endowment of 168 hours is denoted as T. The net wage rates of the male and the female are denoted by respectively w_m and w_f. The y_u-term stands for the net weekly non-labor household income. To simplify this exposition we start by assuming $\gamma = 1$, and also assume for the individual utility functions, that $\sum \alpha_i = 1$ for $i = m, f$ for identification purposes.

We now substitute the constraints into the utility functions. For household n, this yields the unconstrained problem:

$$
\max_{le_{n,m}, wh_{n,m}, le_{n,f}, wh_{n,f}} U_{n,h} = \pi_n U_{n,m} + (1 - \pi_n) U_{n,f} \tag{3.3}
$$

with

$$
\begin{aligned}
U_{n,i} = {} & \alpha_{i,1} \ln(w_m jh_m + w_f jh_f + y_u) + [\alpha_{i,2} + \alpha_{i,2I} \ln(fs + 1)] \cdot \ln(wh_m + wh_f) \\
& + \alpha_{i,3} \ln(le_i) + \alpha_{i,4} \ln(wh_i) + \alpha_{i,5} \ln(T - le_i - wh_i)
\end{aligned}
$$

When the optimization problem is described in the Lagrangean form, it follows that the household utility function is concave, given explicit linear constraints and as a consequence there exists one unique optimum. Assuming for the moment that π_n is fixed, we get four first-order conditions.

Let us assume that the household sets the male's leisure time at le_m, and his household production hours at wh_m, and, consequently, his job hours at $jh_m = (T - le_m - wh_m)$, such that the collective utility function is maximized. Then after re-ordering, the corresponding first-order conditions (FOCs) for the male's leisure time and hours of housework are then:

$$
\frac{\partial U_h}{\partial le_m} = \frac{\partial U_f}{\partial le_m} + \pi \left(\frac{\partial U_m}{\partial le_m} - \frac{\partial U_f}{\partial le_m} \right) = 0 \tag{3.4}
$$

$$
\frac{\partial U_h}{\partial wh_m} = \frac{\partial U_f}{\partial wh_m} + \pi \left(\frac{\partial U_m}{\partial wh_m} - \frac{\partial U_f}{\partial wh_m} \right) = 0 \tag{3.5}
$$

For le_f and wh_f, we find two similar equations. We note that each of the FOCs in (3.4) and (3.5) consists of three terms. The first and the third term refer to the 'female' part of the collective utility function. The explanation for this is that the public goods Y and H figure in the utility functions of both partners. The hours wh_f that the female works in the household affect the utility of the male. The same holds for the job working hours jh_f of the female, because the net wage of the female is part of the household income.

There is no need to spell out all the FOCs in detail. Let us consider the first FOC in more detail. Obtaining the derivative $\frac{\partial U_m}{\partial le_m}$ gives:

$$\frac{\partial U_m}{\partial le_m} = \frac{\alpha_{m,1}}{w_m \cdot (T - le_m - wh_m) + w_f \cdot (T - le_f - wh_f) + y_u} + \frac{\alpha_{m,3}}{le_m} + \frac{\alpha_{m,5}}{T - le_m - wh_m}$$

and this expression is linear in the 'male' utility parameters (α_m). The *coefficients* are non-linear expressions in le_m, le_f, wh_m, wh_f, w_m, w_f, fs and y_u. For instance, the first *coefficient* may be denoted as $x_{1,m,1} = \frac{1}{Y}$.[8] As $\alpha_{m,2}$ does not appear in the first FOC, we have $x_{1,m,2} = 0$. For brevity, we denote the coefficient vector of the first FOC, referring to the male's utility function, by a 6-vector function $x_{1,m}(le_m, le_f, wh_m, wh_f, w_m, w_f, fs, y_u)$. We may write $\frac{\partial U_m}{\partial le_m} = x'_{1,m}\alpha_m$. In a similar way we can derive $\frac{\partial U_f}{\partial le_m}$, which may be written as $\frac{\partial U_f}{\partial le_m} = x'_{1,f}\alpha_f$.

Consequently, we may write the first FOC more concisely as:

$$x'_{1f}\alpha_f + \pi\left(x'_{1m}\alpha_m - x'_{1f}\alpha_f\right) = 0 \tag{3.6}$$

The index 1 refers to the x-vector in the first FOC. The other FOCs with respect to wh_m, le_f and wh_f can be written in a similar way and this yields a linear system of four equations:

$$\begin{bmatrix} \pi x'_{1m} & (1-\pi)x'_{1f} \\ \pi x'_{2m} & (1-\pi)x'_{2f} \\ \pi x'_{3m} & (1-\pi)x'_{3f} \\ \pi x'_{4m} & (1-\pi)x'_{4f} \end{bmatrix} \begin{bmatrix} \alpha_m \\ \alpha_f \end{bmatrix} = \begin{bmatrix} \pi X'_m & (1-\pi)X'_f \end{bmatrix} \begin{bmatrix} \alpha_m \\ \alpha_f \end{bmatrix} = 0 \tag{3.7}$$

where X'_m and X'_f are (4×6)-matrices. For household n, we define the (4×12)-matrix X'_n

[8] Note that $Y = w_m \cdot (T - le_m - wh_m) + w_f \cdot (T - le_f - wh_f) + y_u$.

by:

$$\left[\pi_n X'_{n,m}(1-\pi_n)X'_{n,f}\right] = X'_n \tag{3.8}$$

For convenience, we introduce the shorthand notation $z = (le_m, wh_m, le_f, wh_f)$ for the solution vector. The left-hand side of the system is the gradient of the household utility function $U_h(z)$. We shall write it sometimes as the 4-vector $U'_h(z)$, or alternatively as U_z. The above system describes the equilibrium where the gradient vector equals the zero vector. Similarly, we will denote the (4×4)-matrix of second-order derivatives of $U_h(z)$ by U''_h or U_{zz}.

Specification of the utility weight

The Pareto-weight distribution between the male and the female $(\pi, 1-\pi)$ is assumed to depend on their personal characteristics: in short, a vector (v_m, v_f) of weight characteristics. As is mentioned by Browning et al. (2006), a model that makes use of a Pareto-weight is usually referred to as a collective model. They conclude that, when the Pareto-weight is not assumed to depend on prices (or, in our model, wages) then the model is equivalent to the standard unitary model. The dependency of the Pareto-weight function on wage rates is therefore a crucial element in our model. The Pareto-weight depends on the following distribution factors: the hourly wages of the two partners, the number of children, the ages of the two partners and the weekly non-labor income.[9]

Considering for the moment only the hourly wages of the two partners, we use the convenient functional specification:

$$\pi_n(v) = N(\beta_m \ln(w_{n,m}) + \beta_f \ln(w_{n,f})) \tag{3.9}$$

where $N(\cdot)$ stands for the standard normal distribution function. The advantage of this specification is that the male's power $\pi(v) \in [0,1]$ and the same holds for the female's power $(1-\pi)$. If $\beta_m = -\beta_f$ and $w_m = w_f$, we find $\pi(v) = \frac{1}{2}$. An increase of π implies that the utility function of the male is weighted more heavily in the collective utility function at the expense of the utility of the female. The male's weight $\pi(v)$ is expected to be increasing in the male's wage and, inversely, is expected to be decreasing in the female's wage. Generally, the weight will be asymmetric, except if $\beta_m = -\beta_f$ and $w_m = w_f$. If we add a constant β_0 to the argument in $N(\cdot)$, one of the partners is structurally overweighted. For example, if $\beta_0 > 0$, the utility function of the male is structurally overweighed. However, as in our empirical estimates we found a statistically insignificant value for β_0, we drop it from our

[9]The very presence of children might be the result of decisions regarding fertility that most likely reflect bargaining within the household. However, modelling the decision of having children is beyond the scope of the chapter.

model.

3.3 The Estimation Method

Let us assume we have a data set $\{le_{m,n}, le_{f,n}, wh_{m,n}, wh_{f,n}, w_{m,n}, w_{f,n}\}_{n=1}^{N} = \{z_n, w_n\}_{n=1}^{N}$ of N observations of households n. Clearly, as econometricians usually do, we can try to solve the system of FOCs for each n, yielding predicted values $\widehat{le}_{m,n}$, $\widehat{le}_{f,n}$, $\widehat{wh}_{m,n}$, $\widehat{wh}_{f,n}$ as functions of the individual wages $w_{m,n}$, $w_{f,n}$ and the unknown parameter vector (α, β). However, those functions would be highly non-linear in α and β, and consequently it would be difficult to estimate the unknown parameters. We propose a more convenient indirect estimation method, similar to the Wald-test criterion approach (see also Wales and Woodland (1983) and Blundell and Robin (1999)), in order to estimate the unknown parameter vector (α, β).

Consider again the system

$$\left[\begin{array}{cc} \pi_n X'_{n,m} & (1-\pi_n) X'_{n,f} \end{array} \right] \left[\begin{array}{c} \alpha_m \\ \alpha_f \end{array} \right] = 0 \quad \forall n \tag{3.10}$$

where we assume for a start that the π_n are known. We have

$$\left[\begin{array}{cc} \pi_n X'_{n,m} & (1-\pi_n) X'_{n,f} \end{array} \right] = X'_n$$

Obviously the matrix equality (3.10) will not hold exactly; so we assume that

$$X'_n \alpha = \varepsilon_n \tag{3.11}$$

where we introduce the error vector $\varepsilon \sim N(0, \Sigma_\varepsilon)$, and we assume that the behavior of distinct households is not correlated, that is, $E(\varepsilon_n, \varepsilon_{n'}) = 0$ if $n \neq n'$. The (4×4)-error-covariance-matrix Σ_ε may be non-diagonal in order to include the possibility that errors in time-spending decisions are correlated. Given the overall time budget constraints and the probable correlation between the partners' decisions, such a correlation is probable.

The obvious way to estimate this system is to minimize the sum of squared residuals $\sum_1^N \varepsilon'_n \Sigma_\varepsilon^{-1} \varepsilon_n = \sum_1^N \alpha' X_n \Sigma_\varepsilon^{-1} X'_n \alpha$ with respect to α. We exclude the 'trivial' solution $\alpha = 0$ by adding the two identifying conditions $\sum \alpha_m = 1$ and $\sum \alpha_f = 1$.

The estimation problem is solved by iteration. We start by assuming $\beta_m = \beta_f = 1$, yielding first-round Pareto-weight coefficients $\pi_n^{(1)}$. Note that these Pareto-coefficients are not constant, as households differ with respect to wages w_m and w_f. Then we estimate the

α's, given $\pi_n^{(1)}$.

Consider the system of four equations

$$y_n = X_n'\alpha + \varepsilon_n \tag{3.12}$$

where we introduce the nuisance vector y_n. Surprisingly, the system can be estimated in a simple way by the method of Seemingly Unrelated Least Squares (SUR). If we set $y_n = 0$ for all n, estimation of this system under the constraints $\sum \alpha = 1$ is equivalent to minimizing $\sum_1^N \alpha' X_n \Sigma_\varepsilon^{-1} X_n' \alpha$ with respect to α under the constraints.

The estimation of the collective model is somewhat more complex, as we have to estimate the parameters β_m, β_f as well, which requires a non-linear estimation method. On the basis of the first-round estimate $\alpha^{(1)}$, we estimate $\beta_m^{(1)}, \beta_f^{(1)}$. Using these estimated β-values, we then obtain $\pi^{(2)}$. With $\pi^{(2)}$ we estimate $\alpha^{(2)}$, and we continue this iterative process until convergence is reached. The asymptotic covariance matrix $\Sigma_{\alpha,\beta}$ of the parameter estimates $(\widehat{\alpha}\ , \widehat{\beta})$ is derived in the usual way.

3.4 Data and Estimation Results

We use the 2003-wave (l) of the British Household Panel Survey (BHPS), where we consider a subset of 1497 two-earner households. These households were interviewed between September 2002 and September 2003. The BHPS is a panel that started in 1991 and is household-based; each adult member of the household is interviewed each year. The main objective of the BHPS is to give insight into the social and economic changes at the individual and household levels in the UK.

The information that is used for this study has been derived from questions on how individuals of two-earner households allocate their time. From the proposed empirical model it follows that we are interested in the number of hours that individuals spend on leisure, household tasks, and on their jobs.

Table 3.1 shows the summary statistics on the weekly hours spent on these different activities by males and females. Furthermore, it shows the net hourly wage rates of males and females and the non-labor household income y_u. The latter is defined as the sum of income from social benefits, income from investments and transfer income. By 'transfer income', we mean income that is transferred from one household to another household (for example, gifts from parents to their children). Our data set, unfortunately, does not allow us to make a clear distinction between the origins of the unearned income.

Table 3.1: **Summary Statistics**

	N	Mean	Std.Dev.	Min. 10% percentile	Max. 90% percentile
Leisure hours male	1497	118.742	9.470	107	128
Household hours male	1497	5.328	4.205	1	10
Job hours male	1497	43.931	8.953	37	55
Leisure hours female	1497	121.707	11.616	108	137
Household hours female	1497	13.917	8.548	5	25
Job hours female	1497	32.376	11.460	16	45
Hourly wage male	1497	7.947	8.526	4.50	11.67
Hourly wage female	1497	6.450	2.894	3.75	9.93

As expected, the descriptive statistics indicate that men earn a higher wage than women, and that men spend more time on paid labor than women, while the opposite is true for the time spent on household activities.

In the BHPS we have information on the hours that household members spend on household activities and the specific question is: "About how many hours do you spend on housework in an average week, such as time spent cooking, cleaning and doing the laundry?". While cooking, doing the laundry and cleaning are activities that are explicitly stated in the question, the addition of *such as* shows that we can not be certain how housework is exactly defined. It is likely that housework captures the time spent on the explicitly stated activities, but there may be more, such as child care. Consequently, the distinction between housework and leisure may be ambiguous, and therefore we leave the empirical definition to the respondents themselves. Some love cooking and others hate it. For the former it is a leisure activity, and for the latter it is work. An important issue is that there is no certainty whether respondents consider child care as housework or leisure. For child care we leave the implicit classification to the respondent as well. Furthermore, these activities depend very much on the number of children.

Given the observed quantities of time that are allocated to certain activities, and assuming that individuals maximize their utility following the collective model we can estimate the preference parameters (α_m, α_f). At this point we wish to introduce some more flexibility

with respect to the parameter γ which up to now we assumed to equal 1 for convenience. For the estimation we will distinguish four different alternatives:

- Alternative 1: $\gamma = 1$ and $\alpha_{i,2I}$=0, $(i = 1, 2)$.
- Alternative 2: $\gamma = 1$ and $\alpha_{i,2I}$ to be estimated
- Alternative 3: γ to be estimated and $\alpha_{i,2I} = 0$
- Alternative 4: γ to be estimated and $\alpha_{i,2I}$ to be estimated.

While we assume for Alternatives 1 and 2 that $\gamma = 1$ and consequently that the number of household hours of male and female are perfect substitutes, this assumption is relaxed in Alternatives 3 and 4. For alternatives 2 and 4 an interaction term is included.

Table 3.2 presents the parameter estimates for (α_m, α_f). The FOCs with respect to wh_i are not linear in γ and therefore we estimate the γ parameter numerically. We let γ vary with a grid-width of 0.025, and for each alternative value of γ, choose the value of γ that gives the highest log-likelihood of the system.

The γ-parameters are 0.85 and 0.925 for Alternatives 3 and 4, respectively. γ should be interpreted as the ratio of the marginal productivities and because the marginal rate of substitution is smaller than 1, we find that the performance of one housework hour by men is relatively more productive. An explanation for this result is that the *marginal* household work productivity of the woman is somewhat less than that of the man because she usually spends more time on household tasks. Men may therefore be more efficient when they spend an additional hour on household tasks.

When concentrating on the preference parameters, we note that the interaction parameter drops out of the model for Alternatives 1 and 3 and so there are no estimation results for the interaction of family size with total household production. We see that all parameter values are significant except the interaction effect of total household production with family size for the male in Alternatives 2 and 4.

The estimation results appear to be robust for the different alternatives[10]. The main variables in the utility function for the four different alternatives appear to be leisure and household income, for both the male and the female. The preference for total household production is influenced by family size for the female, while this is not the case for the male.

A Wald test is performed simultaneously on all preference parameters to test if men and women have different preferences. The test results are printed in Table 3.3:

[10]Actually, the results are sometimes incredibly robust, with a t-ratio of 256. As all estimates are plausible, and we have tested several other specifications, we could do nothing other than accept this robustness.

Table 3.2: **Parameter estimates for α**

Alternative 1	***Male***		***Female***	
	Estimate	***t*-value**	**Estimate**	***t*-value**
leisure	0.755	256.33	0.778	213.67
housework	0.003	20.93	0.004	7.30
household production (H)	0.014	7.73	0.032	15.00
H interaction term	.	.	.	.
household income	0.261	57.33	0.204	60.23
job working hours	-0.033	-13.29	-0.017	-21.59
Alternative 2	***Male***		***Female***	
	Estimate	***t*-value**	**Estimate**	***t*-value**
leisure	0.757	219.19	0.823	193.33
housework	0.004	23.51	0.002	3.84
household production (H)	0.013	6.01	0.019	9.70
H interaction term	0.002	0.57	0.013	3.91
household income	0.293	61.69	0.180	54.72
job working hours	-0.069	-26.47	-0.037	-29.14
Alternative 3	***Male***		***Female***	
	Estimate	***t*-value**	**Estimate**	***t*-value**
Leisure	0.739	259.59	0.794	224.26
Housework	0.003	17.36	0.006	13.83
Household production (H)	0.026	15.49	0.016	7.99
H interaction term	.	.	.	.
Household income	0.268	62.22	0.203	61.73
Job working hours	-0.036	-15.54	-0.019	-23.93
Alternative 4	***Male***		***Female***	
	Estimate	***t*-value**	**Estimate**	***t*-value**
Leisure	0.741	237.25	0.767	206.16
Housework	0.003	19.07	0.005	11.16
Household production (H)	0.020	9.13	0.015	6.08
H interaction term	0.005	1.15	0.028	6.38
Household income	0.269	62.16	0.203	59.65
Job working hours	-0.037	-15.64	-0.018	-23.90
	Alt. 1	**Alt. 2**	**Alt. 3**	**Alt. 4**
$\overline{\pi}$	0.532	0.471	0.542	0.534
γ	1	1	0.850	0.925
N	1497	1497	1497	1497

Table 3.3: **'Joint' Wald test to test equality of preference parameters**

	Prob $> \chi^2$			
Preference parameter w.r.t	Alt. 1	Alt. 2	Alt. 3	Alt. 4
Leisure	x	x	x	x
Housework	0	x	x	x
Joint household production (H)	x	0	x	0
H interaction term	.	x	.	x
Household income	x	x	x	x
Job working hours	x	x	x	x

Note: x indicates that the preference parameters of male and female differ significantly; 0 indicates that this is not the case

An x-sign indicates that the parameters are significantly different from one another, while a 0-sign indicates that the parameters do not significantly differ. The test reveals that the coefficients for males and females are, in general, significantly different. The exceptions are the preference parameters for household work in Alternative 1 and the preference parameters for joint household production in Alternatives 2 and 4.

When we return to the estimation results of Table 3.2, we find that male and female leisure are the most important variables by far, followed by household income. The male is more income-oriented than the female and the opposite holds for leisure. Job working hours are negative for both, but more for the male. Finally, housework has a weakly positive effect, where the female derives somewhat more satisfaction from it than the male.

In order to obtain some more insight into the estimates of Table 3.2, we can derive the marginal rate of substitution between leisure hours and job hours for the male and the female *separately*. Since the estimates of the coefficients for the four different alternatives are quite similar, we will only derive the marginal rate of substitution between leisure hours and job hours for Alternative 1. The marginal rate of substitution for the other three alternatives are approximately equal. The marginal rate of substitution between leisure hours and job hours for the male is given by:

$$\frac{\partial U_m}{\partial le_m} \cdot \Delta le_m + \frac{\partial U_m}{\partial jh_m} \cdot \Delta jh_m = 0 \tag{3.13}$$

From (3.13) we can derive

$$\frac{\alpha_{m,1} w_m}{Y} \cdot \Delta jh_m + \frac{\alpha_{m,3}}{le_m} \cdot \Delta le_m + \frac{\alpha_{m,5}}{jh_m} \cdot \Delta jh_m = 0 \tag{3.14}$$

From Table 3.1 we can obtain the average net hourly wage of the male (£7.947) and the average net household income per week (£349+£209 = £558). From Table 3.2 we obtain the estimates of the preference parameters and we find:

$$\frac{0.261 \cdot 7.947}{349 + 209} \cdot \Delta jh_m + \frac{0.755}{119} \cdot \Delta le_m + \frac{-0.033}{44} \cdot \Delta jh_m = 0 \tag{3.15}$$

Rewriting (3.15) gives

$$0.006 \cdot \Delta le_m + (0.004 - 0.001) \Delta jh_m = 0 \tag{3.16}$$

It follows that the (marginal) shadow price of 1 leisure hour is worth about $\frac{1}{2}$ a job hour, and accordingly its money value would be about $\frac{1}{2}$ the male 's hourly wage. Doing the same for females, we find that the (marginal) shadow price of 1 hour of female leisure is worth about $\frac{1}{7}$ of a job hour and its money value is $\frac{1}{7}$ of the female's hourly wage.

In Table 3.4 we present the parameters of the Pareto-weight function for the different Alternatives 1-4, where we add the distribution factors children and age.

Table 3.4: **Estimates of the utility weight function, π_n**

	Alternative 1		***Alternative 2***	
	Estimate	**t-value**	**Estimate**	**t-value**
Log(w_{male})	0.593***	25.71	0.592***	22.62
Log(w_{female})	-0.562***	-25.26	-0.606***	-23.26
Log(#-children 0/2+1)	-0.094**	-2.32	-0.078	-1.65
Log(#-children 3/4+1)	-0.091**	-2.17	-0.062	-1.27
Log(#-children 5/11+1)	-0.056**	-2.37	-0.023	-0.86
Log(#-children 12/16+1)	-0.038	-1.32	0.011	0.34
Log(#-children >16+1)	-0.052	-0.98	0.002	0.04
Log(age_{male})	0.014	0.21	-0.056	-0.71
Log(age_{female})	-0.036	-0.52	0.019	0.24
Log(y_u+1)	0.010*	1.75	-0.004	-0.54
N	1497		1497	
	Alternative 3		***Alternative 4***	
	Estimate	**t-value**	**Estimate**	**t-value**
Log(w_{male})	0.613***	26.31	0.625***	26.20
Log(w_{female})	-0.621***	26.82	-0.628***	26.59
Log(#-children 0/2+1)	-0.025	-0.62	-0.038	-0.91
Log(#-children 3/4+1)	-0.023	-0.56	-0.039	-0.90
Log(#-children 5/11+1)	0.001	0.05	-0.009	-0.38
Log(#-children 12/16+1)	0.012	0.41	0.004	0.14
Log(#-children >16+1)	-0.006	-0.11	-0.011	-0.20
Log(age_{male})	-0.024	-0.34	-0.026	-0.37
Log(age_{female})	0.024	0.33	0.016	0.21
Log(y_u+1)	0.005	0.81	0.006	0.91
N	1497		1497	

Note: * significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

We see that the hourly wage rates are by far the most important. The weight of the male's

wage is about equal to that of the female, while the sign of the female coefficient is negative, as we expected. The utility of the female is weighted more heavily if there are children in Alternative 1, where children below age 5 get more weight compared with children of 5 years and older, while the effect of children above 11 years is non-significant. Indeed, it may be expected that in traditional households the bargaining power of the female increases with the presence of young children. This child effect is not found for the other alternatives. The non-labor household income is slightly significant for the first alternative and non-significant in all other alternatives.

The average (male) Pareto-weight coefficient ($\overline{\pi}_n$) is slightly higher than 0.5 for Alternatives 1, 3 and 4. For Alternative 2 it is just below 0.5. In general it seems that the Pareto-weight distribution in British households is on average about 50-50 for the male and the female within the two-earner households.

We note that the chosen functional form of the Pareto-weight function allows for all sample average values between 0 and 1. The Pareto-weight effects are based on a sub-sample of two-earner households, and so it is possible that the average value of the Pareto-weight coefficient will be different for one-earner households. In Figure 3.1 we depict the distribution density function of π_n over the sample for the different Alternatives 1-4.

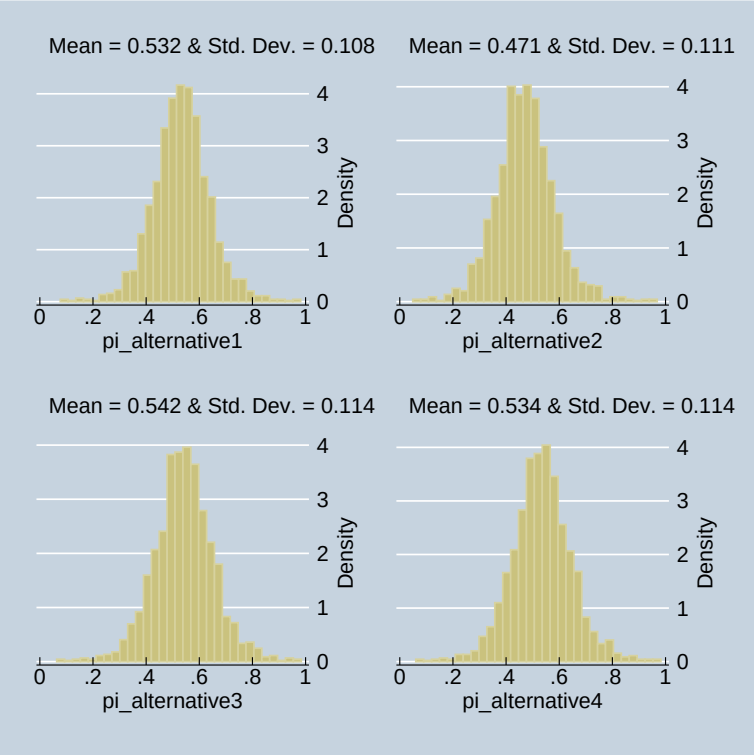


Figure 3.1: Distribution graphs of π_n for the different alternatives

Figure 3.1 shows that, although on average the Pareto-weight is equally divided between the male and the female, there is much variation in the distribution of Pareto-weight between individual households.

We conclude that the Pareto-weight distribution seems to be dominated by the ratio of log hourly wages $\log(\frac{w_m}{w_f})$, where β_m and β_f are about equal. This is empirical evidence for the idea that bargaining power in marriage is determined by differences in (potential) wage rates. This thesis is also suggested by Pollak (2005).

The child effects are significant when the household preference parameter does not depend on family size, and when we do not allow for gender differences in household productivity. However, when the preference for joint household production also depends on family size, the female tends to weight the total household production more heavily when family size increases. We do not find this effect for males. The child effects in the Pareto-weight function then become non-significant. Furthermore, when we allow for differences in the marginal productivity between men and women we also find that the child effects do not significantly influence the Pareto-weight distribution. It seems that the child effects found for the Alternative 1 is captured by the effects of family size and gender differences in household productivity for the other alternatives.

Finally, we present a 'typical' variance-correlation matrix of the error vector in Table 3.5. This matrix refers to the case $\gamma = 1$. The variance-correlation matrix does not change much over the different γ- specifications. The matrix below shows clearly that the error-terms are correlated. The diagonal cells contain variances, while the off-diagonal cells contain correlation ratios.

Table 3.5: Variance-correlation matrix of the error vector

	ϵ_1	ϵ_2	ϵ_3	ϵ_4
ϵ_1	$6.79 \cdot 10^{-7}$			
ϵ_2	0.4106	$2.30 \cdot 10^{-6}$		
ϵ_3	0.7201	0.3787	$5.38 \cdot 10^{-7}$	
ϵ_4	0.3933	0.6488	0.2488	$1.64 \cdot 10^{-6}$

3.5 Wage, Child, and Substitution Effects

In this model w_m and w_f are considered to be exogenous, which brings us to the question how labor supply and leisure consumption react to wage changes.

Let us assume that the wage vector (w_m,w_f) = w changes by Δw. Then what will be the change in $z(w)$? We return to the system in (3.10) and assume that $w^{(0)}, z^{(0)}$ represents the situation *ex ante*, and that $w^{(1)}, z^{(1)}$ is the new equilibrium.

The (4×12)-matrix X is a function of w. Differentiating the elements of the matrix X also with respect to w, we add two columns to the matrix U_{zz}, producing the $(4 \times 6)-$ matrix $(U_{zz} \quad U'_{zw})$. The matrix U'_{zw} is a $(4 \times 2)-$ matrix. However, according to equation (3.2), $\frac{\partial U_h}{\partial z} = \pi \frac{\partial U_m}{\partial z} + (1-\pi)\frac{\partial U_f}{\partial z} = 0$. We have to take into account that π depends on the wage vector as well:

$$\begin{aligned} U_{zz} &= \pi \cdot U_{m,zz} + (1-\pi) \cdot U_{f,zz} \\ U_{zw} &= \pi \cdot U_{m,zw} + (1-\pi) U_{f,zw} + [U_{m,z} - U_{f,z}] \left[\frac{\partial \pi}{\partial w}\right]' \end{aligned} \tag{3.17}$$

where the last element is the product of a (1×2)- matrix and a $(4 \times 1)-$matrix, resulting in a (4×2)- matrix.

Denoting $z^{(1)} - z^{(0)} = \Delta z$, the new equilibrium has to satisfy the equation:

$$U_{zz}\Delta z + U'_{zw}\Delta w = 0 \tag{3.18}$$

and the wage effect matrix is therefore:

$$\frac{\partial z}{\partial w} = -\left(U_{zz}\right)^{-1} \left[\pi U_{m,zw} + (1-\pi) U_{f,zw} + [U_{m,z} - U_{f,z}] \left[\frac{\partial \pi}{\partial w}\right]'\right] \tag{3.19}$$

The effect may be split into a usual gross substitution effect and a separate '*power*' shift effect. Because of the identity $jh + wh + le \equiv 24$, we find for the effects on job hours of the male and the female:

$$\frac{\partial jh_m}{\partial w} = -\left(\frac{\partial wh_m}{\partial w} + \frac{\partial le_m}{\partial w}\right) \tag{3.20}$$

and

$$\frac{\partial jh_f}{\partial w} = -\left(\frac{\partial wh_f}{\partial w} + \frac{\partial le_f}{\partial w}\right) \tag{3.21}$$

The corresponding elasticities are $\frac{\partial jh}{\partial w} \cdot \frac{w}{jh}$. The analysis was performed under the assumption that households were in equilibrium in $z^{(0)}$. The elasticities in the sample average, that is

all matrices evaluated in the sample mean, are presented in Table 3.6.

Table 3.6: **Average Wage Elasticities**

	Alternative 1		**Alternative 2**	
	$\mathbf{w}_m$	$\mathbf{w}_f$	$\mathbf{w}_m$	$\mathbf{w}_f$
le_m	0.211	-0.197	0.186	-0.230
wh_m	-1.409	0.805	-2.027	1.421
jh_m	-0.795	0.862	-0.994	1.138
le_f	-0.237	0.195	-0.224	0.228
wh_f	0.704	-0.577	-0.825	0.856
jh_f	1.242	-1.136	0.493	-0.591
	Alternative 3		**Alternative 4**	
	$\mathbf{w}_m$	$\mathbf{w}_f$	$\mathbf{w}_m$	$\mathbf{w}_f$
le_m	0.134	-0.144	0.261	-0.291
wh_m	-2.151	1.757	-1.830	0.584
jh_m	-0.283	0.353	-1.019	1.238
le_f	-0.260	0.241	-0.073	0.118
wh_f	1.256	-1.272	1.021	-0.587
jh_f	1.266	-1.042	-0.429	-0.048

Table 3.6 indicates that there is a backward-bending labor-supply curve for both household members. The income effect dominates the substitution effect, and, when the hourly wage rate increases, individuals tend to substitute paid labor hours for leisure or household hours. The average wage elasticities are strongly influenced by the interaction effect. Letting the preference for joint household production depend on family size, the average wage elasticities are more negative for the male (-0.994 for Alternative 2 and -1.019 for Alternative four) and less negative for the female (-0.591 for Alternative 2, and even -0.048 for Alternative 4).

The labor-supply curve in terms of the hourly wage rate of the partner is forward-bending. It seems that individuals tend to replace leisure hours with paid job hours when the wage of their partner increases. With the exception of Alternative 2, the empirical results suggest that individuals replace leisure hours with household production hours when the hourly wage

of the partner increases. A possible explanation is that a wage rate increase of the female improves her bargaining position as it increases her share of the total household income. As a result, the male supplies more hours of labor to cancel out the effect of the wage increase of his partner, such that he maintains his bargaining position.

In general, the estimation results suggest that the income effect dominates the substitution effect when the hourly wage rate increases. One would expect that, if household income is not influenced by this substitution of paid labor for leisure, this would not influence the partner's behavior. It seems, however, that it does influence the partner's behavior. The relative 'power' of the individual, whose wage increases, is increased; as a result he/she tends towards a more favorable time allocation scheme, while the partner shifts towards a more unfavorable time allocation scheme.

Because we consider a sample of two-earner households, this might considerably influence the results. First, by considering only two-earner households, we do not consider the initial choice of whether a partner participates in the labor market at all. We merely observe the outcome of this decision process for the case where both partners do participate on the labor market. For these households, household income is on average higher, and as a consequence we may find a backward-bending labor supply curve for both household members.

On the basis of the estimation results of the last section and the wage effects, the unitary model is rejected in favor of the collective model. The empirical results suggest that the preference parameters between the male and the female differ significantly and the Pareto-weight depends significantly on wage rates. Furthermore, a wage rate increase of the male is differently compensated by the female in terms of labor hours, and vice versa (i.e. the *Slutsky* symmetry condition does not hold).

We assume that household income consists of three components: namely, the labor income of male and female *and* an additional unearned income y_u. The additional unearned income is defined as the net non-labor income that was earned in the week before the interview took place. The unearned income effects are:

$$\frac{\partial z}{\partial y_u} = -\left(U_{zz}\right)^{-1}\left[U_{f,zy_u} + \pi \cdot \left[U_{m,zy_u} - U_{f,zy_u}\right] + \left[U_{m,z} - U_{f,z}\right]\frac{\partial \pi}{\partial y_u}\right] \tag{3.22}$$

We see that an additional household income increase has an effect on all time variables simultaneously. The unearned income effects may be derived in the usual way and the results are shown in Table 3.7.

Table 3.7: **Average Unearned Income Elasticities**

	Alt. 1	**Alt. 2**	**Alt. 3**	**Alt. 4**
le_m	0.035	0.034	0.019	0.028
wh_m	0.105	0.138	-0.061	0.061
jh_m	-0.108	-0.110	-0.037	-0.091
le_f	0.000	0.010	0.022	0.005
wh_f	-0.004	-0.014	0.123	0.013
jh_f	0.008	-0.038	-0.155	-0.023
$\bar{y}_u$	40.627			
$median_{y_u}$	17.775			
σ_{y_u}	73.420			

The distribution of y_u in the sample is heavily skewed to the right or, in other words, the median value y_u is smaller than the average value of y_u. Most households do not 'earn' much non-labor household income. Table 3.7 suggests for all alternatives that an increase of household income due to unearned income induces a shift to more leisure hours for male and female, although the effect is small. The opposite effect is found for paid job hours with the exception of the female job hour effect for Alternative 1. The effect on household production hours is ambiguous.

Unfortunately, the data do not provide information on who is the provider of the non-labor income so that it is impossible to split y_u into a male and a female part.

We may also assess the effect of having children using equation (3.19):

$$\frac{\partial z}{\partial \ln(fs)} = -\left(U_{zz}\right)^{-1}\left[\left[U_{m,z} - U_{f,z}\right]\left[\frac{\partial \pi}{\partial \ln(fs)}\right]\right] \tag{3.23}$$

The estimates are presented in Table 3.8. The columns indicate the number of children between certain age levels. Therefore $c02$ refers to the number of children present in the household who are aged between 0 and 2, and so on.

We see that the child effect of young children is considerable but that the child effect for children above 5 years of age is not very robust. The child effect will most likely be different

Table 3.8: **Child Effects**

Alternative 1

	c02	**c34**	**c511**	**c1215**	**c1618**
le_m	-0.0042	-0.0051	-0.0106	-0.0018	-0.0024
wh_m	0.1002	-0.0050	-0.0122	0.0287	-0.0124
jh_m	-0.0309	0.0134	0.0280	-0.0026	0.0078
le_f	0.0040	0.0056	0.0101	0.0030	0.0028
wh_f	-0.1085	0.0133	0.0109	-0.0034	0.0073
jh_f	0.0030	-0.0129	-0.0143	0.0140	-0.0124

Alternative 2

	c02	**c34**	**c511**	**c1215**	**c1618**
le_m	-0.0076	-0.0037	-0.0066	0.0009	0.0000
wh_m	-0.0363	0.0137	0.0140	-0.0070	-0.0008
jh_m	0.0244	0.0005	0.0060	0.0020	0.0002
le_f	0.0049	0.0023	0.0023	-0.0008	0.0000
wh_f	0.0191	-0.0159	-0.0608	0.0188	0.0010
jh_f	-0.0321	0.0025	-0.0050	0.0011	0.0000

Alternative 3

	c02	**c34**	**c511**	**c1215**	**c1618**
le_m	-0.0083	-0.0012	0.0003	0.0013	-0.0004
wh_m	-0.1142	-0.0027	0.0005	-0.0155	-0.0040
jh_m	0.0445	0.0035	-0.0009	0.0011	0.0018
le_f	0.0098	0.0012	-0.0003	-0.0017	0.0005
wh_f	0.0835	0.0033	-0.0002	0.0128	0.0019
jh_f	-0.0745	-0.0017	0.0012	0.0002	-0.0026

Alternative 4

	c02	**c34**	**c511**	**c1215**	**c1618**
le_m	-0.0204	-0.0043	-0.0086	0.0041	0.0008
wh_m	-0.0713	-0.0328	-0.0319	0.0329	-0.0027
jh_m	0.0609	0.0180	0.0260	-0.0142	-0.0094
le_f	0.0346	0.0052	0.0192	-0.0094	0.0032
wh_f	0.0504	0.0262	0.0182	-0.0164	-0.0009
jh_f	-0.2644	-0.0287	-0.1299	0.0700	-0.0279

if one-earner households were considered as well.

It appears that women tend to work fewer hours on the labor market when there are more children younger than 5 present in the household. Men, on the other hand, tend to do the opposite. When there are more young children in the household, women usually specialize in household tasks, while men specialize in labor market tasks. Hence, women replace paid labor hours by household production hours, and men replace their leisure time with job market hours.

3.6 Conclusion

In this Chapter we define a public good version of the collective household model, where household income and household production are viewed as public goods in the household, whereas direct time expenditures by each partner (paid work, household work and leisure) are assumed to affect only the utility of the individual time spender. As is mentioned in Chiappori and Ekeland (2006), this model finds its origin in the household labor supply model that was initially introduced by Chiappori (1988a, 1992).

We develop a two-step iterative estimation procedure by which the proposed model can be estimated. This estimation method enables us to estimate: (1) the (ordinal) utility functions; (2) the utility weight function that necessarily depends on the individual wage rates; and (3) the wage, child and non-labor income effects.

We find that the ordinal utility functions of males and females, and consequently their indifference curves, are significantly different. This provides additional evidence for the collective approach. Although the model is non-linear in the outcome variables male leisure, female leisure, and so on, it appears possible to estimate the utility parameters by means of a simple Seemingly Unrelated Regression approach.

We estimate four alternative models. For Alternatives 1 and 2, it is assumed that the number of household hours of male and female are perfect substitutes; this assumption is relaxed in Alternatives 3 and 4. For Alternatives 2 and 4 an interaction term is included, where joint household production interacts with family size, while we assume that there is no interaction effect in Alternatives 1 and 3.

The estimation results appear to be fairly robust for the different Alternatives 1-4. When we do not postulate that household hours of the male and the female are perfect substitutes, we find that the male is slightly more efficient in performing (his) household tasks. The explanation for this might be that the female spends, on average, more time on household tasks than the male. One additional hour on household production of the female might then

be less productive compared with one additional hour of household production hour by the male. Note that this is a comparison at the margin.

The most important variables in the utility function for Alternatives 1-4 appear to be leisure and household income, for both male and female. When we assume that the preference for total household production is influenced by family size, we find for the female utility function that this preference is influenced by family size, but this is not found for the male.

The negative values of wage elasticities imply that both partners have a backward-bending labor supply curve. For females this result differs from historical results. We conclude, therefore, that the labor supply curve of women tends to resemble that of men. An explanation for the backward-bending labor supply curve for women is that there are now more women with a high income than in the past. For these women, apparently, the income effect dominates the substitution effect, meaning that they reduce their hours of work rather than increasing them when their own wage rate increases.

Research on female labor supply conducted in the 1980s and 1990s generally found high wage elasticities. Typically, a wage elasticity of around 1 was found. Furthermore, the female labor supply curve was forward-bending for the entire range of female wages (see Killingsworth and Heckman 1986). That seems to have changed over time because of the increase in female labor supply and the changed attitude towards female labor participation. Apparently women's behavior on the labor market nowadays resembles that of men, although the descriptive statistics still indicate that the hourly wage rate and the amount of labor supply is, on average, lower for females compared with males.

We also explained the Pareto-weight distribution within the household. We find for this sample of two-earner households that the weight is about evenly distributed between the partners. Still there is considerable variation between households. The Pareto-weight distribution depends mainly on the relative hourly wages (earning potential). The relative weight of the female compared with that of her partner is increased if there are young children in the household, when we assume that there is no family size interaction with household production and that the household hours of the male and the female are perfect substitutes. When we relax these assumptions the child effect disappears.

We concluded this chapter by emphasizing the importance of cross-elasticities and the fact that these elasticities are usually not reported in the economic labor supply literature. Usually, models assume exogenous labor supply of men. However, our findings suggest that a wage change of the female affects the amount of labor supply of the male negatively.

Labor supply of men is therefore influenced by a change in women's wage rate and this result is relevant for government policy. One example where cross-elasticities are important

is ageing. Generally, policy makers believe that increasing women's participation in paid work will reduce the burden of ageing to society. This finding is based on the assumption that men's labor supply is exogenous. However, when women increase their labor supply, higher taxed men may decrease their labor supply. The result may be that the income tax for the government decreases, and consequently the burden of ageing to society increases. Therefore, assuming endogenous labor supply of men will contribute to this discussion. Of course, many other examples can be thought of where cross-elasticities are important for policy evaluation and implementation, e.g. policy related to child care, fertility, taxes, social benefits, etc.

Chapter 4

A Public Good Version of the Collective Household Model: A Comparison of Native Dutch and Immigrant Households in the Netherlands[1]

4.1 Introduction

In this chapter, we estimate the public good version of the collective household model ($PGVCM$) for two-earner households in the Netherlands, where we distinguish between Dutch, Turkish, Surinamese, and Antillean households.

Like all Western countries, the Netherlands has a sizeable minority of immigrants. Nowadays almost 10 percent of the Dutch population consists of non-Western (first- or second-generation) immigrants, and this number is expected to increase to over 20 percent in the year 2050 (CBS 2003a). The four largest immigrant groups are from Turkey, Morocco, Surinam and the Dutch Antilles. During the 1950s, the Dutch decolonization process attracted immigrants from Indonesia. In the 1960s, inhabitants of Surinam and the Antilles received Dutch nationality, which gave them the right to work and live in the Netherlands (Cornelisse-Vermaat (2005)). In the 1960s and 1970s, when the Dutch economy flourished, Surinamese, Antillean, and Turkish workers came to the Netherlands to find (low income)

[1]This chapter is based on Van Klaveren, van Praag & Maassen van den Brink (2006b)

jobs. In general these immigrants were males who had the initial intention to stay in the Netherlands only temporarily. Most of them stayed permanently. The immigrants that we consider in this study are of Surinamese/Antillean and of Turkish descent.

The first group originates from the former Dutch colonies of Surinam and the Dutch Antilles. Their mother tongue is frequently Dutch and they basically received an education which resembles that of the Dutch. Some of them have been in the Netherlands for thirty years or more, while others immigrated rather recently, in the last decade. The Turkish minority is one of the largest minorities in the Netherlands. Most of them came from relatively backward regions in Turkey; they are Muslim, and frequently speak only Turkish within the family. Many Dutch Turks have double nationality, but, a large part of them choose marriage partners from their homeland, who immigrate under the Law of Family Reunion. Their education level is relatively low compared with the Dutch. The main integration problems for both groups are the high percentage of unemployed immigrants relativel to the native Dutch (CBS (2003*b*), SCP (2002)), the lower education levels of immigrants (SCP, 2003), and, according to the Scientific Council of Government policy (WRR), the lack of cohesion between immigrant groups and the native Dutch (WRR, 2001).

In spite of the fact that immigrant households are a substantial and growing group within the total Dutch household population, they are usually under-sampled or neglected in general surveys. Insofar as they participate in a survey, members of those sub-populations are usually lumped together with the main population of Dutch descent. Research on household labor supply decisions in the Netherlands tends to neglect the household labor supply decision process of these immigrants (an exception is Cornelisse-Vermaat (2005)).

The contribution of this chapter is (1) to test the robustness of the estimation results obtained in Chapter 3 by using a different sample; (2) to consider immigrant households, since these households are usually neglected in time allocation studies. It might be that differences in ethnic background reveal interesting differences between Dutch and immigrant households; and (3) to obtain the (cross-) wage and child effects on the different time expenditures of individuals.

This chapter proceeds as follows. In Section 4.2, we specify the public good version of the collective household model that we plan to estimate for the different sub-samples. In Section 4.3, we describe the data that are used. In Section 4.4, the estimation method is described. In Section 4.5, the estimation results are presented. In Section 4.6, we discuss the wage and child effects, and, finally, in Section 4.7 we conclude.

4.2 The Model

The model used in Chapter 4 is similar to the Chapter 3 model. Since readers might be interested particularly in this chapter, we again discuss the theoretical and empirical model of Chapter 3, although in less detail, so this chapter can be read independently from Chapter 3.[2]

We start with the recognition that, according to the collective approach, household n's behavior may be viewed as the outcome of maximizing a household utility function of the following type:

$$U_{n,h} = \pi_n U_{n,m} + (1 - \pi_n) U_{n,f} \tag{4.1}$$

where the log-additive ordinal utility function of household member $i = m(\text{ale}), f(\text{emale})$ is defined as:

$$\begin{aligned} U_i = {} & \alpha_{i,1} \ln(le_m) + \alpha_{i,2} \ln(wh_m) + \alpha_{i,3} \ln(H) \\ & + \alpha_{i,4} \ln(fs + 1) \cdot \ln(H) + \alpha_{i,5} \ln(Y) + \alpha_{i,6} \ln(jh_i) \end{aligned} \tag{4.2}$$

where:

$$\begin{aligned} Y &= w_m \cdot jh_m + w_f \cdot jh_f + y_u \\ H &= wh_m + \gamma \cdot wh_f \\ jh_m &= T - le_m - wh_m \\ jh_f &= T - le_f - wh_f \end{aligned}$$

The household utility function is described as a π_n weighted sum of the two individual utility functions with $0 \leq \pi \leq 1$. For the moment we assume that π is a constant variable.

The arguments of the individual utility functions are the choice variables leisure (le), housework (wh), and job hours (jh). The total time endowment is denoted by T.

Household income Y enters the individual utility function, but this individual utility function is not an indirect utility function. As we do not have information about consumption, we assume a Hicksian composite commodity. This Hicksian commodity represents the value of household consumption, which is income Y. It then automatically implies that Y is a household public good, i.e. consumption by one person does not exclude the consumption of the same good by another person. However, this does not imply that out of the household income no commodities are bought that can only be consumed by one of the two spouses, e.g.

[2]We apologize to those people who read the whole thesis for the overlap between the two chapters.

clothing, the barber, etc., but it does imply that, even then, a purchase by one of them needs the explicit or implicit approval of the other partner. It is an issue of the power distribution between the two partners who in the end gets most of the pie.

We also define the household care level (H) as the γ weighted sum of hours spent by both partners on what they call 'household tasks'. These tasks include cooking, cleaning, doing the laundry, and other such activities. Of course, the distinction between housework and leisure may be ambiguous, and therefore we leave the empirical definition to the respondents themselves. The γ parameter allows for the fact

Moreover, we assume that the utility effect of H depends on the family size (fs), and add an interaction term between family size and household hours. The intuition is that, for example, 20 hours of housework may influence utility differently for a two-person family than it does for a family with two children.

The net wage rates of male and female are denoted by, respectively, w_m and w_f, and the y_u-term stands for the net weekly non-labor household income.

Assuming that men and women allocate their time optimally, we have the following first-order-conditions (FOC) for $i = m$(ale), f(emale):

$$\frac{\partial U_h}{\partial le_i} = \frac{\partial U_{-i}}{\partial le_i} + \pi \left(\frac{\partial U_i}{\partial le_i} - \frac{\partial U_{-i}}{\partial le_i} \right) = 0 \tag{4.3}$$

$$\frac{\partial U_h}{\partial wh_i} = \frac{\partial U_{-i}}{\partial wh_i} + \pi \left(\frac{\partial U_i}{\partial wh_i} - \frac{\partial U_{-i}}{\partial wh_i} \right) = 0 \tag{4.4}$$

The first and the third term in each FOC refers to the partner's part of the collective utility function. The explanation for this is that household income and the household care level figure in the utility functions of both partners. The utility of one spouse is influenced through H by the partner's hours on housework and through Y by the partner's job hours.

Consider the derivative $\frac{\partial U_h}{\partial le_m}$:

$$\frac{\partial U_h}{\partial le_m} = \pi \cdot [\frac{\alpha_{m,1}}{le_m} - \frac{\alpha_{m,5} \cdot w_m}{Y} - \frac{\alpha_{m,6}}{jh_m}] - (1 - \pi) \cdot [\frac{\alpha_{f,5} \cdot w_m}{Y}]$$

This derivative is a linear expression in the utility parameters $(\alpha_m, \alpha_f) = \alpha$ of male and female. The corresponding *coefficients* are non-linear expressions in le_m, le_f, wh_m, wh_f, w_m, w_f, fs and y_u. The first *coefficient*, for example, is denoted as $x_{1,m,1} = \frac{1}{le_m}$. As $\alpha_{m,2}$ does

not appear in the first FOC we have $x_{1,m,2} = 0$. We may write the first FOC as:

$$x'_{1f}\alpha_f + \pi\left(x'_{1m}\alpha_m - x'_{1f}\alpha_f\right) = 0 \tag{4.5}$$

The index 1 refers to the $x-$vector in the first FOC. This $x-$vector is a 6-vector function $x_{1,i}(le_i, le_{-i}, wh_i, wh_{-i}, w_i, w_{-i}, fs, y_u)$ for $i = m$(ale), f(emale). The other FOCs with respect to wh_m, le_f and wh_f can be obtained in a similar manner and the system of FOCs can be written as

$$\begin{bmatrix} \pi x'_{1m} & (1-\pi)\left(x'_{1f}\right) \\ \pi x'_{2m} & (1-\pi)\left(x'_{2f}\right) \\ \pi x'_{3m} & (1-\pi)\left(x'_{3f}\right) \\ \pi x'_{4m} & (1-\pi)\left(x'_{4f}\right) \end{bmatrix} \alpha = \left[\pi X'_m + (1-\pi)X'_f\right]\alpha = 0 \tag{4.6}$$

where X'_m and X'_f are $(4 \times 6)-$matrices; and α stands for a 12-vector of utility parameters.

For household n we define the (4×12)-matrix $X'_{n,h}$ by:

$$\left[\pi_n X'_{n,m} \quad (1-\pi_n)X'_{n,f}\right] = X'_{n,h} \tag{4.7}$$

Throughout this chapter we use the short-hand notation z =(le_m,wh_m,le_f,wh_f). The left-hand-side of system (4.6) is the gradient of the household utility function $U_h(z)$. We shall write it sometimes as the 4-vector $U'_h(z)$ or alternatively as U_z. This system describes the equilibrium where the gradient vector equals the zero vector. The (4×4)-matrix of second-order derivatives of $U_h(z)$ is denoted by U''_h or U_{zz}.

Specification of the utility weight

The utility weight is generally assumed to depend on certain distribution factors and preference factors. More importantly, the utility weight should depend on prices, or in our model wage rates otherwise the proposed model is equivalent to the standard unitary model (see Browning, Chiappori and Lechene (2004) and Chapter 2).

In this chapter, the utility weight depends on the following characteristics: the hourly wages of the two partners, the number of children divided over several age categories and the ages of the two partners.[3] More formally, π_n depends on characteristics v and it is defined as

[3]Age differences and education differences between male and female are usually considered as distribution factors. However, when we include these distribution factors in our model they turn out to be insignificant.

$$\pi_n(v) = N(\beta_1 \ln(w_{n,m}) + \beta_2 \ln(w_{n,f}) + \sum_{j=3}^{J} \beta_j \cdot T_{j,n}) \tag{4.8}$$

where $N(\cdot)$ stands for the standard normal distribution function. Here we choose this functional specification because it is flexible, and π is automatically constrained in [0,1], while the argument can take any value on the real axis. In other words, we use the normal distribution function without any probabilistic connotation. For convenience we have listed the wage characteristics separately in equation (4.8) and the term $\sum_{j=3}^{J} \beta_j \cdot T_{j,n}$ contains the other characteristics that may influence the power distribution. If $\beta_3 = ... = \beta_J = 0$, and if $\beta_1 = -\beta_2$ and $w_m = w_f$, we find $\pi(v) = \frac{1}{2}$. This is the case of an equal power distribution between husband and spouse. The weight $\pi(v)$ increases in the male's wage and decreases in the female's wage. If $\beta_1 \neq \beta_2$, the weight is asymmetric, that is, even if $w_m = w_f$, we may have $\pi(v) \neq \frac{1}{2}$.

Adding a constant, say β_0, to the argument in $N(\cdot)$ would allow for the fact that one of the individual utility functions is structurally overweighted. However, when we include β_0 it turns out to be insignificant and hence we drop it from our model.

As we have shown in Chapter 2, this would allow us to test the hypothesis that a redistribution of unearned income changes household demand, i.e. the income pooling hypothesis. Although there is information on the unearned income of both spouses separately, unfortunately, the number of observations is too small to incorporate it in the utility weight function. Consequently, we are not able to test income pooling.

4.3 Data

The data was collected between September and November 2001 by DESAN, a Dutch organization for market research. The aim was to create a balanced sample with as many Dutch households as Turkish and Surinamese/Antillean households. The Dutch sub-sample is randomly drawn from the total pool of phone numbers of the Royal Dutch Mail (KPN). The immigrant sub-sample is drawn from a register owned by DESAN[4]. We include second-generation households but not mixed marriages. The latter is done because there are many possible ethnic combinations of mixed marriages but only a few observations for each group.

Table 4.1 shows the frequency table of the number of two-earner households differentiated

[4]Households from the second generation cannot officially be labelled as immigrants. However, for convenience, we will refer to Turkish, Surinamese/Antillean households as immigrant households, although strictly speaking this is not the correct definition of an immigrant household.

according to ethnic background.

Table 4.1: **Frequency Table of Households by Ethnicity**

Ethnicity	**Frequency**	**Percentage**
Dutch	153	42.86
Surinamese/Antilleans	113	31.65
Turkish	91	25.49
Total	357	100

The ethnicity of the spouses is defined as follows. For the respondent, we use the immigrant definition of the Netherlands Statistics, i.e. the respondent is considered to be an immigrant if at least one of the parents is born abroad (Netherlands Statistics (2000)). However, this definition cannot be used for the respondent's partner since there is no information with respect to the parental ethnicity of the partner. We use a question that directly asks the partner's ethnicity. If respondent and partner have the same ethnicity, the household can be classified as a Dutch, Surinamese/Antillean, or Turkish household.

In order to estimate the model, we need information on paid labor, leisure, and housework. Although the data provide all this information for the respondent, for the respondent's partner only paid labor hours are known, but there is no information on the time spent on housework. Therefore, we have imputed the time spent on housework by the working partner conditional on individual and household characteristics.

We define the amount of housework of the respondent as wh_r, and that of the partner as wh_p. The total time endowment per week is 168 hours, and so the imputed value of wh_p is $\in$[0,168]. Therefore, we define the auxiliary variable θ for the N available households as:

$$\theta_{n,r} = \log(\frac{wh_{n,r}}{168 - wh_{n,r}}) \tag{4.9}$$

The inverse of (4.9) equals: $wh_r = \frac{168}{1+e^{-\theta_{n,r}}}$. If $\theta = 0$, then $wh_r = 84$; if $\theta \to \infty$ then $wh_r \to 168$; and if $\theta \to$ -∞, then $wh_r \to 0$. It implies that $wh_{n,r} \in$[0,168] for any real number of $\theta_{n,r}$.

We estimate the following equation by means of Ordinary Least Squares (OLS):

$$\theta_{n,r} = \delta_0 + \delta_1 \cdot s^h_{n,1} + ... + \delta_k \cdot s^h_{n,k} + \delta_{k+1} \cdot s^r_{n,k} + ... + \delta_K \cdot s^r_{n,K} + \epsilon \tag{4.10}$$

where s^h_n are household characteristics; and s^r_n are individual characteristics of the respondents for the N available households. The estimation results are shown in Table 4.2.

Table 4.2: **Housework Estimates Respondents**

Characteristics	**Estimate**	**t-value**
Gender dummy	-0.504***	-4.90
Hourly wage rate	0.003	0.40
Age	0.004	0.55
Highest education level	-0.030	-1.11
Log(#-children 0/3+1)	1.126***	7.31
Log(#-children 4/11+1)	0.583***	5.03
Log(#-children 12/15+1)	0.573***	3.86
Log(#-children 16/25+1)	0.393**	2.54
Resp. is Surinamese/Antillean	-0.026	-0.22
Resp. is Turkish	0.166	1.25
Computer at home	0.134*	1.82
constant	-3.251***	-9.45
N	357	
Adjusted R^2	0.274	

Note: * significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

It follows from equation (4.9) that a positive correlation between an explanatory variable and θ can be interpreted as a positive correlation between the explanatory variable and hours spent on housework.

As was to be expected, men spend less time on housework than women, and the presence of children increases the time that respondents devote to housework. The estimation results

suggest that ethnicity does correlate with the time devoted to housework, but it is possible that other explanatory variables capture this effect.

By estimating equation (4.10) and obtaining $\hat{\delta}_1$, ..., $\hat{\delta}_K$, we can impute the missing values $\hat{wh}_{n,p}$ for partner p by calculating $\hat{\theta}_{n,p}$:

$$\widehat{\theta}_{n,p} = \hat{\delta}_0 + \hat{\delta}_1 \cdot s^h_{n,1} + ... + \hat{\delta}_j \cdot s^h_{n,k} + \hat{\delta}_{k+1} \cdot s^p_{n,k} + ... + \hat{\delta}_n \cdot s^p_{n,K} \tag{4.11}$$

In equation (4.11) the respondent's characteristics are replaced by those characteristics of the partner whose housework hours wh_p are not observed. Using $\hat{\theta}_{n,p}$ and equation (4.9) we can obtain values for $\hat{wh}_{n,p}$ in [0,168] from $\hat{\theta}_{n,p}$ by inverting (4.9) as

$$wh_{n,p} = \frac{168}{1 + e^{-\hat{\theta}_{n,p}}} \tag{4.12}$$

In Table 4.3 we present the partly imputed and partly observed time use statistics for the three household types distinguished.

Table 4.3: **Descriptive Statistics**

	Dutch	**Sur./Ant.**	**Turkish**
Male			
Paid working hours	39.97	37.58	39.37
Household hours	8.24	11.33	14.74
Leisure	119.79	119.10	113.89
Education level	5.45	5.33	4.55
Age level	39.35	41.41	36.04
Hourly wage rate	10.00	9.65	8.19
Female			
Paid working hours	25.84	29.27	26.56
Household hours	16.69	17.89	23.59
Leisure	125.48	120.84	117.85
Education level	5.22	4.81	3.67
Age level	37.33	38.07	32.76
Hourly wage rate	9.16	8.82	8.00
Household			
#-children 0/3	0.29	0.27	0.27
#-children 4/11	0.44	0.58	0.88
#-children 12/15	0.23	0.38	0.35
#-children 16/25	0.16	0.42	0.32
#-children 25 plus	0.01	0.03	0.01
Family size	1.13	1.68	1.84
Weekly Household income	637.83	615.44	522.46
N	153	113	91

Men work more paid labor hours than women, while the opposite is true for the hours

spent on housework. Men also tend to be older than their partners and slightly higher educated. Dutch (wo)men have a higher hourly wage than immigrant (wo)men, and this finding is in line with the national data of Netherlands Statistics.

Surinamese men tend to be equally well-educated as Dutch males; Surinamese women, on the other hand, are less well-educated than Dutch women and they have a lower hourly wage. But, in contrast, they work more paid labor hours than Dutch females. This results in a household income for Surinamese/Antillean households that is approximately equal to that of Dutch households. Highly-educated Surinamese/Antillean men are overrepresented in this sample which affects the averages in Table 4.3.

The household income of Turkish households is smaller compared with Dutch households and immigrant households have more children than Dutch households. Also these findings are in line with the national data of Netherlands Statistics.

4.4 The Estimation Method

Consider the system of first-order conditions using equations (4.7) and (4.8) for each household n:

$$\left[\pi_n(\beta; v_n) \cdot X'_{n,m} \quad (1 - \pi_n(\beta; v_n)) \cdot X'_{n,f}\right] \begin{bmatrix} \alpha_m \\ \alpha_f \end{bmatrix} = X'_n \pi_n \alpha = 0 \tag{4.13}$$

where X_n is a linear function in π_n and the parameter vector (α, β) has to be estimated. Solving this system for le_m wh_m, le_f and wh_f for each n would give the optimal solution vector $z^\star = (le^\star_m, wh^\star_m, le^\star_f, wh^\star_f)$.

By comparing $z^\star_n$ with the observed z_n we can find the optimal parameter estimates that would minimize the difference between $z^\star_n$ and z_n. However, this solution vector $z^\star$ is highly non-linear in the α and β parameters. Consequently, it is difficult to estimate the unknown parameters by a direct method.

We use the two-stage iterative estimation procedure of Chapter 3 to estimate the unknown parameter vector (α, β). The method is inspired by the fact that (4.13) is linear in the parameter vector α.[5]

First, assume that β and consequently π_n are known for each household. Since the matrix equality in (4.13) does not hold exactly, we add a stochastic component and assume

$$X'_n \, \alpha = \varepsilon_n \tag{4.14}$$

[5]see also Wales and Woodland (1983) and Blundell and Robin (1999))

where ε is an error vector for which it holds that $\varepsilon \sim N(0, \Sigma_\varepsilon)$. We assume that the time allocation choices of spouses are not correlated between households, i.e. $E(\varepsilon_n, \varepsilon_{n'}) = 0$ if $n \neq n'$. Given the time budget constraints and the interdependence of preferences, we do allow the ε terms to be correlated within households, since such a correlation is probable.

The system in equation (4.14) can be estimated by minimizing the sum of squared residuals $\sum_1^N \varepsilon_n' \Sigma_\varepsilon^{-1} \varepsilon_n = \sum_1^N \alpha' X_n \Sigma_\varepsilon^{-1} X_n' \alpha$ with respect to α. The 'trivial' solution is excluded by two identifying conditions $\sum \alpha_m = 1$ and $\sum \alpha_f = 1$. We note that the utility functions can be interpreted as a net of indifference curves and the analysis does not change if we apply a monotonic transformation on the α-parameters.

Estimation of the full collective model is more complex, since the β coefficients are unknown as well. Therefore, in the first step, we set $\beta_1^{(1)} = ... = \beta_J^{(1)} = 1$ yielding the first round power coefficients $\pi_n^{(1)}$. The superscript indicates the iteration round. Notice that these coefficients are not constant, as households have different characteristics. Then we estimate the α coefficients, given $\pi_n^{(1)}$.

Consider the system of four equations:

$$y_n = X_n' \alpha + \varepsilon_n \tag{4.15}$$

where y_n is a nuisance vector. This system can be estimated by the method of Seemingly Unrelated Least Squares (SUR). If we set $y_n = 0$ for all n, estimation of this system under the constraints $\sum \alpha_m = 1$ and $\sum \alpha_f = 1$ is equivalent to minimizing $\sum_1^N \alpha' X_n \Sigma_\varepsilon^{-1} X_n' \alpha$ with respect to α under those constraints.

On the basis of the estimated α-coefficients denoted by $\alpha^{(1)}$, we estimate $\beta_{1,...,J}$ denoted by $\beta^{(2)}$ that will be used in the second iteration round.

In the second iteration round, we determine $\pi_n^{(2)}$ by using $\beta^{(2)}$. Then α is re-estimated and with the $\alpha^{(2)}$-coefficients we estimate $\beta^{(3)}$. These β's are then used in the third iteration round. We continue this iterative process until convergence is reached.

4.5 Estimation Results

Conditional on spouses' time use, and assuming that individuals maximize their utility following the collective household model, we can estimate the preference parameters (α_m, α_f) and the power parameters β for the Dutch, Surinamese/Antillean and Turkish households. The estimation results (α_m, α_f) are shown in Table 4.4, and those for β in Table 4.5.

Table 4.4: **Parameter Estimates** α

Dutch	***Male***		***Female***	
	Estimate	z**-value**	**Estimate**	z**-value**
leisure	0.752	66.00	0.759	50.55
housework	0.005	4.19	-0.003	-2.35
household production (H)	-0.010	-0.59	0.066	3.15
H interaction term	-0.001	-0.04	0.084	2.86
household income	0.223	10.61	0.095	4.63
job working hours	0.031	3.44	-0.001	-0.15
Surinamese/Antillean	***Male***		***Female***	
	Estimate	z**-value**	**Estimate**	z**-value**
leisure	0.841	62.72	0.681	63.47
housework	0.006	5.97	-0.014	-10.13
household production (H)	-0.053	-0.56	0.133	1.37
H interaction term	-0.140	-1.55	0.167	1.84
household income	0.299	8.61	0.009	0.28
job working hours	0.048	3.85	0.024	3.5
Turkish	***Male***		***Female***	
	Estimate	z**-value**	**Estimate**	z**-value**
leisure	0.924	64.82	0.499	34.08
housework	0.019	8.12	-0.009	-6.4
household production (H)	-0.095	-1.78	0.205	3.11
H interaction term	-0.107	-1.90	0.180	2.57
household income	0.115	4.36	0.133	5.64
job working hours	0.144	13.69	-0.009	-3.79

	Dutch	***Sur./Ant.***	***Turkish***
$\overline{\pi}$	0.548	0.473	0.522
γ	0.975	1.35	0.8
N	153	113	91

Following the definition of household tasks, it is not assumed that household hours of male and female are perfect substitutes ($\gamma = 1$). In order to asses γ, we let γ vary with a width of 0.025, and choose the γ estimate that yields the highest log likelihood of the linear parameters.

The rate of substitution of time spent in the household is 0.975 for Dutch households, 1.35 for Surinamese/Antillean households, and 0.8 for Turkish households. It seems that the marginal household hour of the Surinamese/Antillean female is more valuable than that of her partner. The marginal household hour of the Dutch male is about equal to that of the Dutch female, and the marginal household hour of the Turkish male is more valuable than that of the Turkish female.

γ may reflect the ratio of productivity, but may also reflect cultural backgrounds where different norms and values apply. It is well known that the roles of male co-workers in the household are very differently interpreted in the three ethnic communities considered. Hence, we do not make a productivity statement based on the value of the γ parameter. However, the model is made more flexible by allowing for a rate of substitution that may be different from 1.

When we compare the preference parameters α with those obtained in Chapter 3, we observe that the estimated preference parameters appear to be very similar to the estimated preference parameters that we obtain for Dutch households. For Dutch men, the most important variables in their utility function are leisure and household income. For Dutch women, leisure seems to be the most important variable and household income less so. On average, the labor participation of Dutch women is similar to that in surrounding countries. However, the amount of hours that Dutch women work on the labor market is on average lower compared with other European countries. Although Dutch women do not derive utility from individual household chores, they do find joint household production important. So household tasks have to be done, but preferably not by themselves but by the partner. The importance of joint household production increases the larger the size of the family.

For Surinamese/Antillean men, it holds that leisure and household income are the most important variables in the utility function. For these men, we find that leisure, household production and joint household production interacted with family size are important. The estimation results for Dutch and Surinamese/Antillean men are very similar, which may because they have very similar background characteristics (see Table 4.3).

Surinamese/Antillean and Dutch women appear to have different preferences. While joint household production and household production interacted with family size significantly enter the utility function of both Dutch and Surinamese/Antillean women, these variables

are much more important for the latter group.

Turkish families appear to be different from Surinamese/Antillean and Dutch households. The most important variable for Turkish men is leisure. Other, but less important variables, are household income and job hours. Household production and household production interacted with family size appear negatively in the utility function of Turkish men. For Turkish women, on the other hand, household production and household production interacted with family size are very important, just as leisure is important to these women. While leisure is important, the coefficient of leisure is smaller than the leisure coefficient of Surinamese/Antillean and Dutch women (and men). An explanation for the preference differences between Turkish men and women is that these households are in general more traditional: men specialize on the labor market, and women specialize in household work.

In Table 4.4 we also report the average utility weight ($\overline{\pi}$). An increase of the $\overline{\pi}$ means that the utility function of the male is more heavily weighted in the collective utility function. For Dutch households, $\overline{\pi}$ is slightly higher than 0.5 as is also the case for Turkish households.

For Surinamese/Antillean households, we find that the value is slightly below 0.5. This indicates that the relationship between the two spouses in Surinamese/Antillean households differs from that in Dutch and Turkish households. In Surinamese/Antillean households the female may depend less on her partner than the females in the latter two household types. The distributions of π_n for the three types of households are shown in Figure 4.1.

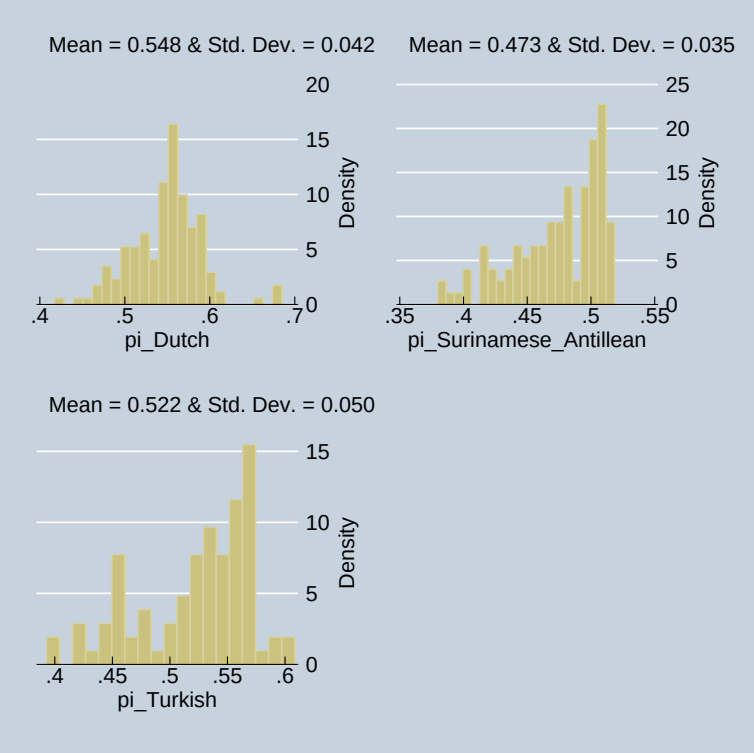


Figure 4.1: Distribution graphs of π_n for the three types of households

For Dutch households we find that π is approximately normally distributed around the mean. The power distribution for Surinamese/Antillean households in the sample is heavily skewed to the left or, in other words, the median value π is smaller than the average value of π. A t-test shows that $\overline{\pi}$ is significantly smaller than 0.5. This indicates that the weight assigned to women's utility function is frequently higher than the weight assigned to the men's utility function in Surinamese/Antillean households.

For Turkish households we find very different values for π for different households, although most values are above 0.5. A t-test indicates that $\overline{\pi}$ is significantly greater than 0.5, and this means that the utility of Turkish men is on average slightly more weighted in the collective household utility function.

More generally, Figure 4.1 shows that there is substantial variation in the distribution of the utility weight between individual households.

Table 4.5: **Estimates of the Power Function π_n**

	Dutch		***Sur./Ant.***	
	Estimate	z-value	**Estimate**	**z-value**
Log(w_{male})	0.174***	3.20	0.011	0.40
Log(w_{female})	-0.190***	-3.96	0.029	0.94
Log(#-children 0/3+1)	-0.185***	-3.87	-0.222***	-6.91
Log(#-children 4/11+1)	0.033	0.89	-0.089***	-4.43
Log(#-children 12/15+1)	0.001	0.02	-0.043**	-2.04
Log(#-children >16+1)	-0.073	-1.22	0.030	1.36
Log(age_{male})	0.445***	2.92	0.050	0.57
Log(age_{female})	-0.402**	-2.62	-0.082	-0.89
N	153		113	

	Turkish	
	Estimate	**z-value**
Log(w_{male})	0.144***	4.2
Log(w_{female})	-0.100***	-3.88
Log(#-children 0/3+1)	-0.360***	-8.38
Log(#-children 4/11+1)	-0.007	-0.27
Log(#-children 12/16+1)	-0.064**	-2.06
Log(#-children >16+1)	-0.099***	-2.95
Log(age_{male})	-0.032	-0.42
Log(age_{female})	0.041	0.55
N	91	

Note: * significant at the 10% level, ** significant at the 5% level,
*** significant at the 1% level.

Table 4.5 shows the estimation results concerning the utility weight, where the utility weight depends on wage rates, the number of children between certain age levels and age.

For Dutch households we find that age, the hourly wage rate, and the number of children aged between 0 and 3 influences the utility weight distribution. When partners are about the same age, the age effect will be small. However, if the age difference increases, the utility weight distribution shifts to the advantage of the older partner, mostly men. The utility weight distribution shifts to the advantage of women when there are children present in the household who are aged between 0 and 3. The wage rate effects are as expected, the power distribution will shift in the direction of the partner whose hourly wage rate increases.

For Surinamese/Antillean households, the variation in the power distribution is entirely driven by the presence of children in the household. The more children aged below 16 are present in the household, the more the utility weight distribution will shift in the direction of the female. Wages have a non-significant effect.

Similar to Dutch households, we find a wage effect for Turkish households, although this effect is not as strong. Furthermore, the presence of children shifts the utility weight distribution towards the Turkish female.

4.6 Wage and Child Effects

Time allocation choices depend on the wage rates of both partners, so it is interesting to examine how time allocation choices react to marginal wage changes. In Chapter 3 we saw that the wage effect matrix can be written as:

$$\frac{\partial z}{\partial w} = -\left(U_{zz}\right)^{-1}\left[\pi U_{m,zw} + (1-\pi)U_{f,zw} + \left[U_{m,z} - U_{f,z}\right]\left[\frac{\partial \pi}{\partial w}\right]'\right] \tag{4.16}$$

The corresponding elasticities, $\frac{\partial z}{\partial w}.\frac{w}{z}$, can be obtained using (4.16). The wage elasticities, evaluated in the sample mean, are shown in Table 4.6.

Table 4.6: **Average Wage Elasticities**

	Dutch		***Sur./Ant.***	
	$\mathbf{w}_m$	$\mathbf{w}_f$	$\mathbf{w}_m$	$\mathbf{w}_f$
le_m	-0.15	0.15	-0.02	0.12
wh_m	-4.41	4.11	-4.24	2.32
jh_m	1.16	-1.10	1.08	-0.85
le_f	0.17	-0.16	0.07	-0.14
wh_f	2.63	-2.60	2.51	-1.24
jh_f	-1.89	1.78	-1.88	1.54

	Turkish	
	$\mathbf{w}_m$	$\mathbf{w}_f$
le_m	-0.02	0.06
wh_m	-1.46	1.26
jh_m	0.53	-0.57
le_f	0.23	-0.26
wh_f	0.38	-0.48
jh_f	-1.31	1.75

The wage elasticities for Dutch men and women are remarkably symmetric. Spouses tend to work more hours on the labor market as their wage increases. The partner tends to work less hours on the labor market as a reaction to this wage rate increase. Hence, we find a forward-bending labor supply curve for both Dutch spouses. Women work more labor hours and spend less hours on housework if their wage increases. As a consequence, men work less hours on the labor market and increase the number of hours they spend on housework so that the household production remains the same.

For Surinamese and Antillean households too, we find a forward bending labor supply curve for both men and women. The wage elasticities of Surinamese and Antillean men are very similar to those of Dutch men. As is mentioned earlier, the descriptive statistics for Dutch and Surinamese men are very similar and this probably explains the similarities in the wage elasticities. A wage increase for Surinamese and Antillean women has less impact on the time spent on housework by men and women than for Dutch households. This might be

because Surinamese/Antillean women already spend a large number of hours on housework.

Turkish women tend to work more hours on the labor market when their wage rate increases. The effect of a wage rate increase on the labor supply of the Turkish men is much smaller than for Turkish women, and also smaller than for Dutch and Surinamese/Antillean men. Furthermore, when women tend to work more labor hours as a result of a wage rate increase, this leads to an increase of the number of hours that Turkish men spend on housework.

In general we can conclude that labor supply curves for both men and women are forward bending in terms of their own wages. In the labor supply literature it is generally found that the labor supply curve of men is backward-bending (see Pencavel (1986)) and that the labor supply curve of women is forward-bending (see Killingsworth and Heckman (1986)). Comparing our results with these results, we find similar results for women but opposite results for men. The labor supply curves in terms of the partner's wage are backward-bending, and this implies that, when the wage rate of the spouse increases, the partner will supply less hours of paid labor.

Child effects can be obtained in a similar way as the wage effects. We expect to find that having young children will have a negative effect on labor supply, most likely for females. Using equation 3.23 of Chapter 3 the effect of having children can be obtained:

$$\frac{\partial z}{\partial \ln(C_l^u)} = -\left(U_{zz}\right)^{-1}\left[\pi U_{m,zfs} + (1-\pi)U_{f,zfs} + \left[U_{m,z} - U_{f,z}\right]\left[\frac{\partial \pi}{\partial \ln(C_l^u)}'\right]\right] \tag{4.17}$$

where C_l^u is the number of children within a certain age interval. The l-subscript indicates the lower age bound and the u-superscript indicates the upper age bound. The corresponding elasticities are then $\frac{\partial z}{\partial \ln(C_l^u)} \cdot \frac{\partial \ln(C_l^u)}{z}$. The results are shown in Table 4.7.

Table 4.7: **Child Effects**

Dutch

	$\mathbf{C}_0^3$	$\mathbf{C}_4^{11}$	$\mathbf{C}_{12}^{15}$	$\mathbf{C}_{16}^{+}$
le_m	-0.027	-0.004	-0.002	-0.006
wh_m	0.097	-0.022	-0.091	-0.027
jh_m	0.054	0.019	0.043	0.024
le_f	0.010	-0.019	-0.008	0.001
wh_f	0.098	0.210	0.301	0.117
jh_f	-0.208	-0.109	-0.157	-0.173

Sur./Ant.

	$\mathbf{C}_0^3$	$\mathbf{C}_4^{11}$	$\mathbf{C}_{12}^{15}$	$\mathbf{C}_{16}^{+}$
le_m	-0.036	-0.030	0.003	0.008
wh_m	0.284	0.326	-0.263	-0.169
jh_m	-0.026	-0.018	0.049	0.006
le_f	0.006	-0.003	-0.017	-0.012
wh_f	0.003	0.003	0.404	0.172
jh_f	-0.060	-0.072	-0.128	-0.032

Turkish

	$\mathbf{C}_0^3$	$\mathbf{C}_4^{11}$	$\mathbf{C}_{12}^{15}$	$\mathbf{C}_{16}^{+}$
le_m	-0.051	-0.007	-0.009	-0.007
wh_m	0.141	-0.005	-0.017	-0.081
jh_m	0.025	0.012	0.040	0.047
le_f	0.012	-0.030	-0.011	-0.010
wh_f	0.091	0.330	0.283	0.423
jh_f	-0.236	-0.045	-0.211	-0.192

In general, we find that the presence of (more) children in the household has a negative effect on labor supply of women for all household types. This effect is largest for Turkish females.

Dutch and Turkish men supply more labor hours when the number of children increases.

Surinamese/Antillean men supply less hours of labor when there are young children present in the household and supply more hours of labor when there are older children in the household.

For Turkish and Dutch households, we find that, although males increase the hours spent on housework when there are (more) children between 0 and 3, they do not increase the time spent on housework when the children are older than 3 years old. Women tend to spend more hours on housework when there are more children present in the household. For Dutch and Turkish families with children, men specialize on the labor market, while women specialize in household tasks.

For Surinamese/Antillean families, it seems that men and women are very similar in changing their time allocation when there are more children present who are 11 years old or younger. Both men and women reduce their labor supply and increase the hours spent on housework. However, when the number of children aged above 12 increases, women tend to spend more time on household activities, while men reduce their time spent on household activities.

4.7 Conclusion

In this chapter we have estimated the public good version of the collective household model ($PGVCM$) for two-earner households in the Netherlands, where we distinguish between Dutch, Turkish, Surinamese, and Antillean households. The contribution of this chapter is (1) to test the robustness of the estimation results obtained in Chapter 3 by using a different sample; (2) to consider immigrant households, since these households are usually neglected in time allocation studies. It might be that differences in ethnic background reveal interesting differences between Dutch and immigrant households; and (3) to obtain the (*cross*) wage and child effects on the different time expenditures of individuals.

We find for all households that leisure and household income are the most important variables in the individual utility functions, which is in line with Chapter 3. Although the household production of both spouses (with and without a family size interaction) is important for all household types, it is much more important for Turkish and Surinamese/Antillean women.

The utility weight for Dutch households is approximately normally distributed around a mean of 0.548 in favor of men. For Surinamese/Antillean households (π_n=0.473) and Turkish households (π_n=0.522), we find that the distribution is heavily skewed to the right with fat tails to both sides.

While the utility weight depends on both partners' wage rates for Dutch and Turkish

households, this is not the case for Surinamese/Antillean households. An increase in the individual's wage rate in Dutch and Turkish households will shift the utility weight distribution in favor of this individual.

The utility weight distribution is significantly influenced by the presence of children and this is found for all households. For Dutch households with children between 0 and 3 years old, we find a utility weight distribution more to the advantage of women, and this effect is even larger for Surinamese/Antillean and Turkish households. Furthermore, a similar effect is found for Surinamese/Antillean and Turkish households with older children.

Because time allocation choices depend on the wage rates of both partners, we examine how these time allocation choices react to marginal wage changes. We find that the labor supply curve is forward-bending for both men and women in terms of their own wage. A forward-bending labor supply curve for men was not found in Chapter 3 and also not generally found in labor supply studies (see Killingsworth and Heckman (1986) and Pencavel (1986)).

The labor supply curves in terms of the partner's wage are backward-bending, which implies that when the wage rate of the spouse increases, the partner will supply less hours of paid labor. In Chapter 3 we found the opposite for English households, even though the estimation results of the ordinal utility functions and utility weights are rather similar between the two chapters.

We furthermore find that the wage elasticities for Dutch males and females are remarkably symmetric. The wage elasticities for Surinamese/Antillean and Dutch males are very similar, probably because their background characteristics are very similar.

The presence of (more) young children in the household reduces the paid labor supply of women and increases the paid labor supply of men. For Turkish and Dutch households, this result is found for children of all age categories; for Surinamese/Antillean households, this result is only found for the presence of (more) children of 12 years and older. So the labor market behavior of Turkish and Dutch households appear to be very similar, while Surinamese/Antillean households show different labor market behavior when there are children up to 12 years old present in the household.

Finally, we emphasize the importance of cross-elasticities as we did in Chapter 3. The point of departure for current Dutch government policies is the idea that an increase in women's wage rate will increase the number of paid labor hours that is supplied by them. This result is in line with the Chapter 4 findings. However, according to those findings, an increase in women's wage rates also decreases the amount of paid labor supplied by men. In general, men's income is more heavily taxed than that of their partner because they work

more hours of paid labor. Therefore, government tax policy should take these cross-effects into account when they estimate the prospective tax benefits of increasing female labor participation.

Chapter 5

A Public Good Version of the Collective Household Model with Non-Participation in Paid Labor

5.1 Introduction

Until now, we have considered households where both partners perform paid labor. In this chapter we allow for the possibility that one of the partners in the household is not active in a paid job. As in our database of single-earner families, in most cases the male is the only income earner, we assume in the exposition that, if there is only one income earner, it will be the male partner. For the non-working female, $jh_f = 0$ will hold. This extension is not trivial. It raises the question what information is conveyed by the observation $jh_f = 0$? It may be that female unemployment is the result of an optimizing decision, i.e. we have voluntary unemployment. It may also be that unemployment is involuntary. Unfortunately, we do not have information in our data set on whether unemployment is voluntary or involuntary. As we know that much unemployment is involuntary, we cannot assume that $jh_f = 0$ corresponds to a situation of equilibrium. However, the non-participation choice itself is endogenous with the number of paid labor hours and considering only two-earner households might result in a selectivity bias. Empirical applications on collective household labor supply that take into account the non-participation of household members are scarce[1]. In this chapter we empirically extend the Public Good Version of the Collective Model by allowing for the possibility that household members do not perform paid work.

[1]Exceptions are Bloemen (2004), Blundell, Chiappori, Magnac and Meghir (2005) and Vermeulen (2006)

Again we use data from the British Household Panel Survey (BHPS), where we distinguish between a sub-sample of two-earner families (as in Chapter 3) and a sub-sample of one-earner households. The sub-sample of one-earner households consists of households where only the man works. As there are only 40 cases where only the woman works, we will not consider these households.

In this chapter the structural model for the behavior of two-earner households is similar to the one used in Chapter 3. For one-earner households we assume that the household behavior can be described as if the household maximizes a household utility function, conditional on the zero job-hour choice of the woman. It implies that the non-participation decision may not be optimal for the household as the zero job-hour choice may not optimal, but forced upon the female by external circumstances. In addition, we define a model where we assume that the choice of job hours may be non-optimal for *both* one- and two-earner households.

By estimating the various models, we obtain more insights into how individual preferences and bargaining between spouses differ between one- and two-earner households. Furthermore, we obtain information on how individual utility and household utility is influenced by working an additional hour of paid labor. This is interesting as it gives more information about why women do or do not participate.

This chapter proceeds as follows. In Section 5.2, we discuss the theory. In Section 5.3, we describe the estimation method. In Section 5.4, the estimation results are presented and discussed, and finally, in Section 5.4.2, we conclude. In order to make this chapter self-contained, we repeat some of what has been written down more extensively in Chapter 3.

5.2 Theory

We start by considering two-earner households. Then we look for the modifications needed to describe the behavior of one-earner households.

Consider a two-earner household, where the preferences of spouse s ($s = m, f$) are represented by the following direct utility functions:

$$U_s = v_s(C, H, le_s, wh_s, jh_s) \tag{5.1}$$

where $v_s(\cdot)$ is twice continuously differentiable and a strictly concave utility function. The individual utility functions depend on the household consumption, C, and the household production, H. As in the earlier chapters, the utility function of spouse s depends on the time that is spent on leisure (le_s), housework (wh_s) and paid job hours (jh_s). It is somewhat

unusual to include job hours directly in the utility function, as it is usually assumed that the working effort influences utility only negatively through a corresponding loss of leisure hours. However, there are numerous studies on life satisfaction that suggest that it is the experience of unemployment itself, rather than the loss of income through unemployment, that reduces life satisfaction (see Booth and van Ours (2007)). We also assume that men and women may derive direct utility from the performance of housework.

As we do not observe the household expenditures, we assume that consumption, C, can be seen as a Hicksian composite good. This composite good represents total household consumption, the money value of which is household income, y.[2] Hence, in our model, C can be expressed as:

$$C = y = w_m jh_m + w_f jh_f + y_u \tag{5.2}$$

where w_s stands for the wage rate of spouse s; and y_u stands for unearned income of the household. Household production is generally not observed in data sets either. Therefore, the household production is represented by the household technology $h(wh_m, wh_f)$ that is a function of the hours that both spouses spend on housework. We assume the following functional form for this household technology:

$$H = h(wh_m, wh_f) = wh_m + \gamma wh_f \tag{5.3}$$

where γ represents the marginal productivity of the woman relative to that of the man.

As in Section 2.3, we model the household consumption and the household production as if they are public goods in the household. As the aggregated level of household income (that represents consumption) and the weighted sum of the individual hours spent on housework each represent one value for each household, it is not possible to examine how the various goods are distributed over the household members.

According to the Collective Model (CM), the household decision process can be described as if the household maximizes a weighted sum of the individual utility functions, subject to the individual time constraints that spouses face.[3] Spouses are assumed to choose the optimal bundle (le_m, wh_m, le_f, wh_f) that maximizes the following household utility function:

$$\begin{aligned} U_h = {} & \pi(w_m, w_f, \mathbf{d}) \cdot v_m(y, H, le_m, wh_m, T - le_m - wh_m) \\ & + (1 - \pi(w_m, w_f, \mathbf{d})) \cdot v_f(y, H, le_f, wh_f, T - le_f - wh_f) \end{aligned} \tag{5.4}$$

[2]For simplicity, and without loss of generality, we assume that the price of this Hicksian composite good equals 1.

[3]For a more detailed discussion on the collective household model, see Chapter 2

where H is defined as in (5.3), and y is redefined as:

$$y = w_m(T - le_m - wh_m) + w_f(T - le_f - wh_f) + y_u \tag{5.5}$$

where w_m and w_f stand for the hourly wage rates. The number of job hours of spouse s (jh_s) that appears in (5.5) and directly in the individual utility function is rewritten, using the individual time constraint, as $(T - le_s - wh_s)$, where T is the total time endowment per week. By substitution, we have incorporated the household budget constraint and the individual time constraints in the model.

The individual utility functions are weighted by the utility weight $\pi(\cdot)$ that is assumed to lie in the interval [0,1]. An intuitive interpretation of this weight is that it represents the division of bargaining power between the spouses. Browning et al. (2006) point out that, although generally π is considered as a function, there has been confusion about what the arguments of this function should be. They show that, when π is 'misspecified' and does not depend on the individual wage rates, the CM collapses into the conventional unitary model. The disadvantages of the unitary setting compared with a collective setting are explained in Chapter 2. In addition $\pi(\cdot)$ is assumed to depend on several distribution factors ($\mathbf{d}$). These factors influence the division of bargaining power between the spouses, but not the preferences of the spouses.

In Chapter 2, we discussed why the CM is, currently, the most suitable model to describe household behavior. Here, we just emphasize that the collective model merely assumes that the outcome of the household decision process is a Pareto-efficient outcome. In other words, in the optimum one of the spouses cannot be made better off by choosing a different time allocation, without making the other spouse worse-off.

Since consumption goods and household production goods are assumed to be public, we refer to this model as a Public Good Version of the Collective Model (PGVCM).[4] For identification purposes, each spouse's leisure is assumed to be a private good, i.e. the husband does not benefit from the wife's leisure, and conversely (see Chiappori and Ekeland (2006)).

The corresponding system of first-order-conditions (FOCs) with respect to the man's and

[4]A more detailed discussion on the PGVCM, and how this model differs from the more general CM, is given in Chapter 2.

woman's leisure and housework is then:

$$\begin{aligned}
\frac{\partial U_h}{\partial le_m} &= \pi \frac{\partial U_m}{\partial le_m} + (1-\pi)\frac{\partial U_f}{\partial le_m} \\
\frac{\partial U_h}{\partial wh_m} &= \pi \frac{\partial U_m}{\partial wh_m} + (1-\pi)\frac{\partial U_f}{\partial wh_m} \\
\frac{\partial U_h}{\partial le_f} &= \pi \frac{\partial U_m}{\partial le_f} + (1-\pi)\frac{\partial U_f}{\partial le_f} \\
\frac{\partial U_h}{\partial wh_f} &= \pi \frac{\partial U_m}{\partial wh_f} + (1-\pi)\frac{\partial U_f}{\partial wh_f}
\end{aligned} \tag{5.6}$$

Let us focus on the first partial derivative with respect to male leisure. This partial derivative consists of two terms. The first term represents the male part of the collective utility function, while the second term represents the female part of the collective utility function. It follows that the leisure choice of the man influences the household utility through the utility of the man *and* the utility of the woman, and vice versa.

In order to see how this happens, we can write the first FOC more extensively as:

$$\frac{\partial U_h}{\partial le_m} = \pi[\frac{\partial U_m}{\partial le_m} + \frac{\partial U_m}{\partial y}\frac{\partial y}{\partial le_m} + \frac{\partial U_m}{\partial jh_m}\frac{\partial jh_m}{\partial le_m}] + (1-\pi)[\frac{\partial U_f}{\partial y}\frac{\partial y}{\partial le_m}] \tag{5.7}$$

From the partial derivative in (5.7), we can deduct through which components the household utility function is influenced. The first term ($\frac{\partial U_m}{\partial le_m}$) indicates that the man's leisure influences the household utility directly through the utility function of the male. This is a consequence of the identifying assumption that the individual leisure is a private good.

Because we replace job hours by the individual time constraints, the leisure of the man influences the household utility through consumption y and through the man's job hours. As consumption goods are public, the household utility is influenced by the leisure time of the man, through the utility function of both man and woman. As both utility functions are differently weighted in the household utility function, the sum of the individual partial effects are weighted by the utility weight π as well.

We do not repeat this exercise for the other FOCs, as the intuition is the same. Solving the FOCs for the choice variables leisure and housework (and consequently job hours) gives the following system of demand functions:

$$\mathbf{z} = (w_m, w_f, y_u, \mathbf{d}) \tag{5.8}$$

where we introduce the shorthand notation $\mathbf{z}$ that stands for the solution vector $z =$

(le_m, wh_m, le_f, wh_f). These 'time' demand functions are functions of the wage rates, the unearned income and the distribution factors that appear in the utility weight.

The model above applies for two-earner households. However, we have now to consider the situation where the female partner is not participating in the labor market.

For these one-earner households, we assume that the household behavior can be described as if the household maximizes a household a utility function that is conditional on the zero job-hour choice of the woman. Optimization is performed only with respect to the three variables (le_m, wh_m, le_f). Hence equation (5.4) is rewritten such that, for these one-earner households, spouses choose the optimal bundle (le_m, wh_m, le_f) that maximizes the household utility function:[5]

$$\begin{aligned} U_h = \pi(w_m, \widetilde{w}_f, \mathbf{d}) \cdot v_m(C, H, le_m, wh_m, T - le_m - wh_m) \\ + (1 - \pi(w_m, \widetilde{w}_f, \mathbf{d})) \cdot v_f(C, H, le_f, T - le_f) \end{aligned} \tag{5.9}$$

where H and C are defined as:

$$\begin{aligned} C = y = w_m(T - le_m - wh_m) + y_u \\ H = wh_m + \gamma(T - le_f) \end{aligned} \tag{5.10}$$

To simplify the notation, we leave out the subscript, indicating that the situation applies for one-earner households. Household consumption is again considered as a Hicksian composite good, and therefore we can represent the total household consumption C by the household income y.

When we compare equation (5.9) with equation (5.4), the changes are the following. As the woman is not participating in the labor market, she works zero job hours, but we have no information suggesting that an equilibrium condition is fulfilled with respect to jh_f. We do not observe an hourly wage rate for her, which we can use as a determinant for the distribution of power between male and female. Her economic power is reflected by $\widetilde{w}_f$, which is the hourly wage that she would receive if she decided to work a positive number of labor hours. This market wage $\widetilde{w}_f$ will have to be estimated.

The utility function of the household is now conditional on the zero labor supply choice of the woman. When the woman does not work, she may receive social benefits which influence her behavior. The utility function of the male essentially remains the same, but the non-

[5]We assume additive individual utility functions, i.e. $v_f(C, H, le_f, wh_f, jh_f) = v_f^A(C, H, le_f, wh_f) + v_f^B(jh_f)$, and so we can exclude the zero job hours of the woman as it does not affect the optimal solution.

participation of the woman affects his utility through household income and the household production of goods.

The utility weight is defined similarly for one-earner households as for two-earner households, with one exception. For the woman we do not observe her hourly wage rate, and the utility weight depends on her estimated wage rate, $\widetilde{w}_f$, i.e. the wage rate that she would receive if she works.

As for the two-earner case, we substitute the individual time constraints in the utility functions and the budget constraint of the household. As the time constraint of the woman is $wh_f = T - le_f$, we need to solve the the FOCs with respect to the choice variables le_m, le_f and wh_m. The corresponding system of first-order-conditions, by which we can determine the optimal time allocation for one-earner households is then

$$\begin{aligned} \frac{\partial U_h}{\partial le_m} &= \pi \frac{\partial U_m}{\partial le_m} + (1-\pi)\frac{\partial U_f}{\partial le_m} \\ \frac{\partial U_h}{\partial wh_m} &= \pi \frac{\partial U_m}{\partial wh_m} + (1-\pi)\frac{\partial U_f}{\partial wh_m} \\ \frac{\partial U_h}{\partial le_f} &= \pi \frac{\partial U_m}{\partial le_f} + (1-\pi)\frac{\partial U_f}{\partial le_f} \end{aligned} \tag{5.11}$$

where there are only three parameter-identifying conditions instead of four in the case of the two-earner household.

Focusing on the third FOC and writing it more extensively gives:

$$\frac{\partial U_h}{\partial le_f} = \pi[\frac{\partial U_m}{\partial H}\frac{\partial H}{\partial le_f}] + (1-\pi)[\frac{\partial U_f}{\partial le_f} + \frac{\partial U_f}{\partial wh_f}\frac{\partial wh_f}{\partial le_f} + \frac{\partial U_f}{\partial H}\frac{\partial H}{\partial le_f}] \tag{5.12}$$

Besides the direct effect of leisure on household utility, the amount of leisure influences household utility indirectly through housework and the household production. This is because the time constraint of the woman is substituted in her utility .

When we solve the FOCs for the choice variables le_m, le_f and wh_m, we obtain the following system of demand functions:

$$\widetilde{\mathbf{z}} = (w_m, \widetilde{w}_f, y_u, \mathbf{d}) \tag{5.13}$$

where $\widetilde{\mathbf{z}}$ stands for the solution vector for one-earner households, i.e. $\widetilde{z} = (le_m, wh_m, le_f)$. This vector contains one element less than the solution vector we found for the two-earner household. The time-demand functions depend on the wage rate of the man, the predicted market wage rate of the woman, the unearned income and the distribution factors that

appear in the utility weight.

The model for one-earner households assumes that the man's job hours and the amount of leisure and housework of both spouses are optimally chosen. We do not know whether the zero job hours of the female is the result of optimization or whether it is forced upon her by the labor market. However, the fact that we do not have all the information we would like to have does not prevent us from identifying and estimating a subset of preference parameters.

5.3 The Empirical Model and Estimation Method

For the estimation procedure we distinguish between two-earner households and one-earner households, where only the man works. First, we focus on the two-earner households, and afterwards we consider how the empirical model changes for one-earner households.

Two-earner households

The preferences of spouse s ($s = m, f$) are again represented by the following log-additive utility functions:

$$\begin{aligned} v_s(y, H, le_s, wh_s, jh_s) = \alpha_{s,1} \ln(le_s) + \alpha_{s,2} \ln(wh_s) + \\ [\alpha_{s,3} + \alpha_{s,3I} \ln(fs + 1)] \ln(H) + \alpha_{s,4} \ln(y) + \alpha_{s,5} \ln(jh_s) \end{aligned} \tag{5.14}$$

where again the household consumption, C, is denoted as:

$$C = y = w_m \cdot jh_m + w_f \cdot jh_f + y_u \tag{5.15}$$

The weekly net wage rates and the unearned income are measured in UK pounds for both spouses. As in Section 5.2, the household production is defined as

$$H = wh_m + \gamma \cdot wh_f \tag{5.16}$$

In (5.14), the utility effect of the total household production depends on family size. In this way we recognize that the utility derived from the total (weighted) housework hours (H) is likely to be influenced by the size of the family. This dependency is modeled by including an interaction term between family size fs and H.

Furthermore, the following time constraints apply:

$$\begin{aligned} jh_s &= T - le_s - wh_s \\ 0 &\leq le_s \leq T \\ 0 &\leq wh_s \leq T \end{aligned} \tag{5.17}$$

When we substitute (5.15) and (5.16) into the utility function described in (5.14), the behavior of household n can be described as if the household maximizes a household utility function of the following type:

$$\max_{le_{n,m}, wh_{n,m}, le_{n,f}, wh_{n,f}} U_{n,h} = \pi_n v_{n,m} + (1 - \pi_n) v_{n,f} \tag{5.18}$$

subject to (5.17) with

$$\begin{aligned} v_s = {} & \alpha_{s,1} \ln(le_s) + \alpha_{s,2} \ln(wh_s) + [\alpha_{s,3} + \alpha_{s,3I} \ln(fs + 1)] \ln(wh_m + \gamma wh_f) \\ & + \alpha_{s,4} \ln(w_m jh_m + w_f jh_f + y_u) + \alpha_{s,5} \ln(jh_s) \end{aligned}$$

It is important to recognize that job hours of both spouses are replaced by $T - le_s - wh_s$, such that there are four choice variables, i.e. the time spent on leisure and housework by both spouses.

For now, we assume that the utility weight is constant for each household, although it varies over the households. The solution to the optimization problem for each household can be obtained by deriving the system of first-order conditions:

$$\begin{aligned} \frac{\partial U_h}{\partial le_m} &= \pi[\frac{\alpha_{m,1}}{le_m} - \frac{\alpha_{m,4} w_m}{y} - \frac{\alpha_{m,5}}{jh_m}] + (1 - \pi)\frac{-\alpha_{f,4} w_m}{y} \\ \frac{\partial U_h}{\partial wh_m} &= \pi[\frac{\alpha_{m,2}}{wh_m} + \frac{\alpha_{m,3}}{H} + \frac{\alpha_{m,3I} \log(fs)}{H} - \frac{\alpha_{m,4} w_m}{y} - \frac{\alpha_{m,5}}{jh_m}] \\ & \quad + (1 - \pi)[\frac{\alpha_{f,3}}{H} + \frac{\alpha_{f,3I} \log(fs)}{H} - \frac{\alpha_{f,4} w_m}{y}] \\ \frac{\partial U_h}{\partial le_f} &= \pi\frac{-\alpha_{m,4} w_f}{y} + (1 - \pi)[\frac{\alpha_{f,1}}{le_f} - \frac{\alpha_{f,4} w_f}{y} - \frac{\alpha_{f,5}}{jh_f}] \\ \frac{\partial U_h}{\partial wh_f} &= \pi[\frac{\alpha_{m,3}\gamma}{H} + \frac{\alpha_{m,3I}\gamma \log(fs)}{H} - \frac{\alpha_{m,4} w_f}{y}] \\ & \quad + (1 - \pi)[\frac{\alpha_{f,2}}{wh_f} + \frac{\alpha_{f,3}\gamma}{H} + \frac{\alpha_{f,3I}\gamma \log(fs)}{H} - \frac{\alpha_{f,4} w_f}{y} - \frac{\alpha_{f,5}}{jh_f}] \end{aligned} \tag{5.19}$$

To obtain the optimal solution for a two-earner household, we would normally set the partial

derivatives in (5.19) to zero and solve the system for the endogenous choice variables leisure and housework. However, these functions are highly non-linear in the estimation parameters, and therefore we use the more convenient two-step iterative estimation procedure, developed in Chapter 3, to estimate the unknown parameter estimates. This estimation procedure relates to the Wald test criterion approach (see Wales and Woodland (1983) and Blundell and Robin (1999)). Before we can explain, and apply the estimation method, we simplify the system in (5.19).

We rewrite the first partial derivative, $\frac{\partial U_h}{\partial le_m}$, in a more convenient way, so that each model parameter α has one accompanying coefficient x:

$$\frac{\partial U_h}{\partial le_m} = \pi[\alpha_{m,1}x_{1,m,1} + \alpha_{m,4}x_{1,m,4} + \alpha_{m,5}x_{1,m,5}] + (1-\pi)[\alpha_{f,4}x_{1,f,4}] \tag{5.20}$$

Equation (5.20) is essentially the same as equation (5.7), where the partial derivative with respect to the man's leisure was extensively rewritten. Leisure influences the household utility through the utility function of the man in three ways: (1) directly ($x_{1,m,1}$); (2) through the household income ($x_{1,m,4}$); and (3) through job hours ($x_{1,m,5}$). Household utility is also influenced by household income through the utility of the woman ($x_{1,f,4}$). Similarly, we rewrite the other three FOCs as well and we show the full system of FOCs in Appendix 5.7.

The linear system of FOCs can be written as:

$$\begin{bmatrix} \pi x'_{1m} & (1-\pi)x'_{1f} \\ \pi x'_{2m} & (1-\pi)x'_{2f} \\ \pi x'_{3m} & (1-\pi)x'_{3f} \\ \pi x'_{4m} & (1-\pi)x'_{4f} \end{bmatrix} \begin{bmatrix} \alpha_m \\ \alpha_f \end{bmatrix} = \begin{bmatrix} \pi X'_m & (1-\pi)X'_f \end{bmatrix} \begin{bmatrix} \alpha_m \\ \alpha_f \end{bmatrix} = 0 \tag{5.21}$$

where the index 1 refers to the x-vector in the first FOC and where X'_m and X'_f are (4×6)-matrices. The matrix X'_s contains some zero elements. For example, the parameter $\alpha_{m,2}$ does not appear in equation (5.20) and the coefficient that belongs to this parameter in matrix X'_m is therefore set to zero.

More concisely, we can now define a (4×12)-matrix X'_n by:

$$\begin{bmatrix} \pi_n X'_{n,m} & (1-\pi_n)X'_{n,f} \end{bmatrix} = X'_n \tag{5.22}$$

The gradient of the household utility function $U_h(\mathbf{z})$ can then be written as $X'_n\alpha$, where $\mathbf{z}$ stands for the solution vector $z = (le_m, wh_m, le_f, wh_f)$.

The utility weight is a function that must depend on wage rates and usually depends on

certain factors that are thought to influence the distribution of bargaining power. We model the utility weight as:

$$\pi_n(w_m, w_f, \mathbf{d}) = N(\beta_m \log(w_{n,m}) + \beta_f \log(w_{n,f}) + \sum_{j=3}^{J} \beta_j \cdot d_{j,n}) \tag{5.23}$$

where $N(\cdot)$ stands for the standard normal distribution function. The use of a normal distribution function is convenient since $\pi_n(w_m, w_f, \mathbf{d}) \in (0, 1)$, while the β-parameters are not bounded and may take any real value. The utility function of the man is weighted more heavily in the collective utility function when π increases and this is at the expense of the utility of the woman. We would expect that w_m affects the utility weight positively as a wage increase of the man is likely to cause a change in the utility weight that is to his advantage, and that the coefficient of w_f will be negative . The distribution factors in our model are unearned income, the number of children, and the age of both spouses. We note that the inclusion of a constant would allow for the situation where one partner 's utility is structurally overweighted. However, we found that the estimate of this constant was consistently insignificant, and therefore we do not include it in the distribution function. Other distribution factors, such as differences in educational level and age level, were also consistently insignificant, and so we also omitted these factors from the model.

One-earner households: Only the man works

One earner households are assumed to maximize a household utility function with respect to housework wh_m, wh_f and the male's leisure le_m, while jh_f is fixed at zero. For these households the time constraints are:

$$\begin{aligned} jh_m &= T - le_m - wh_m \\ wh_f &= T - le_f \\ jh_f &= 0 \\ 0 \leq &le_s \leq T \\ 0 \leq &wh_s \leq T \end{aligned} \tag{5.24}$$

The time constraint of the woman is $T = le_f + wh_f$, and spouses choose the optimal time allocation. We notice that the zero labor hours of the woman may not be optimally chosen.

The behavior of one-earner households can be described as if the household maximizes

the following household utility function:

$$\max_{le_{n,m},wh_{n,m},le_{n,f}} U_{n,h} = \pi_n v_{n,m} + (1-\pi_n) v_{n,f} \tag{5.25}$$

with

$$\begin{aligned} v_s = {} & \alpha_{s,1} \ln(le_s) + \alpha_{s,2} \ln(wh_s) + [\alpha_{s,3} + \alpha_{s,3I} \ln(fs+1)] \ln(wh_m + \gamma(T - le_f)) \\ & + \alpha_{s,4} \ln(w_m jh_m + y_u) + I \cdot \alpha_{s,5} \ln(jh_s) \end{aligned}$$

subject to (5.24). The indicator variable I equals 1 in the utility function of the male and 0 in the utility function of the woman. The woman's utility function does not contain the $\alpha_{f,5} \ln(jh_f)$-term when the woman does not perform paid work. The parameter $\alpha_{f,5}$ is not identified. For one-earner households, we therefore set $\alpha_{f,5}$ to zero. We note that we are not interested in the absolute values of α, but only in their relative values.

The spouses of one-earner households maximize with respect to the three choice variables $le_{n,m}, wh_{n,m}, le_{n,f}$, yielding a system of three FOCs. The expressions for $\frac{\partial U_h}{\partial le_m}$ and $\frac{\partial U_h}{\partial wh_m}$ are similar for one- and two-earner households. Therefore, we show only the partial derivative with respect to the woman's leisure:

$$\begin{aligned} \frac{\partial U_h}{\partial le_f} = {} & \pi[-\frac{\alpha_{m,3}\gamma}{H} - \frac{\alpha_{m,3I}\gamma \log(fs)}{H}] \\ & + (1-\pi)[\frac{\alpha_{f,1}}{le_f} - \frac{\alpha_{f,2}}{wh_f} - \frac{\alpha_{f,3}\gamma}{H} - \frac{\alpha_{f,3I}\gamma \log(fs)}{H}] \end{aligned} \tag{5.26}$$

More concisely, we may rewrite (5.26):

$$\begin{aligned} \frac{\partial U_h}{\partial le_f} = {} & \pi[\alpha_{m,3} x_{3,m,3} + \alpha_{m,3I} x_{3,m,3I}] + \\ & (1-\pi)[\alpha_{f,1} x_{3,f,1} + \alpha_{f,2} x_{3,f,2} + \alpha_{f,3} x_{3,f,3} + \alpha_{f,3I} x_{3,f,3I}] \end{aligned} \tag{5.27}$$

such that for one earner households the linear system of three equations becomes

$$\begin{bmatrix} \pi x'_{1m} & (1-\pi) x'_{1f} \\ \pi x'_{2m} & (1-\pi) x'_{2f} \\ \pi x'_{3m} & (1-\pi) x'_{3f} \\ & \end{bmatrix} \begin{bmatrix} \alpha_m \\ \alpha_f \end{bmatrix} = \begin{bmatrix} \pi X'_m & (1-\pi) X'_f \end{bmatrix} \begin{bmatrix} \alpha_m \\ \alpha_f \end{bmatrix} = 0 \tag{5.28}$$

As in equation (5.21), the index 1 refers to the x-vector in the first FOC. However, the matrices X'_m and X'_f are now (3×6)- and (3×5)-matrices, and the parameter vector α_f is now a five-vector, as the parameter $\alpha_{f,5}$ is set to 0.

For one-earner households n, we define a (3×11)-matrix X'_n by:

$$\begin{bmatrix} \pi_n X'_{n,m} & (1-\pi_n) X'_{n,f} \end{bmatrix} = X'_n \tag{5.29}$$

Again the left-hand-side of (5.21) is the gradient of the household utility function $U_h(\widetilde{\mathbf{z}})$, where $\widetilde{\mathbf{z}}$ stands for the solution vector $\widetilde{z} = (le_m, wh_m, le_f)$ for one-earner households.

The definition of the utility weight function is similar for both one- and two-earner households, although we note that for the wage rate of the non-participating woman we use the predicted market wage rate, as we do not observe her wage rate.

To distinguish between one-earner and two-earner households we refer to the one-earner households by using the subscript o, because only *o*ne of the spouses works. We refer to the two-earner households by using the subscript b, because *b*oth spouses work. We can rewrite the system of FOCs in (5.22) and (5.30) as:

$$X'_{n,h} \alpha_h = 0, \text{ for } h = b, o \tag{5.30}$$

The Estimation Method

Basically, we use the same estimation methodology as explained in Chapter 3. However, we divide the population S into two sub-samples, i.e. a sample of two-earner households (S_b), and a sample of one-earner households (S_o). We start by considering the observations belonging to S_b and have the following system:

$$X'_{n,b} \alpha_b = 0, \quad \forall n \in S_b \tag{5.31}$$

We start by assuming that the values for the β-parameters are known, and hence $\pi_n(\cdot)$ is known for each household. As the equality does not hold exactly, we assume for households in the sample S_b that:

$$X'_{n,b} \alpha_b = \varepsilon_{n,b} \quad \forall n \in S_b \tag{5.32}$$

where ε is the stochastic error vector with $\varepsilon \sim N(0, \Sigma_\varepsilon)$ that is not correlated between households (i.e. $E(\varepsilon_n, \varepsilon_{n'}) = 0$ if $n \neq n'$).

By introducing the nuisance (4-)vector y_n, we can write equation (5.32) as

$$y_n = X'_{n,b}\alpha_b + \varepsilon_{n,b}, \quad \forall n \in S_b \tag{5.33}$$

When setting $y_n = 0$ for all n, the system in (5.33) can be estimated by minimizing $\sum_{n\in S_b} \varepsilon'_{n,b}\Sigma_\varepsilon^{-1}\varepsilon_{n,b}$ with respect to the α_b-parameters, subject to the parameter constraints $\sum \alpha_{m,b} = 1$ and $\sum \alpha_{f,b} = 1$. This is equivalent to estimating the system in (5.33) with a Seemingly Unrelated Least Squares (SUR), where we exclude the 'trivial' solution, i.e. all α parameters are zero, by imposing that $\sum \alpha_{m,b} = 1$ and $\sum \alpha_{f,b} = 1$.

In order to estimate the model for one-earner households, we need to modify the estimation model slightly. When the woman does not participate in paid labor, her job hours are fixed at $jh_f = 0$. Those households maximize a conditional utility function where they again maximize with respect to $le_{n,m}, wh_{n,m}, le_{n,f}, wh_{n,f}$, but where the time constraint for the woman is now $le_{n,f} + wh_{n,f} = T$, as $jh_f = 0$. We eliminate the variable $wh_{n,f} = T - le_{n,f}$, and maximize with respect to the three remaining variables $le_{n,m}, wh_{n,m}, le_{n,f}$, yielding three FOCs, again linear in the parameters α. It follows that we get a 3-equation system:

$$y_n = X'_{n,o}\alpha_o + \varepsilon_{n,o}, \quad \forall n \in S_o \tag{5.34}$$

By minimizing the likelihood $\sum_{n\in S_o} \varepsilon'_{n,o}\Sigma_\varepsilon^{-1}\varepsilon_{n,o}$ under the assumptions that $\sum \alpha_m$=1 and $\sum \alpha_f$=1, and with Σ_ε^{-1} being a (3×3)-matrix, we can retrieve the α-parameters.

In the system in (5.34), the $\alpha_{f,5}$-parameter does not appear so that it cannot be estimated. In this chapter, we assume that, for one-earner households, $\alpha_{f,5}$ is 0 and impose that the other α-parameters for the woman add up to 1, such that the utility function of the woman is linearly homogeneous.

In section 5.4.2, we examine how the estimation results for two-earner households change, when we assume that these households maximize a conditional utility function as well. Those households then maximize with respect to $le_{n,m}, wh_{n,m}, le_{n,f}, wh_{n,f}$, where the time constraint for the woman is $le_{n,f} + wh_{n,f} + \widetilde{jh}_{n,f} = T$. The constant $\widetilde{jh}_{n,f}$, represents the number of hours that the woman participates in paid labor. As is the case for one-earner households, we obtain a 3-equations system that can be estimated with a SUR method under the assumption of linear homogenous utility functions.

When we estimate the 3-equation system separately for one- and two-earner households, we take into account that both household types may have different parameter vectors α. Besides estimating the 3-equation system separately for one- and two-earner households, it is also possible to estimate this model jointly for both household types. In this case we

assume that both household types have the same parameter values α. Under this assumption, we minimize the sum of squared residuals $\sum_{n\in S_b} + \sum_{n\in S_o}$, which is a quadratic expression in all α-parameters.

Up to this point we have assumed the β-parameters, figuring in π, to be known. However, as this is not the case, we use the two-step iterative estimation procedure that we developed in Chapter 3. The steps of this estimation procedure for two-earner households are given below.

- Initiation:

Set $i = 1$
set $\beta_1^{(i)} = ... = \beta_J^{(i)} = 1$ and calculate $\pi_n(\cdot)^{(i)}$

- Step 1:

  1. Estimate the system in (5.33) by means of SUR and obtain $\hat{\alpha}^{(i)}$ using $\pi_n(\cdot)^{(i)}$

- Step 2:

  1. Using $\hat{\alpha}^{(i)}$ and estimate $\beta_1^{(i+1)}, ...\beta_J^{(i+1)}$ by (non-linear) maximum likelihood
  2. calculate $\pi_n(\cdot)^{(i+1)}$
  3. $i = i + 1$
  4. Stop , if abs($\pi_n(\cdot)^{(i)}$- $\pi_n(\cdot)^{(i-1)}$)< $\frac{1}{1000}$;
     Go to Step 1 , otherwise.

The non-linear nature of $\pi_n(\cdot)$ complicates the estimation of the parameters α in the first estimation step. The advantage of this indirect estimation procedure is that we avoid estimating all model parameters simultaneously, as this would mean that the non-linear $\pi_n(\cdot)$ function appears in each α-coefficient. The estimation procedure for one-earner households is equivalent to that of two-earner households, but with the exception that we estimate the system in (5.34) in Step 1.

5.4 Data and Estimation Results

5.4.1 Data

We use the 2003-wave (J) of the British Household Panel Survey (BHPS). This household-based panel began in 1991, and each adult member of the household is interviewed each year.

The main objective of the BHPS is to give insight into the social and economic changes at the individual and household level in the UK.

From the 2003 wave, we use a sub-sample of 1759 couples where household members were interviewed between September 2002 and September 2003. When both spouses are not participating in paid labor or when one of the spouses is self-employed, we do not consider those households in the analysis.

In the BHPS, both spouses are asked to report their participation status. In Table 5.1 we show the participation status of the women in our sample.

Table 5.1: **Participation Status Women**

	Women	
	Freq.	**%**
Yes	1496	85.10
No	262	14.90
Total	1759	100.00

The reason for showing only the participation status for women and not for men is because there are only 40 households where only the woman works. We will not consider these households. Approximately 15 percent of the women in our sample do not participate in paid labor. In order to have a better understanding of who these persons are, we show the gender-specific descriptive statistics in Table 5.2. We distinguish between one- and two-earner households and between men and women. The level of education is measured on a 7-point scale, where 1 is the lowest possible education level (no study was finished), and 7 is the highest possible education level (higher degree). Men are on average older, higher-educated and have a higher hourly wage than women, which is a common finding in empirical studies. The spouses of two-earner households are higher educated and older than the spouses of one-earner households.

Table 5.2 also shows information concerning the time use of the spouses. The information on housework time is obtained by asking spouses the following question:

> "About how many hours do you spend on housework in an average week, such as time spent on cooking, cleaning, and doing the laundry?"

Table 5.2: **Descriptive Statistics**

	Two-earner Households			
	Men		**Women**	
	Mean	Std.Dev.	Mean	Std.Dev.
Leisure hours per week	118.7	9.5	121.7	11.6
Housework hours per week	5.3	4.2	13.9	8.5
Job hours per week	43.9	9.0	32.4	11.5
Net hourly wage	7.7	3.4	6.4	2.9
Age	40.0	10.0	38.3	9.9
Education level	3.7	1.7	3.6	1.7
	One-earner Households			
	Men		**Women**	
	Mean	Std.Dev.	Mean	Std.Dev.
Leisure hours per week	118.8	10.6	144.2	13.2
Housework hours per week	5.0	4.0	23.8	13.2
Job hours per week	44.2	9.9	.	.
Net hourly wage	8.3	4.9	.	.
Age	39.6	10.5	37.1	10.4
Education level	3.5	1.8	3.1	1.6

Table 5.3: **Descriptive Statistics**

	Two-earner		**One-earner**	
	Mean	Std.Dev.	Mean	Std.Dev.
Child present aged between 0-2	0.1	0.3	0.3	0.5
Child present aged between 3-4	0.1	0.3	0.3	0.5
Child present aged between 5-12	0.4	0.7	0.7	0.8
Child present aged >12	0.2	0.4	0.2	0.410
Weekly net household income	583.7	214.0	490.4	215.8
Weekly net non-labor household income	40.0	71.3	84.0	78.3

Clearly, the time spent on housework contains the time spent on cooking, cleaning, and doing the laundry, but the addition *such as* indicates that spouses can include other housework activities as well, such as child care. Consequently, the distinction between housework and leisure is ambiguous and the empirical definition is left to the respondents themselves.

Women spend more hours on housework and, if they participate in paid labor, they work less hours than men. The paid labor hours of men in one-earner households is about equal to that of men in two-earner households, and the same holds for leisure and housework. Women in one-earner households do not perform paid labor, and as a consequence they spend more hours on leisure and housework.

The total number of housework hours is higher for one-earner households than it is for two-earner households. One explanation is that the spouses of two-earner households earn more income and that this income is (partly) used to outsource some of the household tasks that they dislike. Examples of outsourcing are hiring a cleaner and buying a dishwasher. Another explanation is that the spouses of one-earner households have on average more children, so that there is more housework to do. This can also be the reason why women of one-earner households do not participate in the labor market in the first place.

In Table 5.3 we show the descriptive statistics that concern the children that are present in the household and the household income. The number of children are divided into four subgroups, so that differences in the number of children between one- and two-earner households can be linked to the children's age. The average number of children below 12 years old is much higher for one-earner households than it is for two-earner households. On average

there are about three times as many children aged below 5 in one-earner households. This confirms the idea that the decision to have children is endogenous with the labor participation choice of women, i.e. women choose not to work when they do not choose to have a child, and vice versa.

The household income of two-earner households is substantially higher than that of one-earner households. The difference in the household labor income is even more pronounced because one-earner households receive about 45 pounds more unearned income than two-earner households. Unfortunately, there is no information available in the data on the amount of money that spouses spend on the outsourcing of household tasks. Therefore we cannot examine whether high income households spend more money on the outsourcing of household tasks.

5.4.2 Estimation Results

Since we do not observe the wage rate of the non-participating women, we predict their market wage rates by making use of a Heckman sample selection model (Heckman, 1979). The intuition behind this model is that persons with more favorable characteristics have a higher probability of participating in paid labor and also have a higher wage rate. If we were to estimate a wage equation using OLS, it can be that the predicted wage rates are, on average, upwards biased due to a censored wage rate. We will show the estimation results of the Heckman model together with a more detailed explanation in Appendix 5B.

The predicted wage rate of the non-participating women ($\widetilde{w}_f$) and that of the woman who are participating in paid labor (w_f) are presented in Table 5.4.

Table 5.4: **Wage Rates of Women**

	Freq.	mean	Std.Dev.
$\widetilde{w}_f$	262	5.88	1.22
w_f	1496	6.45	2.89

The average wage rate predicted for the non-participating women is lower than the average wage rate of the participating women. On the basis of the descriptive statistics on the level of education and age in Table 5.2, this is what we would expect.

By using the information mentioned in Tables 5.2 to 5.4, we can now estimate the model as is explained in Section 5.3. The estimates of the preference parameters of one- and two-earner households are presented in Table 5.5.

Table 5.5: **Estimates of Preference Parameters**

	One-earner		**Two-earner**	
	Estimate	t-value	Estimate	t-value
Men				
Leisure	1.041	97.62	0.741	234.51
Housework	0.004	9.08	0.003	18.91
Household production (H)	-0.063	-4.84	0.021	9.30
H interaction term	0.068	3.79	0.006	1.48
Household income	-0.061	-3.05	0.267	60.70
Job hours	0.010	0.55	-0.038	-15.75
Women				
Leisure	0.521	46.25	0.767	206.17
Housework	-0.021	-11.96	0.005	11.57
Household production (H)	0.136	10.07	0.015	5.79
H interaction term	-0.045	-2.69	0.026	5.93
Household income	0.408	28.38	0.205	59.20
Job hours	.	.	-0.017	-23.12
γ	0.975		0.925	

For two-earner households we find that leisure and the amount of household income are the most important variables in the individual utility function for both spouses.[6]

For one-earner households we cannot identify the woman's preference with respect to the number of job hours and so we report dots in Table 5.5 for $\alpha_{5,f}$. However, if we assume that

[6]We note the estimation results for two-earner households are not exactly similar to the results of Chapter 3 because we removed one outlier from the sample.

their $\alpha_{5,f}$ is of the same order of magnitude as in two- earner families, that is 0.01, then we might compare the absolute values of the parameters for both household types as well.

For women we find that leisure and household income are the most important variables in their utility function. However, women in one-earner households value leisure time less and household income more than the women of two-earner households do. These women also value household production positively in their utility function, and this can be explained by the fact that there are, on average, more children present in one-earner households than in two-earner households.

When we compare men in one- and two-earner households, they appear to have different preferences. Although leisure is the most important variable for men in both household types, men in one-earner households value their leisure time even more than men in two-earner households do. The household income enters negatively in the utility function of men, and this effect is the opposite of what we found for men in two-earner households. It implies that for them income and leisure are complementary goods and not substitutes.

The differences between one-earner and two-earner households appear to be consistent with the specialization behavior of the spouses. The one-earner man is the sole provider of the household labor income, and his non-participating wife takes care of the children and performs household tasks. A consequence of this specialization behavior is that each spouse values those activities the most that are scarce for them.

Table 5.5 also shows the γ parameter that represents the marginal productivity of the woman relative to that of the man. The first order conditions that we estimate for one- and two-earner households are not linear in the γ-parameter. Therefore we estimate γ numerically and perform a grid search method on an interval level. We vary γ with a width of 0.025 and choose that value of γ that gives the highest log-likelihood of the system that is estimated.

The γ-parameters are 0.925 and 0.975 for two- and one-earner households, respectively. An explanation can be that, on average, the man is somewhat more efficient when spending an additional hour on household tasks, simply because the woman spends more time on household tasks. We note that γ can also be different from 1 for reasons that are non-related to productivity. Therefore, the main reason to include the γ-parameter into our model is to make the model more flexible by allowing for the fact that the rate of substitution may be different from 1.

In Table 5.6 we present the parameters of the utility weight function.

Table 5.6: **Estimates of the Utility Weight Function**

	One-earner		**Two-earner**	
	Estimate	t-value	Estimate	t-value
Log(w_m)	0.278	3.63***	0.714	27.18***
Log(w_f)	-0.031	-0.30	-0.742	-28.11***
Log(y_u+1)	-0.040	-3.28***	0.006	0.95
Log(#-children 0/2+1)	-0.106	-1.79*	-0.004	-0.09
Log(#-children 3/4+1)	0.036	0.57	-0.009	-0.22
Log(#-children 5/11+1)	-0.098	-2.33**	0.007	0.30
Log(#-children 12/15+1)	-0.110	-2.17**	-0.008	-0.28
Log(#-children >15+1)	0.032	0.43	0.002	0.04
Log(age_m)	0.240	1.76*	-0.008	-0.12
Log(age_f)	-0.342	-2.07**	0.011	0.15
π	0.468		0.532	
N	262		1496	
Log-Likelihood	4046.1504		31487.118	

Note: * significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

The dominant variables in the utility weight distribution for two-earner households are the hourly wage rates. In fact, the only factor that seems to matter is the ratio of the log hourly wages because the wage estimates for man and woman are about equal. This means that an increase of a persons wage rate implies that this persons utility function is weighted more in the household utility function. The impact of an increase in wage rate on the utility weight distribution is about equal for men and women.

The estimation results differ for one-earner households. The man's wage rate is positive and significant, but the estimate is smaller compared with that of men in two-earner households. Therefore, a wage increase of the man in one-earner households implies that his utility function is weighted more in the household utility function but the impact of a wage increase is less strong than for men in two-earner households.

The predicted wage rate of the woman does not enter the utility weight function significantly. Pollak (2005) reasons that the utility weight distribution is influenced by the spouses' wage rates as it represents the potential earnings. This reasoning is not confirmed by our study, at least not for the women in our sample.

For these women, we find that it is not the potential earnings that matter, but that the children variables are important instead. An explanation is that women who do not participate in our sample could find a job but choose not to in order to take care of the children. We find a strong child effect on the utility weight distribution that is to the advantage of women. We also find a small but significant effect of unearned income in the advantage of the woman.

Another difference between one- and two-earner households is that the age variables matters for one-earner households. As spouses become older the utility weight distribution tends to shift in their advantage. The impact of the woman's age is higher than that of the man's age. Furthermore, a small but significant effect is found for the unearned income.

In Table 5.6 we also show the average value of the utility weight function for both household types. For one-earner households, we find that the utility function of women is weighted more in the household utility function than that of men (π=0.468), while we find the opposite for two-earner households (π=0.532).

5.5 When Two-earner Households behave as One-earner households

In this section we assume that the behavior of two-earner households can be described as if each household maximizes a household utility function considering the labor supply of the woman as a non-zero constant. The household utility function that is maximized with respect to leisure time and housework time is similar to the household utility function in (5.4), but the time constraint for the woman in two-earner households now becomes $le_f + wh_f = T - \widetilde{jh}_f$, so that we can substitute $wh_f = T - \widetilde{jh}_f - le_f$. Consequently, the system that is estimated for two-earner households resembles that of the system in (5.34), where we take into account that women supply a positive amount of labor by considering $\widetilde{jh}_f$ as a constant in the woman's time constraint.

Estimation of this alternative model for two-earner households is informative in two ways. First, we can examine how the estimation results for two-earner households change when we assume that the woman's paid labor supply may not be optimally chosen. Secondly, we can compare the model estimates of one-earner and two-earner household where the system of

first-order conditions is now equivalent for both household types.

Additionally, we consider for each household that the woman's labor supply is constant, and estimate the model simultaneously for both household types. In doing so, we assume that the preferences of both household types are similar.

In Table 5.7 we present the estimation results of these two alternative models.

Table 5.7: **Estimates of Preference Parameters**

	Two-earner Fixed $\widetilde{jh}_f$		**All households jh_f = constant**	
	Estimate	t-value	Estimate	t-value
Men				
Leisure	0.730	219.00	0.820	218.23
Housework	0.007	39.99	0.005	33.54
Household production (H)	0.000	0.52	-0.009	-4.34
H interaction term	0.005	2.48	0.022	5.89
Household income	0.342	40.67	0.144	17.71
Job ours	-0.084	-13.45	0.017	2.79
Women				
Leisure	0.397	38.95	0.526	66.02
Housework	-0.009	-9.98	-0.009	-14.80
Household production (H)	0.047	17.56	0.072	20.09
H interaction term	0.004	0.85	-0.020	-3.20
Household income	0.561	50.97	0.432	46.10
Job hours	.	.	.	.
γ	0.925		0.925	

First, we focus on the alternative estimation results for the two-earner households. We find that the preference parameters for men do not deviate much from the estimated preference parameters for two-earner households in Table 5.5. For women, we observe a preference

shift, where the household income is weighted more and leisure is weighted less compared with the two-earner estimates of Table 5.5. Nevertheless, it is the case that the household income and leisure are still the most important variables in the utility function of both spouses.

When we assume that jh_f = constant for all households and estimate the model simultaneously for both household types, we find that the estimates are in-between the estimates for one- and two-earner households separately. The estimates obtained for men are more similar to those of the two-earner situation, while the estimates for women are more similar to those of the one-earner situation.

The value of γ represents the marginal productivity of the woman relative to that of the man. This value does not vary much over the different alternatives that we estimated and we conclude that the marginal rate of substitution is slightly smaller than 1 for both one- and two-earner households.

The estimation results of the utility weight function are presented in Table 5.8. The estimation results represented by the One-earner and Two-earner columns are those obtained earlier in Table 5.6 and we have included these results so that the reader can compare the variation of the estimates over the different alternatives.

Table 5.8: **Alternative Estimates of the Utility Weight Function**

	(1) **Two-earner** **Fixed $\widetilde{jh}_f$**		**(2)** **All households** **jh_f = constant**		**(3)** **One-earner** (from Table 5.6)		**(4)** **Two-earner** (from Table 5.6)	
	Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Log(w_m)	0.858	22.87***	0.530	7.90***	0.278	3.63***	0.714	27.18***
Log(w_f)	-0.605	-20.42***	-0.276	-7.70***	-0.031	-0.30	-0.742	-28.11***
Log(y_u+1)	-0.076	-9.94***	-0.019	-2.40**	-0.040	-3.28***	0.006	0.95
Log(#-children 0/2+1)	0.297	6.07***	0.119	2.39**	-0.106	-1.79*	-0.004	-0.09
Log(#-children 3/4+1)	0.276	5.51***	0.212	2.60**	0.036	0.57	-0.009	-0.22
Log(#-children 5/11+1)	0.136	4.79***	0.015	0.48	-0.098	-2.33**	0.007	0.30
Log(#-children 12/15+1)	0.120	3.63***	-0.011	-0.39	-0.110	-2.17**	-0.008	-0.28
Log(#-children >15+1)	-0.032	-0.56	-0.033	-0.59	0.032	0.43	0.002	0.04
Log(age_m)	-0.054	-0.69	0.109	1.14	0.240	1.76*	-0.008	-0.12
Log(age_f)	0.090	1.14	-0.161	-1.45	-0.342	-2.07**	0.011	0.15
π	0.722		0.633		0.468		0.532	
N	1496		1758		262		1496	
Log-Likelihood	22737.771		26620.161		4046.150		31487.118	

Note: * significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

When we estimate the model for all households under the assumption that jh_f = constant, we find that the estimates are between those obtained for two-earner households, where $\widetilde{jh}_f$ = constant, i.e. (1), and those obtained for one-earner households, where $jh_f = 0$, i.e (3). Therefore, we conclude that one-earner and two-earner households are distinct groups with their own set of preference parameters and their own set of utility weight parameters.

When we estimate the model where $\widetilde{jh}_f$ is considered as a constant for two-earner households, i.e. (1), we find that the utility weight distribution depends on the wage rate of both spouses. Compared with the estimates for two-earner households in Table 5.6, we find that the wage rate of men becomes somewhat more important, while we find the opposite for the wage rate of women. For the unearned income we now find a small but negative effect on the utility weight distribution.

The most important change in the estimation results is caused by the presence of children in the household. While we found no effect for two-earner households in Table 5.6, and found that the presence of children was to the advantage of women for one-earner households, we find in (1) that the presence of children is to the advantage of men.

An explanation is that the women in two-earner households are, in general, also the main child care providers in the household. In this case, women are responsible for earning a substantial share in the household income, and the presence of (more) children increases the burden on these working women. Hence, although this situation can be beneficial for the entire household, it is not necessarily beneficial for the woman.

5.6 Labor Supply Effects

The amount of labor supply for the woman is not necessarily the optimal amount of labor supply if we consider the labor supply of the woman as a constant. In this case, it is interesting to calculate $\frac{\partial U_h}{\partial jh_f}$ so that we can examine how an additional hour of female labor supply would influence the household utility.

Using the appropriate household utility function for both household types, we determine $\frac{\partial U_h}{\partial jh_f}$ and by substituting all the relevant parameter estimates and household characteristics, we may then assess the value of $\frac{\partial U_h}{\partial jh_f}$. We will denote this value by τ_h, and are particularly interested in the sign of that magnitude.

For women of one-earner households this variable τ represents the marginal non-zero utility of working for the household. When we find that $\tau_h < 0$, this means that an increase of the number of paid labor hours of the female, i.e. the female starts working, leads to a decrease of the household utility level. When we find that $\tau_h > 0$ this means that an increase

of paid labor hours leads to an increase of the household utility level. In the latter case it would be beneficial for the household if the woman were to work a positive number of paid labor hours. In a similar way, we can define $\frac{\partial U_f}{\partial jh_f}=\tau_f$ and $\frac{\partial U_m}{\partial jh_f}=\tau_m$. The variables τ_f and τ_m represent the effect that an increase of the paid labor hours of the woman has on the utility of, respectively, the female and the male.

If we assume for two-earner households that the amount of labor supply for the woman is not necessarily the optimal amount of labor supply then we can calculate the values τ_h, τ_m and τ_f in a similar way. For these two-earner households the variable τ represents the marginal utility when the woman works slightly more labor hours than she currently does. The interpretation of the signs of τ is similar for one- and two earner households.

It should be noted that the τ variables are ordinal variables. The sign of τ is interpretable, but the absolute value is not interpretable without making further assumptions. So we do not know whether the difference between τ =2 and $\tau = 3$ is large or non-significant in terms of a deviation from the equilibrium. However, we do know that the amount of labor is optimally chosen whenever we find that $\tau = 0$. In Table 5.9, we find that the calculated average values of τ are all significantly different from zero.

Table 5.9: **The Marginal Utility of Labor**

	One-earner	**Two-earner**
τ_h	+	+
τ_m	−	+
τ_f	+	+

Note: All estimates are significantly different from zero at the 1% level.

The average values of the τ variables are significant and positive for two-earner households. An increase of the woman's labor hours would therefore be beneficial for the man, the woman, and the household. This is an interesting result as a marginal increase in the woman's labor hours is a Pareto-improvement, i.e. at least one household member benefits from the marginal increase, while no household member is worse-off.

For one-earner households we find that an increase of the number of paid labor hours of the female, i.e. the female starts working, leads to a increase of the household utility level and

her own utility level, but it will negatively affect the utility level of the man. Interestingly, we observe that the observed labor supply of women is Pareto-efficient, although the woman herself benefits from working.

5.7 Conclusion

In this chapter, we have extended the model developed in Chapter 3, and take into account that the woman does not participate in paid labor. For this purpose we use the BHPS data.

We estimated the PGVCM separately for one- and two-earner households. While we described the behavior of two-earner households as if the spouses maximize a household utility function, we described the behavior of one-earner households as if the spouses maximize a household utility function conditional on the zero job-hour choice of the woman.

We find that leisure and household income are the most important variables in the individual utility functions. The non-participating women value leisure somewhat less and household income somewhat more than the women in two-earner households do. The same holds for the total amount of household production and this is because there are, on average, more children present in one-earner households than in two-earner households. Men in one-earner households find leisure much more important than men in two-earner households do, and value the household income negatively in the utility function. The latter effect is the opposite of what we found for men in two-earner households. The differences between one-earner and two-earner households may reflect the specialization behavior of the spouses.

With respect to the utility weight distribution, we find that the utility function of non-participating women is weighted more in the household utility function than that of men, while we find the opposite for two-earner households. An increase of a person's wage rate implies that this person's utility function is weighted more in the household utility function, but only if this person is participating in paid labor. For the non-participating woman, we observe that the presence of children improves her bargaining position but her wage rate, which is her potential wage rate that she can earn when she works, is not significant. It seems that women obtain their bargaining power through their wages when they perform paid labor, and through their children when they decide not to work.

We then describe the behavior of two-earner families as if the spouses maximize a household utility function, conditional on the zero job-hour choice of the woman. In this alternative model, the labor supply of the woman may be non-optimal, as was the case for one-earner households. On the basis of the estimation results we conclude that one-earner and two-earner households are distinct groups with their own set of preference parameters and their

own set of utility weight parameters.

For two-earner households the men's preference parameters for the alternative estimation model remain rather similar to the earlier two-earner estimates. For women, on the other hand, we observe a shift in the preference parameters, where the household income is valued more and leisure is valued less compared with the two-earner estimates obtained earlier.

Concerning the utility weight distribution, the most important change is caused by the presence of children in the household. While we found no effect for two-earner households, and found a child effect to the advantage of the woman for one-earner households, we found in the alternative model that the child effect is to the advantage of the man. An explanation is that the women in two-earner households are, in general, also the main child care providers in the household. In this case, women are responsible for earning a substantial share of the household income, and the presence of (more) children increases the burden on these working women. Although this situation can be beneficial for the entire household, it is not necessarily beneficial for the woman.

Finally, we evaluated how an additional hour of female labor supply would influence the utility level of the household, the man and the woman, when we assume that the labor supply of women may be non-optimal. We note that the labor supply of women may be non-optimal for both one-earner and two-earner households according to the alternative definition. For two-earner households we find that an increase of the woman's labor hours would be a Pareto improvement because it would benefit the man, the woman, and consequently the entire household.

For one-earner households, we find that the household utility and the utility level of the woman would increase if the woman decides to supply a positive amount of paid labor. This increase in labor supply would lower the utility level of the man, and this is interesting because it means that the zero job-hour choice of the woman is actually Pareto-efficient, even though the woman herself would benefit from a positive supply of paid labor.

Appendix 5.A

This Appendix shows the system of first order conditions, where the system is written in a way that each preference parameter in each equation had its own coefficient:

$$\begin{aligned}
\frac{\partial U_h}{\partial le_m} &= \pi[\alpha_{m,1}x_{1,m,1} + \alpha_{m,4}x_{1,m,4} + \alpha_{m,5}x_{1,m,5}] + (1-\pi)[\alpha_{f,4}x_{1,f,4}] \\
\frac{\partial U_h}{\partial wh_m} &= \pi[\alpha_{m,2}x_{2,m,2} + \alpha_{m,3}x_{2,m,3} + \alpha_{m,3I}x_{2,m,3I} + \alpha_{m,4}x_{2,m,4} + \alpha_{m,5}x_{2,m,5}] \\
&\quad + (1-\pi)[\alpha_{f,3}x_{2,f,3} + \alpha_{f,3I}x_{2,f,3I} + \alpha_{f,4}x_{2,f,4}] \\
\frac{\partial U_h}{\partial le_f} &= \pi\alpha_{m,4}x_{3,m,4} + (1-\pi)[\alpha_{f,1}x_{3,f,1} - \alpha_{f,4}x_{3,f,4} - \alpha_{f,5}x_{3,f,5}] \\
\frac{\partial U_h}{\partial wh_f} &= \pi[\alpha_{m,3}x_{4,m,3} + \alpha_{m,3I}x_{4,m,3I} + \alpha_{m,4}x_{4,m,4}] \\
&\quad + (1-\pi)[\alpha_{f,2}x_{4,f,2} + \alpha_{f,3}x_{4,f,3} + \alpha_{f,3I}x_{4,f,3I} + \alpha_{f,4}x_{4,f,4} + \alpha_{f,5}x_{4,f,5}]
\end{aligned} \tag{5.35}$$

Appendix 5.B

We estimate the probability that a woman participates in paid labor based on characteristics that influence the hourly wage rate (i.e. equation 5.37). On the basis of these estimates we obtain the inverse Mills ratio and include this variable in the wage regression. The inverse mills ratio corrects for the fact that we do not observe the wage rate for the non-participating women, a wage rate that is on average upwards-biased due to a censored dependent variable.

More formally the estimation model is

$$log(w) = V'\upsilon + \eta_1 \tag{5.36}$$

A person is in the labor force if:

$$S'\theta + \eta_2 > 0 \tag{5.37}$$

Furthermore, it is assumed that

$$\begin{aligned}
&\eta_1 \sim N(0, \sigma) \\
&\eta_2 \sim N(0, 1) \\
&corr(\eta_1, \eta_2) = \rho
\end{aligned} \tag{5.38}$$

The explanatory variables that are in the wage regression are represented by V. The variables that determine whether a woman is selection in paid labor is represented by S. The identification in this study relies exclusively on the model and the normality assumption concerning the two error terms being correct. Therefore, the explanatory variables that appear in V also appear in S.[7] The characteristics that are used as explanatory variables are age, the number of children between certain age levels and the education level. For all variables we took the logarithm and added one when necessary.

The estimation results of equation (5.36) and (5.37) are shown in Table 5.10.

[7]We used information on whether there has been change in marital status over the past 4 years, but this variable did not significantly enter the selection equation.

Table 5.10: **Heckman Selection Model**

Estimates of the Selection Equation		
	Estimate	t-value
Log(#-children 0/2+1)	-1.238***	-7.94
Log(#-children 3/4+1)	-1.014***	-6.61
Log(#-children 5/11+1)	-0.659***	-7.09
Log(#-children 12/15+1)	-0.116	-0.88
Log(#-children >15+1)	0.253	-1.01
Log(education level)	0.424***	6.21
Log(age level)	0.160	-0.94
constant	-1.064**	2.55
Estimates of the Wage Equation		
	Estimate	t-value
Log(#-children 0/2+1)	-0.056	-0.41
Log(#-children 3/4+1)	0.077	0.63
Log(#-children 5/11+1)	-0.046	-0.68
Log(#-children 12/15+1)	-0.082**	-2.23
Log(#-children >15+1)	0.003	0.04
Log(education level)	0.362***	8.45
Log(age level)	0.277***	6.22
constant	0.299*	1.72
mills ratio	0.325	1.15
N	3486	
Censored observations	262	
Uncensored observations	1496	
Wald chi2(16)	454.48	

Note: * significant at the 10% level, ** significant at the 5 % level, *** significant at the 1 % level.

The probability that a woman will work is increasing in her education level and decreasing

in the number of children, which is as expected. The wage rate of two earner households are mainly influenced by age and education level. Also having children between 12 and 15 years old explains some of the variation in $\log w_f$, but this effect is small compared to the other effects that are found. The Inverse Mills ratio that corrects for selection is not significant.

On the basis of the wage equation estimates we can make an out-of-sample prediction and obtain $E(w_i|\text{not-working})$.

Chapter 6

Intra-Household Work Timing: The Effect on Joint Activities and the Demand for Child Care[1]

6.1 Introduction

Economic models of labor supply generally distinguish between two effects that labor supply may have on a person's utility: a negative effect as the working effort reduces utility, and a positive effect since paid work generates income that enables consumption. Studies that examine these effects for dual-earner households usually focus on how spouses choose the optimal amount of labor, while the timing of these labor hours is often not taken into account.

Over the past 40 years there has been an enormous increase in female labor participation in Europe, and this has resulted in more dual-earner households over time. For the Netherlands, for example, the labor force participation rate for women as a percentage of the population of women aged between 15 and 64 increased from 26 percent in 1960 to 71 percent in 2007. A similar increase could also be observed in other European countries.[2] As a consequence, work timing between spouses is of more importance now than in the past. The argument for this is straightforward: the presence of two job schedules makes coordination of family time more difficult than in a traditional one-breadwinner household. Therefore, spouses of contemporary couples in Europe face two potentially conflicting work schedules

[1] In this chapter we mention the results of Carriero, Ghysels and Van Klaveren (2009). Furthermore, we would like to thank Carlijn Kamphuis of the Social and Cultural Planning Office of the Netherlands, who provided representative data for the Netherlands on work times, specifically for men and women.

[2] Statistics on the increase in female labor participation can be found in, among others, OECD Employment Outlook (2007) and Kaiser (2006).

when figuring out how to allocate their time over a week.

In this chapter we examine how the spouses of Dutch dual-earner households time their work hours. This is an intriguing question because, first of all, heterogeneity between spouses and between households in working schedule arrangements and restrictions in choosing the optimal work schedule are normally not part of the traditional time allocation model. As a result, neglecting the work timing behavior of the spouses may cause biased estimates of the (economic) incentives for labor supply and when it is performed (Hallberg (2003)). Second, parents who have more control of their work times may have different public child care demands. The latter is important for policy that is related to child care subsidy and female labor participation.

We consider the timing of work hours as an act that leads to hours of paid work performed by both spouses at the time, the joint nature of which cannot be explained by factors other than the partners' potential to communicate on the timing of their paid work. The timing of work hours is measured by the hours that spouses simultaneously work per week. We refer to this as the 'overlap in paid working hours', or ,in short, work time overlap (WTO).

Different behavioral arguments can underlie the observed WTO of spouses, and we illustrate two of them by using the notion that the spouses of a dual-earner household have in fact one joint work schedule. According to this work schedule, we can distinguish three situations: (1) both spouses are at work; (2) one of the two spouses is at work; and (3) none of the spouses are at work. When spouses have a preference for togetherness, they can decide to maximize the hours that they are both at work at the same time as this maximizes the potential for joint leisure time. Parents, on the other hand, may want to minimize the cost of paid child care or may prefer parental care to non-parental care. These parents maximize the hours that one of the parents is at work (i.e. situation 2) as this maximizes the potential time that one of the parents can care for their child.

How far WTO is the result of timing behavior is difficult to analyze, because it is hard to disentangle which part of the observed WTO is caused by the (non-observed) timing behavior of the spouses, and which part is caused by the fact that persons with certain characteristics end up in certain jobs with associated working times. The ideal setting for measuring work timing is one where we examine the WTO of two random samples, say sample I and II. The spouses in both samples are, on average, identical in their characteristics, with this difference: that the spouses in sample I cannot time their working hours, while the spouses in sample II can time their working hours. An estimate that measures the average amount of work timing is obtained by comparing the average WTO between the two samples. Given this setting, it would be possible to examine how the work timing measure varies for different

household types.

In practice, we can observe spouses who possibly time their work hours but we do not observe a control group where the possibility of work timing is ruled out. The nature of this problem relates to the potential outcome model (see (Splawa)-Neyman, J. (1923, 1990), Roy (1951), Rubin (1974), Rubin (1976) and Holland (1986)). According to this model, we would observe two potential outcomes for each household. The first outcome relates to the situation where spouses can time their paid working hours, and the second outcome relates to the situation where spouses cannot time their working hours. However, we can never observe both outcomes at the same time.[3]

Studies by Hamermesh (1996, 2000), Hallberg (2003), Jenkins and Osberg (2005), recognize this problem.[4] In both studies a control group is simulated where the possibility of work timing is ruled out. This control group consists of matched singles with characteristics similar to that of the spouses. The underlying thought is that, although the matched singles have similar characteristics than the spouses, they cannot interact, so that no timing behavior can take place. When Hallberg (2003) and Jenkins and Osberg (2005) compare the WTO of the spouses with that of the control group, a small but significant difference is found. This means that there is empirical evidence for work timing but that the effect that is found is small.

The drawbacks of using a singles sample for the construction of a control group are that: (1) singles are differently constrained and may have different preferences from non-singles. When comparing working time hours, it seems difficult to justify that singles with children are comparable to non-singles with children; and (2) there may be selection into marriage so that the probability of two persons becoming a couple increases when there is more WTO. In this case observing more WTO can be the result of marriage as such, rather than work timing. Because of these drawbacks, the work timing estimates of Hallberg (2003) and Jenkins and Osberg (2005) may be biased and consequently it is not clear whether their findings can be ascribed to work *timing* or if there are other factors involved.

The first contribution of this chapter is that we propose an alternative simulation method to distinguish between the work timing behavior of the spouses and the overlap in work times caused by the fact that persons with certain characteristics end up in certain jobs. Because we do not use information on singles we overcome the above-mentioned problems. We simulate how the amount of WTO would vary if spouses did not have the possibility to time their work hours and identify the amount of WTO that is the result of work timing.

[3]The outcome that is not observed is usually referred to as the counterfactual outcome.

[4]Other interesting studies that discuss the timing of work hours are Sullivan (1996) and Van Velzen (2001).

In this simulation we match couples to other identical couples in the sample and then the couples that are matched switch partners. The average WTO of the couples that remain after the partner switch can be regarded as the control situation where spouses have similar characteristic but cannot time their work hours. Comparing this control outcome with the observed WTO of the spouses provides us with a work timing estimate.[5]

The second contribution of this chapter is that we examine how the work timing estimate relates to the demand for child care and relates to the time that spouses spend jointly on other activities, such as, leisure, housework and, if applicable, child care.

The relation between the timing of work and the demand for child care is interesting as it may shed some light on how spouses decide on their labor supply, taking into account the timing possibilities they have and the current state of child care services and costs. Although the relation between labor supply and child care is discussed in many studies (see, among others, Becker and Lewis (1973), Maassen van den Brink (1994), Hamermesh (2000), Hallberg and Klevmarken (2003), Del-Boca and Vuri (2005)), the focus of these studies is mainly on the quantity of labor supply instead of the timing behavior. We may find, for example, that parents who create more WTO also demand less child care, which means that parents can avoid expensive child care costs by the timing of their work schedules or that parents have a preference for parental child care. Finding a correlation between the work timing estimate and the demand for child care is interesting from a policy perspective: more flexible working times could become one of the ingredients of a policy mix such that the focus is more on the work-family balance. Finding this balance is now often difficult for spouses in dual-earner households because labor market rigidities restrict them in the timing of their working hours (Carriero et al. (2009)).

The work timing behavior of spouses may relate to the time that spouses spend jointly on leisure, housework, and child care. The intuition is that when spouses create more WTO, they create potentially more time to perform other activities together. In van Velzen (2001), Hallberg (2003), Jenkins and Osberg (2005) and Van Klaveren and Maassen van den Brink (2007), there is empirical evidence that spouses have a preference for togetherness. Timing behavior may also relate to the time that spouses jointly spend on housework and child care but these relations have been little investigated in labor economics and sociology.

The outline of this chapter is a follows. In Section 6.2, the data are described. In Section 6.3, we illustrate the procedure that is used to simulate the control group and discuss the simulation results. In Section 6.4, we examine how work timing relates to the demand for child care and the time that spouses jointly spend on leisure, housework and child care. In

[5]In Van Klaveren and Maassen van den Brink (2007), we find a small work timing effect using this methodology.

Section 6.5, we summarize the results of a study by Carriero et al. (2009). In this study the authors study the work timing behavior of parents in Belgium, Italy and the Netherlands. Section 6.6 concludes.

6.2 Data

For this study we had the opportunity to ask several questions in the Post Initial Schooling Survey. The data set was collected in December 2005 by the Dutch Institute for Public Opinion and Market Research (TNS NIPO) and is a cross-section of the Dutch population aged from 16 to 64.

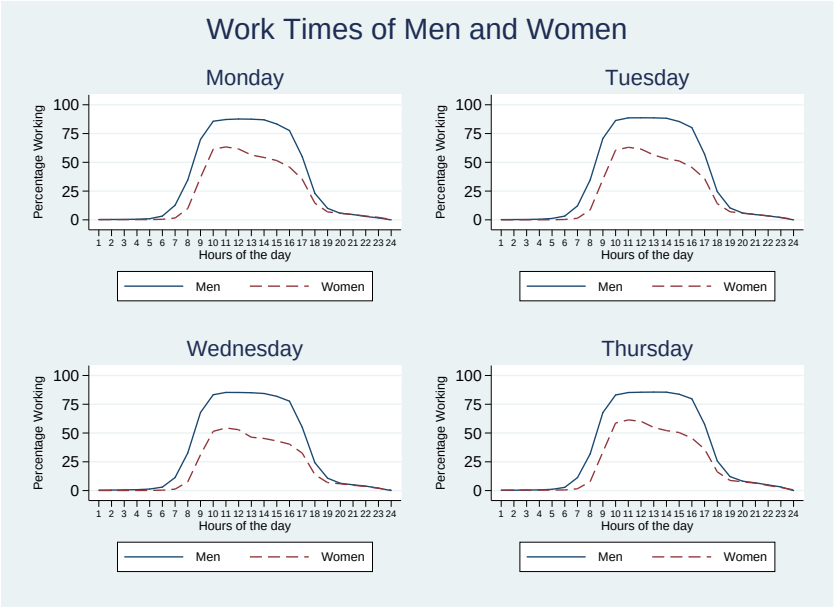
Various questions were asked in order to obtain accurate work timing information. Control questions were included, in order to minimize the effort required from parents to fill in their work schedules. For example, parents were asked (1) on which day of the week they usually work; and (2) whether they work during the same hours each day. If a spouse answered the second question affirmatively, then he or she had to fill in the working times for only one of the days he or she works. On the other hand, if a spouse did not answer the second question affirmatively, then he or she had to fill in the working times for each day of the week they usually work. This information suffices to determine when and how many hours both spouses work.

For this study we use data on 1830 two-earner households. For both spouses there is information available on when they work during the week, but it is possible that one of the spouses answered on behalf of the partner.

In Figure 6.1 we show during which hours the men and the women in our sample work. The horizontal axis represents the 24 hours of the day, while the vertical axis represents the percentage of men and women who work during these hours. Men are represented by a straight line, while women are represented by a dotted line.

Although most men work between 8 am and 5 pm, the labor activity of men starts around 6 am and finishes approximately around 7 pm. Most women work between 10 am and 5 pm and we observe a peak between 10 am and 12 noon. The labor activity of women starts somewhat later than men (around 7 am) and ends somewhat earlier than men (around 6 pm). As was to be expected, spouses usually do not work on a Saturday or a Sunday. These graphs confirm the patterns that are generally found for the Netherlands (see Breedveld, van den Broek, de Haan, Harms, Huysmans and van Ingen (2006) and the time use study of 2005 performed by the Social and Cultural Planning Office of the Netherlands (*in Dutch* :

het SCP Tijdsbestedingsonderzoek, 2005)).[6]



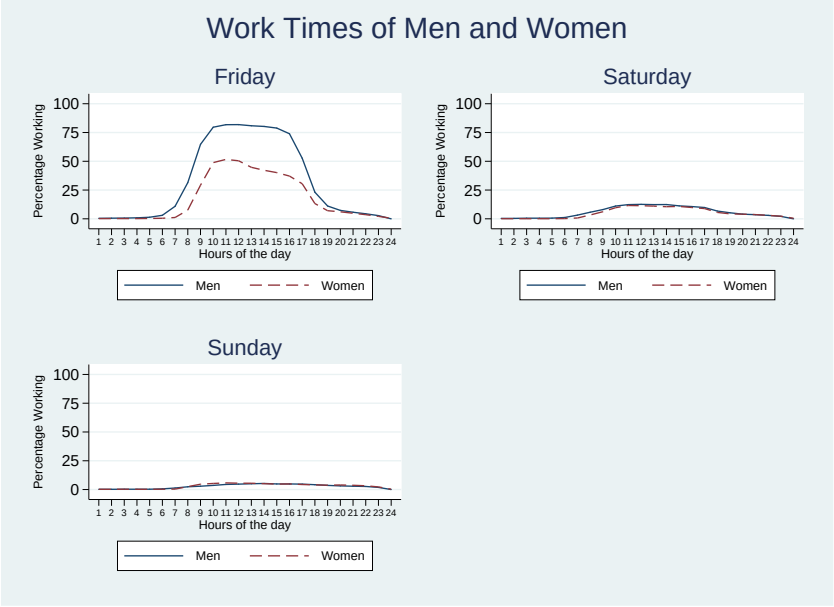


Figure 6.1: When do men and women work during the day?

[6]We would like to thank Carlijn Kamphuis of the Social and Cultural Planning Office of the Netherlands, who provided representative data for the Netherlands on work times for men and women.

Information regarding the working days and the working hours of spouses is shown in Table 6.1. Men usually work 4 or 5 days per week and about 83 percent of them work 5 days per week or more. Women are part-time workers since about 65 percent of the females work 4 days per week or less. On average, men work more labor hours (44.2 hours per week) compared with women (27.14 hours) as is generally found for the Netherlands.

Table 6.1: **Descriptive Statistics Working Days & Working Hours**

	Men		**Women**	
	Freq.	**%**	**Freq.**	**%**
# working days				
1	12	0.66	48	2.62
2	11	0.60	231	12.62
3	42	2.30	512	27.98
4	247	13.50	425	23.22
5	1,323	72.30	530	28.96
6	134	7.32	39	2.13
7	61	3.33	45	2.46
Total	1830	100	1830	100
Average labor hours	44.21		27.14	
St. Dev. of labor hours	11.44		13.44	

To find out if spouses are able to time their work schedules, we asked them if they can influence the time they start or end working. The descriptive statistics of their answers are printed in Table 6.2. 38 percent of the men and 43 percent of the women report that it is not possible or difficult, to influence their work timing substantially. For these persons we cannot distinguish between spouses for whom work timing is very difficult or for whom work timing is not even possible. On the other hand, 62 percent of the men and 57 percent of the women answer that they can time their work hours to a considerable extent. This means that these persons have the opportunity to time their work hours according to their preferences.

Table 6.2: **Flexibility in Work Times**

	Freq.	%
Men		
Not at all/very difficult	690	37.70
Within boundaries but I have to report it in advance	397	21.69
Within boundaries but I don't have to report it in advance	386	21.09
I can determine (almost) fully when I work during the day	357	19.51
Total	1830	100
Women		
Not at all/very difficult	791	43.22
Within boundaries but I have to report it in advance	512	27.98
Within boundaries but I don't have to report it in advance	279	15.25
I can determine (almost) fully when I work during the day	248	13.55
Total	1830	100

In Table 6.3 we show the respondents' answers on whether they found their current job before or after they started living together. This question was asked because persons have the opportunity to switch to jobs with more favorable work times, and this can be considered as work timing as well. If the spouses answered that they found their current job before they started living together, then more favorable work times have not been realized by means of a job switch. It is possible that these persons were able to realize more favorable working times at their current employer, and this may even be one of the reasons why they are still in their current job. However, on average, we would expect that in the latter case work time adjustments are more difficult as an agreement has to be reached with the employer. In our sample, approximately 42 percent of the men and 31 percent of the women were in their current jobs before they started living together, and so these persons did not time their work schedules by switching jobs. The work timing is therefore solely dependent on the extent to which they can influence the daily starting/ending times of their job.

Table 6.3: **Current job was obtained before living together**

	Men		**Women**	
	Freq.	**%**	**Freq.**	**%**
True	759	41.48	559	30.55
Not true	895	48.91	1095	59.84
Non-response	176	9.62	176	9.62
Total	1830	100	1830	100

Work timing is measured by the amount of paid labor hours hours that the spouses simultaneously work per week. In Table 6.4, we show the OLS estimation results, where we have regressed the WTO of spouses on variables that are thought to have a significant influence on this WTO.[7] In order to have an idea of the magnitude of the effects, we report the average amount of WTO.

We emphasize that the obtained estimates give an impression of how the amount of WTO varies over the different household types in the sample. They do not necessarily reflect how spouses time their work schedules because the significance of certain characteristics may also arise from the fact that there is selection into job types. For example, higher educated persons are more likely to self-select a full-time job, and as a consequence we find that the level of education is positively related to WTO. However, in this case the observed relation can not be ascribed to the timing of work schedules.

[7]For presentational convenience, we do not show the estimates of 12 dummies that indicate on which days the spouses work. The full estimation results are available on request.

Table 6.4: **Work Time Overlap Regression**

	Estimate	t-statistic
Household Characteristics		
# Children between 0-4	-1.844***	-4.69
# Children between 4-12	-1.709***	-7.11
# Children between 12 plus	-0.425*	-1.65
Spouses met each other at work (N=219)‡	1.019	1.61
Spouses met at a club (N=173)‡	-0.014	-0.02
Spouses met each other through friends (N=317)‡	0.898	1.61
Spouses met each other by the internet (N=102)‡	-0.303	-0.34
Spouses met each other somewhere else (N=446)‡	0.572	1.13
Men's Characteristics		
Weekly work hours	0.177***	8.86
Timing of current job and living together†	0.304	0.76
Education level	0.291**	2.23
Flexible work times	0.908***	5.27
Women's Characteristics		
Weekly work hours	0.603***	32.70
Timing of current job and living together†	0.320	0.75
Education level	0.539***	3.87
Flexible work times	0.400**	2.23
Control†	2.326**	2.31
Constant	-25.412***	-15.79
Set of work day dummies (– *results suppressed*–)		
Adjusted R^2	0.687	
N	1830	
$\overline{WTO}$	20.60	

Note: * significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level. †the relation between the start of the current job and the moment spouses started living together contains 179 missing values that are replaced to -1. To control for these missing values, we included a dummy variable, *control*, that is 1 for each -1-value and zero otherwise. ‡The reference group are partners who have met each other at places of entertainment (N=573).

The amount of WTO is lower when spouses have children and this effect is stronger the younger the children. Although parents may prefer to maximize the time that they themselves can take care of their children, it may also reflect the fact that women usually choose to work less hours when children are born. The latter reflects work timing by the job-hour choice, and this is not the effect we are interested in. The observation that WTO is lower when spouses have children is also found by Hamermesh (2000), Hallberg (2003), van Velzen (2001) and Van Klaveren and Maassen van den Brink (2007).

There may be selection into marriage, and therefore the probability of two persons becoming a couple increases when there is more WTO. As a consequence the 'realization' of a couple is caused by the fact that there is more overlap in work times in the first place. Therefore, we asked the spouses in our sample where they met each other, so that we can empirically test if there is a positive correlation between the place where partners meet and the amount of WTO. We find that the meeting place is not significantly correlated with the amount of WTO and so the variation in WTO, is not influenced by the selection into marriage.

Necessarily, the amount of WTO is significantly influenced by the working hours of both spouses. On the one hand, the maximum amount of WTO is determined by the spouse who works the smallest amount of labor hours. On the other hand, the probability of observing more WTO increases when the amount of working hours of the spouse who works the most is higher.

The education variables represent the highest attained education level of the spouses, and this level is measured on a scale from 1 to 7. The lowest education level represents primary education and the highest education level represents having a university degree. When spouses are higher educated they tend to have more WTO.

A large proportion of men and women found their current job before they started living together and, as we argued earlier, it is possible that these persons have less possibility to switch to jobs with more favorable work times. We find that when partners start living together does not influence the amount of WTO.

As was to be expected, we find that if spouses can influence when they start or end working, this is significantly and positively correlated with WTO.

6.3 Matching Procedure and Estimation Results

6.3.1 Matching Procedure

To obtain an estimate of work timing, it would be desirable to compare the WTO of the couples in our sample with the WTO of a control group of couples. Both the spouses and the control group should have similar characteristics, but while the spouses in our sample have the possibility to interact, this interaction should be ruled out for the control group.

In Van Klaveren and Maassen van den Brink (2007), this control group was simulated by using an exact matching strategy that matches households to other households. The problem of using an exact matching strategy is that the probability of finding an exact match decreases with the number of matching characteristics. Moreover, it is not possible to use continuous variables as matching variables as the probability of finding an exact match drops dramatically. As a result, it is less likely that a match can be found for households with unusual characteristics and the estimate that is obtained is then more similar to a regression-towards-the-mean-estimate. In this chapter, we therefore use a different matching technique than in our former research.

We start by matching each household in the sample to the best look-alike household in the sample, and this matching strategy is usually referred to as Nearest Neighbor Matching. In order to do so we use a distance measure that is referred to as the Mahalanobis distance. This distance measure is used to determine the distance from one household to another household and is based on certain matching characteristics (X) that are thought to influence that amount of WTO. The Mahalanobis distance measures the distance between the households, correcting for the statistical variation in the X-variables. We impose a matching rule that minimizes this distance between households. More formally, household i can be matched to another household j, in a sample with N households, according to the following rule:

$$M(i,j) = 1 \; if \; j = \arg \min_{j=1,\ldots,N^{-i}} (X_i - X_j)' \Sigma^{-1} (X_i - X_j),$$

where $M = 1$ if a match is possible, and where N^{-i} stands for the sample N with the exception of couple i. It can happen that household i is matched to more than one household and in this case we randomly pick a household from the group of potential matches. An advantage of the Mahalanobis distance is that it is non-parametric and consequently does not rely on any functional form or distribution.

The WTO of the control group is obtained as follows. Couples are matched with other identical couples in the sample based on the Mahalanobis distance measure and then the

couples that are matched switch partners. The average WTO of the couples that remain after the partner switch is regarded as the control outcome. We will refer to this outcome as WTO_c.

Let us define an indicator variable, I, that equals 1 if spouses can interact, and 0 otherwise. The WTO when the spouses do not interact is approximated by the WTO of the control group, WTO_c, such that we have:

$$\Delta = E(WTO|X, I = 1) - E(WTO_c|X_c, I = 0). \tag{6.1}$$

By construction, the spouses of the control group couples cannot interact, so that $I = 0$. The work timing estimate is represented in Equation (6.1) by Δ, under the assumption that differences in WTO cannot be attributed to the differences in individual and household characteristics between the couples and the matched couples.

6.3.2 Matching Results

The matching variables that enter the WTO regression significantly in Table 6.4 are used as matching variables. In Table 6.5, we show the descriptive statistics of the matching variables for the couples and the matched control couples selected by the Nearest Neighbor Matching method, i.e. the matched couples. The last column represents the difference of the means of these variables.[8]

[8] Again, we do not mention the 14 work day dummies as they are not significantly different, and presenting them in Table 6.5 would make the the table more difficult to read.

Table 6.5: **Descriptive statistics for couples and matched couples**

	Couples		Matched Couples		
	Mean$_1$	**Std.Dev.**	**Mean$_2$**	**Std.Dev.**	**Mean$_1$-Mean$_2$**
Household Characteristics					
# Children between 0-4	0.23	0.52	0.23	0.53	0.00
# Children between 4-12	0.51	0.83	0.50	0.82	0.01
# Children between 12 plus	0.41	0.79	0.38	0.76	0.03
work time overlap	20.60	13.91	20.90	14.22	-0.30
Men's Characteristics					
Weekly work hours	48.84	12.52	49.32	12.58	-0.48
Education level	3.04	1.64	3.03	1.64	0.01
Flexible work times	2.22	1.15	2.22	1.16	0.00
Women's Characteristics					
Weekly work hours	29.56	14.58	29.77	14.52	-0.21
Education level	3.16	1.54	3.12	1.52	0.04
Flexible work times	1.99	1.06	1.92	1.04	0.07***
N	1830		1830		

Note: * significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

The matching variables do not differ significantly between the couples and the matched couples, with the exception of the variable flexible work times of women. Although, the latter is significant, the difference is small. We also test whether the amount of WTO differs between the couples and the matched couples and we find that this is not the case. Obviously the amount of WTO was not included as a matching variable, since this is an outcome variable.

We conclude the match was successful, in the sense that the matched couples are good look-alike couples and that differences in WTO cannot be attributed to differences in individual and household characteristics.

Do couples time their work hours?

A work timing estimate is obtained by comparing the WTO of the couples with the WTO_c of the control couples. It may be that some couples minimize the amount of WTO, while other couples maximize this amount of WTO, and therefore we will examine the work timing estimate for different household types.

We first perform a regression where WTO and WTO_c are separately regressed on a set of dummies, that characterize the household. These household characteristics concern the presence of children of certain age levels, the education level of both spouses, the (gross) level of household income, and whether spouses have control over their own working times. The estimation results are shown in Table 6.6.

The first and second columns of Table 6.6 represent the household type that is considered. The third column shows the number of these household types in the sample. The fourth and fifth columns show the values of the predicted WTO and WTO_c. The sixth column represents the work timing estimates for the different household types. This work timing estimate is referred to as Δ, as in equation (6.2), and this is the variable of interest. We refer to work timing resulting in a positive (negative) estimate of Δ as couples who create more (less) WTO. All effects are measured in hours per week unless mentioned otherwise.

We find that couples create less WTO when there is a child present in the household, and this effect is more pronounced with younger children. Childless couples create on average 5 hours more WTO compared with parents of a child aged between 0 and 4. As children become older this effect diminishes.

Spouses without children create 2.25 hours more WTO, and these hours can be potentially used to spend more time on another joint activity, such as leisure. Parents, on the other hand, create less WTO. For parents with a child aged between 0 and 4, we find that they create 2.75 hours less WTO. Parents with a child aged between 5 and 12 or aged 12 years and older create -2.42 and -1.26 hours less WTO, respectively. This is in line with the intuition that parents minimize the amount of WTO to minimize costs of child care or because they prefer parental care over non-parental care. In Section 6.4.2 we return to this issue in more detail.

Table 6.6: **Comparison of the WTO of couples and the Control Group**

		Obs.	WTO	WTO_c	Δ
Household					
No child		429	24.96	22.71	2.25***
Child present aged 0-4		338	15.32	18.07	-2.75***
Child present aged 4-12		592	15.92	18.34	-2.42***
Child present aged 12 plus		471	17.94	19.20	-1.26***
Gross Household income	low	424	18.98	19.67	-0.70***
	med.	701	20.22	20.47	-0.25***
	high	381	23.44	21.92	1.51***
Men					
Education level	low	450	21.14	20.71	0.43
	med.	881	20.42	20.45	-0.03
	high	499	20.43	20.72	-0.28
Flexible work times	very low	690	18.84	19.46	-0.63***
	low	397	19.69	20.37	-0.67***
	high	386	21.96	20.54	1.42***
	very high	357	23.56	23.07	0.50***
Women					
Education level	low	310	17.62	18.56	-0.93***
	med.	1029	20.01	20.28	-0.28***
	high	491	23.90	22.64	1.26***
Flexible work times	very low	791	19.20	20.17	-0.97***
	low	512	20.76	20.46	0.30***
	high	279	23.67	21.58	2.09***
	very high	248	21.30	21.07	0.23***

Note: * significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

Men's education level does not affect the work timing estimate, but the education level of the women does. Couples where the woman has a high education level create 1.26 hours more

WTO. On the contrary, couples where the woman has a medium or a low education level create less WTO. An explanation is that the couples where the woman is higher educated have, on average, less children and the household income is, on average, higher. Consequently, these couples are presumably more flexible in arranging their work times and are more interested in maximizing the overlap in work times to maximize the amount of joint leisure.

The household income represents the gross yearly income measured in euros. We distinguish three categories: (0,45000], (45000,68000] and $>$ 68000. Couples with a high (medium, low) household income create more (less) WTO. Similar to the education effect of women, it could be that higher income couples have less children, and are more interested in maximizing the overlap in work times to maximize the amount of joint leisure.[9]

Couples where men and women are more in control of their own working times create more WTO. However, this effect is not found for spouses who have full control over their own working times. An explanation is that these spouses have jobs with autonomous responsibilities and work on average more hours. These responsibilities and the number of job hours may limit these persons to time their work hours.

6.4 Work Timing, Joint Activities and Child Care Demand

Until now, we have examined whether there is work timing and how this work timing differs for different household types. There are different reasons why couples may time their working hours. When couples create more WTO, spouses can, for example, spend more time with their partner on other activities. In this section we test whether work timing behavior affects the amount of time that couples spend jointly on leisure, household tasks and child care. When couples create less WTO they can in principle spend less time together on other activities. However, parents may prefer such behavior as it increases the amount of time that one of the parents is at home taking care of the children. In this section we, therefore, test whether work timing behavior affects the demand for child care.

As in equation 6.1, the work timing estimate is represented by the difference between the WTO of the couples and that of the control group couples, i.e.

$$\Delta = WTO - WTO_c. \tag{6.2}$$

[9]The income variable contains many missing values. On account of these missing values, we replaced the records by zero, and added a dummy in the regression equation, indicating 1 when the information on household income was missing, and 0 otherwise.

6.4.1 Work timing and the Time Spent on Joint Activities

In this subsection we examine how work timing relates to the time that couples spend jointly on leisure, household tasks, and child care. We start our discussion by focusing on the relation between work timing and joint leisure.

The Effect of Work Timing on Joint Leisure

In the data there is information on the total amount of leisure (t_l) that is spent by each spouse per week, and there is information on the joint leisure that spouses spend with their partner per week ($t_{l,joint}$). For each household, we can construct a measure that represents the amount of joint leisure of the spouses as a fraction of the total amount of leisure time:

$$LTO = \frac{2 \cdot t_{l,joint}}{t_{l,male} + t_{l,female}} \tag{6.3}$$

where LTO represents a fraction and stands for the amount of leisure time overlap. The amount of joint leisure can never be more than the amount of the spouses leisure time that is lowest, i.e. $\min(t_{l,male}, t_{l,female})$. Therefore, we have multiplied the numerator by 2, such that the fraction LTO lies in the interval [0,1]. Besides the practical purpose of this multiplication, it is also intuitive as there are two spouses in the household who both enjoy the amount of joint leisure.

In Table 6.7, we present the distribution of LTO by means of a frequency table. For one of the households we did not have the appropriate information to construct LTO so there is information on 1829 households. The table can be read as follows. When we consider the first and the second columns, we find that 117 households have 10 to 20 percent LTO. From the third column we deduce that 117 households cover 6.4 percent of the households in the sample, and the fourth column indicates that 10.77 percent of the households have between 0 and 20 percent LTO.

We find that the distribution of LTO is skewed left. Although about 65 percent of the households have more than 50 percent LTO, we observe at the same time that households are well spread over the different LTO intervals.

Table 6.7: **Frequency table of Leisure Time Overlap**

% LTO	**Freq.**	**%**	**Cum. %**
0-10	80	4.37	4.37
10-20	117	6.40	10.77
20-30	104	5.69	16.46
30-40	176	9.62	26.08
40-50	169	9.24	35.32
50-60	170	9.29	44.61
60-70	181	9.90	54.51
70-80	186	10.17	64.68
80-90	275	15.04	79.72
90-100	371	20.28	100
Total	1829	100	100

We could use a linear regression model to model the relation between joint leisure and work timing. We would then regress LTO on Δ while controlling for several household characteristics. The estimation model would then look like:

$$LTO = \lambda_0 + \lambda_1 \cdot x_1 + ... + \lambda_n \cdot x_n + \delta_{LTO} \cdot \Delta + \varepsilon_{LTO} \tag{6.4}$$

where the estimation parameters are represented by λ and δ_{LTO}; x represent the n control variables; and Δ represents the work timing estimate. Since the equality in (6.4) will not hold exactly we add the usual error term $\varepsilon_{LTO} \sim N(0, \sigma_{\varepsilon_{LTO}})$. The problem that arises is that the model presented in (6.4) can predict values for LTO that are greater than 1 or smaller than 0, since the model does not 'know' that the dependent variable is a fraction with only values in the interval [0,1]. Therefore, we transform the LTO variable by using a logistic transformation and rewrite the model as:

$$\log(\frac{LTO}{1 - LTO}) = \lambda_0 + \lambda_1 \cdot x_1 + ... + \lambda_n \cdot x_n + \delta_{LTO} \cdot \Delta + \varepsilon_{LTO} \tag{6.5}$$

Because of the logistic transformation of LTO, the predicted LTO will always lie in the interval [0,1], although the model parameters can be any real number. The model is estimated using a maximum likelihood estimation procedure.

The control variables that we use in the estimation model are the following:[10]

- A dummy indicating if there are no children in the household;
- A dummy indicating if there are more than two children present in the household;
- A dummy indicating if there is a child present in the household aged between 0 and 4;
- A dummy indicating if there is a child present in the household aged between 4 and 12;
- Education level dummies for men and women, where we distinguish between a low, medium, and high education level (high is used as the reference group).

It is possible that the timing behavior of households with children is different from that of households without children. Therefore, we have interacted Δ with the dummy variable that indicates if there is a child present aged between 0 and 4, and with the dummy variable that indicates if there is a child present between 4 and 12.[11]

The estimation results are shown in Table 6.8. The amount of LTO is significantly lower when there are more than two children present in the household and when there are children present in the household aged below 12. The signs of the education levels of men are positive but insignificant. The lower woman's education level, the less joint leisure time both spouses have.

We are particularly interested in the effect of the work timing variables. We find that there is a constant work timing effect on LTO that is positive and significant. To have an idea of the impact of Δ on LTO, we simulate how increasing Δ by 1 hour affects the fraction LTO, evaluating all other variables in their sample averages. We find that the fraction LTO will increase by 0.0012 when Δ increases by 1 hour per week. When we express this number in terms of joint leisure hours it implies that couples increase the amount of joint leisure by 0.14 hours when they create 1 more hour of WTO more. We have calculated this as follows. An increase of the fraction LTO by 0.0012 means that couples spend 0.0012 percent of their total leisure time per week (L_{total} in the table) more on joint leisure. Because the sample average of the total amount of leisure equals 116.15 hours, the increase in joint leisure equals $0.0012 \cdot 116.15 = 0.14$ hours.

[10] We also included the household income, the size of the municipality, and the firm size, because we expected that these variables could be explanatory for the variation in LTO. However, it turned out that this was not the case and so we did not include these variables in the model.

[11] We have also included interaction effects with the education levels of men and women, but these interaction effects were not significant and were dropped from the model.

Table 6.8: **Leisure Time Overlap regression**

Dependent Variable: $\log(\frac{LTO}{1-LTO})$		
	Estimate	t-statistic
Control variables		
Dummy more than two children	-0.502***	-3.31
Dummy child present between 0-4	-0.295**	-2.47
Dummy child present between 4-12	-0.934***	-9.10
Male has low education level	0.169	1.26
Male has middle education level	0.067	0.59
Female has low education level	-0.334**	-2.22
Female has middle education level	-0.141	-1.27
Constant	1.210***	11.38
$\Delta\cdot$ Dummy child present 0-4	-0.041***	-3.33
$\Delta\cdot$ Dummy child present 4-12	-0.011	-1.14
Δ	0.019***	3.60
Likelihood	-3762.43	
Observations	1829	
$\overline{L}^{\dagger}_{total}$	116.15	

Note: * significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level. $^{\dagger}\overline{L}_{total}$ is the sample average of the aggregated leisure hours of men and women.

We also find that the amount of LTO is negatively and significantly influenced by Δ interacted with the dummy that indicates that there is a child present in the household aged between 0 and 3. This means that couples with a young child create less LTO by the timing of their work schedules than couples without young children. Again, we can simulate how increasing Δ by 1 hour affects LTO, conditioning on whether there is a young child present in the household or not. We find that when couples with a young child create 1 more hour of WTO this will result in -0.06 hours joint leisure. On the other hand, when couples without young children create 1 more hour of WTO, this results in 0.35 hours of joint leisure.

We conclude that the results are in line with the hypothesis that couples without (young) children increase the amount of joint leisure when they create more WTO. For couples with young children, we find a small and negative effect, meaning that they tend to reduce the amount of joint leisure by timing their work schedules. These findings are in line with the empirical findings of Hallberg (2003), Jenkins and Osberg (2005), and Van Klaveren and Maassen van den Brink (2007).

The Effect of Work Timing on Joint Housework

The relation between work timing and the joint time spend on household chores can be analyzed in a similar way as we did for joint leisure. Consequently, we do not elaborate on the estimation method in order to avoid repetition.

In the data used, there is information on the weekly joint hours that couples spend on household chores. Household chores include activities such as cooking, repairing the car, cleaning, and doing the laundry, but it does not include the household activities that are related to child care. The amount of joint housework as a fraction of the total time that both partners spend on housework is represented by:

$$HTO = \frac{2 \cdot t_{h,joint}}{t_{h,male} + t_{h,female}} \tag{6.6}$$

where HTO stands for housework time overlap; $t_{h,joint}$ is the joint time spent on housework; and $t_{h,i}$ is the amount of individual time spent on housework by $i = male, female$. In Table 6.9 we present the frequency table of HTO and the interpretation of this table is similar to that of Table 6.7. We find that the fractions of joint household time are clustered around the lower intervals. Almost 70 percent of the households in our sample spend less than 40 percent of the total housework time jointly.

Table 6.9: **Frequency table of Housework Time Overlap**

% HTO	**Freq.**	**%**	**Cum. %**
0-10	415	22.75	22.75
10-20	309	16.94	39.69
20-30	310	17.00	56.69
30-40	193	10.58	67.27
40-50	169	9.27	76.54
50-60	138	7.57	84.10
60-70	119	6.52	90.63
70-80	39	2.14	92.76
80-90	57	3.13	95.89
90-100	75	4.11	100.00
Total	1824	100	100

Performing a logistic transformation on HTO we estimate the following model:

$$\log(\frac{HTO}{1-HTO}) = \gamma_0 + \gamma_1 \cdot x_1 + ... + \gamma_n \cdot x_n + \delta_{HTO} \cdot \Delta + \varepsilon_{HTO} \tag{6.7}$$

with $\varepsilon_{HTO} \sim N(0, \sigma_{\varepsilon_{HTO}})$, where γ and δ_{HTO} are the parameters to be estimated, x represent the same n control variables that we used in (6.5); and Δ represents the work timing estimate.

We find that couples spend less joint time on household chores, the lower the woman's education level. An explanation is that women in conventional households are relatively lower educated and are mainly responsible for doing the household chores. As a consequence, the amount of joint housework time is lower. This reasoning may also explain the negative significance of the dummy that indicates that the man has a low education level. When there are children present in the household this negatively affects the amount of time that spouses spend jointly on household chores. However, only the dummy that indicates whether there are children present aged between 4 and 12 is significant.

Table 6.10: **Housework Time Overlap regression**

Dependent Variable: $\log(\frac{HTO}{1-HTO})$		
	Estimate	t-statistic
Control variables		
Dummy more than two children	-0.190	-0.88
Dummy child present between 0-4	-0.065	-0.38
Dummy child present between 4-12	-0.378***	-2.59
Male has low education level	-0.706***	-3.71
Male has middle education level	-0.108	-0.68
Female has low education level	-0.570**	-2.67
Female has middle education level	-0.282*	-1.79
Constant	-0.788***	-5.22
$\Delta\cdot$ Dummy child present 0-4	-0.019	-1.08
$\Delta\cdot$ Dummy child present 4-12	-0.032***	-2.43
Δ	0.036***	4.92
Likelihood	-4388.74	
Observations	1824	
$\overline{H}_{total}$	21.47	

Note: * significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

The effect of work timing on the joint time that spouses spend on household chores may be influenced by the presence of children in the household. Therefore we have interacted Δ with the two child dummies, as we did before. We find that there is a constant work timing effect of 0.036, and that work timing affects the amount of HTO positively and significantly. When we simulate how an increase of Δ by 1 hour affects the amount of HTO we find that the joint hours spent on household chores increases by 0.09 hours when couples create 1 hour more work time overlap.

When there are children present in the household aged between 4 and 12, this affects how work timing influences the amount of time that couples spend jointly on household

chores. When we simulate how an increase of Δ by 1 hour affects HTO, while conditioning on whether there is a young child present in the household or not, we find the following. Couples with a child between 4 and 12 spend 0.05 hours jointly on household chores when they create 1 more hour of WTO. When couples have no child between 4 and 12 and create 1 more hour of WTO they spend 0.01 joint hours more on household chores.

We conclude that the time that couples spend jointly on household chores is significantly related to how couples time their working hours, but the correlation is very small.

The Effect of Work Timing on Child Care

Finally, we examine whether work timing and joint child care are related. We again use the following measure that represents joint child care as a fraction of the total amount of child care:

$$CTO = \frac{2 \cdot t_{c,joint}}{t_{c,male} + t_{c,female}} \tag{6.8}$$

where CTO stands for child care time overlap and $t_{c,joint}$, $t_{c,male}$ and $t_{c,female}$ stand for respectively, the time that spouses jointly spend on child care and the time that each partner spends on child care in total. The frequency table of CTO is presented in Table 6.11.

Table 6.11: **Frequency table of Child care Time Overlap**

% CTO	**Freq.**	**%**	**Cum. %**
0-10	206	20.44	20.44
10-20	82	8.13	28.57
20-30	105	10.42	38.99
30-40	99	9.82	48.81
40-50	103	10.22	59.03
50-60	108	10.71	69.74
60-70	111	11.01	80.75
70-80	38	3.77	84.52
80-90	67	6.65	91.17
90-100	89	8.83	100.00
Total	1008	100	100

The number of observations necessarily drops because not all couples in our sample have

children. In Table 6.11 we do not observe a systematic pattern in how CTO is distributed. Most households answer that the amount of CTO is between 0 and 10 percent of the total amount of child care time. With the exception of the intervals 70-80 and 80-90, it seems that each of the other intervals contain about 10 percent of the households in the sample.

We estimate the following model:

$$\log(\frac{CTO}{1-CTO}) = \tau_0 + \tau_1 \cdot x_1 + ... + \tau_n \cdot x_n + \delta_{CTO} \cdot \Delta + \varepsilon_{CTO} \tag{6.9}$$

with $\varepsilon_{CTO} \sim N(0, \sigma_{\varepsilon_{CTO}})$, where τ and δ_{CTO} are the estimation parameters; x represent the same n control variables that we used before; and Δ represents the work timing estimate.

We note that only parents will appear in the estimation sample, so that having zero children is not possible. The small reference group is therefore parents who only have children older than 12 years old, and hence the result that the presence of children aged below 12 affects CTO positively seems plausible.

We do not find evidence that the timing of work hours affects the time that parents spend jointly on child care. We also estimated an alternative estimation model where we included the hours of child care that parents outsourced. These hours may affect the total amount of child care by the parents and may also affect CTO. However, the hours of child care that parents outsourced did not enter the regression model significantly.

A priori, we expected that parents with (more) young children are more likely to create less WTO, either because the have a preference for parental child care or because they want to avoid expensive child care costs. This behavior presumably leads to less CTO, because parents behave in a way that maximizes the time that *one* of the parents is at home. The hypothesis that (more) young children lead to less CTO is not supported by the data.

Table 6.12: **Child care Time Overlap regression**

Dependent Variable: $\log(\frac{CTO}{1-CTO})$		
	Estimate	t-statistic
Control variables		
Dummy more than two children	-0.462	-1.63
Dummy child present between 0-4	0.730***	2.96
Dummy child present between 4-12	1.060***	4.58
Male has low education level	-1.137***	-3.49
Male has middle education level	-0.471*	-1.70
Female has low education level	-0.090	-0.24
Female has middle education level	-0.117	-0.42
Constant	-1.001***	-3.14
$\Delta\cdot$ Dummy child present 0-4	-0.026	-1.05
$\Delta\cdot$ Dummy child present 4-12	-0.006	-0.25
Δ	0.017	0.85
Likelihood	-2653.61	
Observations	1008	
$\overline{C}_{total}$	10.74	

Note: * significant at the 10% level, ** significant at the 5% level, *** significance at the 1% level.

We will shortly summarize the findings of Section 6.4.1 on how work timing behavior affects joint leisure, the time spent on household tasks, and the amount of child care given by the parents together.

First of all, we find that work timing behavior hardly affects the joint time of spouses on household tasks, and does not affect the amount of child care given by the parents together. With respect to the latter, we expected that parents with (more) young children would create less WTO because these parents either have a preference for parental child care or want to avoid the expensive child care costs. This behavior would then, presumably, result in parents maximizing the time that one of the parents is at home, and this automatically comes at

the expense of the time that two parents are at home together. In this study, this relation between work timing and child care is not supported by the data.

We find empirical evidence that couples time their work hours so that they can spend more leisure time together, and this is usually referred to as a 'togetherness preference'. This result is in line with earlier studies, such as Hallberg (2003), Jenkins and Osberg (2005) and Van Klaveren and Maassen van den Brink (2007). However, an important difference is that we only find this togetherness preference for childless couples. Spouses with no children have 0.35 more hours joint leisure when they create 1 more hour WTO. On the other hand, parents have -0.06 less hours of joint leisure when they create 1 more hour WTO.

6.4.2 Work Timing and Child Care Demand

In this section we examine the relationship between work timing and the demand for child care. Before we start our analysis we explain how child care is arranged in the Netherlands. The government child care policy in the Netherlands drastically changed after January 2005. Before January 2005, formal child care institutions were financed by the local authorities so child care institutions could offer child care to parents for a lower price. However, this placed these child care institutions in a dominant position, for several reasons. First of all, parents were usually not aware about the actual costs of the child care they demanded. This was caused by the fact that the child care institutions and not the parents received a subsidy from the local authorities. In addition, the amount of the subsidy varied somewhat arbitrarily over different localities which made prices of child care non-transparent. Second, child care demand exceeded child care supply, and as a consequence parents could not freely choose between different alternatives of child care. Because of the long waiting lists, parents were happy if they could make use of the services of a child care institution, and this meant that they were less critical about the quality of the child care.

After January 2005 several changes were implemented to improve the way child care was arranged. Subsidies were no longer given to child care institutions but were given to the parents instead. Parents first paid the cost of child care themselves and then received a reimbursement from the government and the employer if they applied for it. Assuming that both spouses work, as is the case for the spouses in our sample, both employers had to reimburse one-third of the child care costs to the parents. The reimbursement of the government is income-dependent and logically decreases as the household income increases. For example, in the year 2005, for the first child in the household, this reimbursement changed from 63.2 percent when the yearly household income was 16.000 euros or less to 1.8 percent when the yearly household income was 71.883 euros (see Kok, Groot, Mulder and Sadiraj

(2006)). Because the level of the reimbursement is price dependent, the contribution that parents pay themselves is also price dependent. This gives parents an incentive to demand child care at a reasonable price.

As well as, or because of, the change in child care policy, the number of child care institutions increased enormously, such that child care demand was no longer higher than child care supply. A direct result was that parents could choose freely between the different child care alternatives, and could choose the child care institution that offered a good price/quality ratio. Given this new situation, child care institutions now have an incentive to offer efficient child care as they are competing with other institutions and this leads to lower prices and child care that is of better quality.[12]

For our study, parents were asked how many formal and informal child care hours they demand. As we mentioned, parents first pay the child care costs themselves and then receive a reimbursement. Therefore, we expect that parents have a fairly good idea of the amount *they* paid for the amount of child care they had demand.

In Table 6.13 we show the descriptive statistics of the child care demand per month and the prices they paid for this amount of child care. Parents use informal child care relatively more than formal child care. The hourly price of formal child care is much higher than that of informal child care, as would be expected. Informal child care is often supplied by grandparents, and parents usually do not pay them for their caring service. The hourly price of formal child care is 7.92 euros per hour and this is higher than the price of informal child care, as was to be expected. We note that parents may use both formal and informal child care, and this happens in 72 cases and the average demand for informal child care for these 72 couples is 29.1, which is about equal to the average informal child care in Table 6.13. The average demand for formal child care is higher than the average demand for informal child care. Parents are likely to demand more child care hours if they decide to supply more labor hours. Also it may be that grandparents supply child care hours up to a certain threshold level.

[12] An elaborate study (in Dutch) is given in Kok et al. (2006).

Table 6.13: **Child care demand and prices**

			Percentiles	
	Freq.	**Mean**	**5 %**	**95 %**
Quantity				
Formal child care demand	150	67.13	8	160
Informal child care demand	404	29.99	3	85
Prices				
Hourly price formal child care	150	7.92	2.39	18.04
Hourly price informal child care	404	1.47	0	7.69

In order to examine whether work timing affects child care, we estimate the following two equations seperately:

$$\begin{aligned} \log FC &= \kappa_0 + \kappa_1 \cdot z_1 + ... + \kappa_j \cdot z_j + \delta_{FC} \cdot \Delta + \varepsilon_{FC} \\ \log IC &= \eta_0 + \eta_1 \cdot z_1 + ... + \eta_j \cdot z_j + \delta_{IC} \cdot \Delta + \varepsilon_{IC} \end{aligned} \tag{6.10}$$

where FC and IC stand for, respectively, the hours of formal child care and the hours of informal child care. The model parameters are represented by κ, η, δ_{IC} and δ_{FC}. Δ represents the work timing estimate; and we also have the usual two error terms $\varepsilon_{FC} \sim N(0, \sigma_{\varepsilon_{FC}})$ and $\varepsilon_{IC} \sim N(0, \sigma_{\varepsilon_{IC}})$. In the regression we control for various household characteristics that are represented by the variables z. These characteristics are:

- Hourly price of child care;
- # of children aged between 0 and 4;
- # of children aged between 4 and 12;
- Education level dummies for men and women;
- Household income and a dummy variable that controls for the missing values;
- Dummy that indicates 1 if the household uses informal and formal child care.

Both equations are estimated separately, and we control for the fact that some households use both formal and informal child care by including a dummy variable in both regressions,

indicating 1 if households make use of both formal and informal child care, and 0 otherwise. Since the reimbursement of the government is income-dependent, and because households with a higher income can afford child care more easily, we include the logarithm of the household income. Income is measured in categories, and the income variable that we construct is the logarithm of the gross household income that represents the mid-income of the interval that is appropriate for the household.

Because we expected that the work timing behavior of parents relates to the presence of young children, we have interacted Δ with a child dummy that indicates 1 if there is a child present in the household aged between 0 and 4, and 0 otherwise. The estimation results are printed in Table 6.14.

Table 6.14: **The Effect of Work Timing on Child Care Demand**

Variable	**Estimate**	**t-statistic**
Formal Child Care		
Price per hour formal child care	-0.360***	-2.98
# Children between 0-4	1.009***	4.82
# Children between 4-12	0.048	0.28
Male has low education level	0.138	0.78
Male has medium education level	0.034	0.25
Female has low education level	-0.839**	-2.48
Female has medium education level	-0.166	-1.29
Log(household income)	-0.166	-0.6
Control for 22 missing values of the household income	-0.453	-0.58
Dummy: both formal and informal care	-0.387***	-3.32
Constant	4.763***	5.54
$\Delta\cdot$ Dummy child present 0-4	0.018	1.26
Δ	0.008	0.71
Informal Child Care		
Price per hour informal child care	-0.064	-1.02
# Children between 0-4	0.714***	4.05
# Children between 4-12	-0.187	-1.28
Male has low education level	-0.229	-1.53
Male has medium education level	-0.183	-1.49
Female has low education level	0.171	0.92
Female has medium education level	0.180	1.53
Log(household income)	0.281	0.88
Control for 73 missing values of the household income	1.042	1.19
Dummy: both formal and informal care	-0.257*	-1.88
Constant	2.058**	2.28
$\Delta\cdot$ Dummy child present 0-4	0.018*	1.74
Δ	0.014*	1.88
	Formal	Informal
Likelihood	-155.66	-567.07
Observations	150	404

Note: * significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

When the price of formal child care is higher, parents demand less child care, as was to be expected. We do not find such a price effect for the demand of informal child care, although the sign points in the right direction. This is likely caused by the fact that most of the prices of informal child care are either zero or very low, so it is the lack of variation of this variable that causes the insignificance.

Parents demand more child care when there are more young children in the household. This result is found for the demand for both formal and informal child care. When parents demand formal child care, this influences the demand for informal child care negatively, and vice versa. We do not find an effect for children aged between 4 and 12. This may be caused by the fact that, in the Netherlands, children go to school when they are 4/5 years old. Therefore, we would expect a reduction in the demand for child care at the point when the children go to school.

We do not find any income effect, which is surprising. We would expect that the demand for child care is higher when the household income is higher. First of all, households with more income can afford child care more easily. Second, when households earn more money they will, on average, also work more labor hours, which makes the need for child care higher. It may be that the small number of observations, together with the fact that income is measured on an interval level and has many missing values, results in an insignificant effect of income on child care demand.

Households where women are lower-educated demand less formal child care. For these women the differences between the hourly child care price and the hourly wages is relatively small, so that they are more likely to decide to take care of the children themselves.

Of course, we are particularly interested in whether the work timing estimate is related to the demand for child care. We find that work timing affects the demand for informal child care positively, but does not affect the demand for formal child care. There is a constant work timing effect on the demand for informal child care, but also the interaction effect with having a young child is significant.

On the basis of the estimates, we can simulate how the demand for informal child care

changes when parents create 1 more hour of WTO. In order to do so, we first predict the amount of informal child care based on the parameter estimates, where we evaluate all explanatory variables in their sample mean, i.e.

$$\widehat{IC}_{\Delta} = e^{\hat{\eta}_0 + \hat{\eta}_1 \cdot \bar{z}_1 + \ldots + \hat{\eta}_j \cdot \bar{z}_j + \hat{\delta}_{IC} \cdot \overline{\Delta}} \tag{6.11}$$

Then we replace Δ by Δ+1 and predict again the amount of informal child care as in 6.11:

$$\widehat{IC}_{\Delta+1} = e^{\hat{\eta}_0 + \hat{\eta}_1 \cdot \bar{z}_1 + \ldots + \hat{\eta}_j \cdot \bar{z}_j + \hat{\delta}_{IC} \cdot \overline{\tilde{\Delta}}} \tag{6.12}$$

with

$$\tilde{\Delta} = \Delta + 1$$

The difference between $\widehat{IC}_{\Delta+1}$ and $\widehat{IC}_{\Delta}$ then represents the change in informal child care when parents create 1 more hour of WTO. We note that we have corrected in the calculation for the fact that we measure work timing per week and the demand for informal child care per month. In Table 6.15 we show the descriptive statistics of $\widehat{IC}_{\Delta+1}$ - $\widehat{IC}_{\Delta}$.

In the first row of Table 6.15, we show the effect of work timing on the demand for child care without considering the interaction effect. We find that parents demand 0.127 hours more informal child care if they create 1 more hour of WTO per month. This is what we would expect, since the creation of more WTO results in less time that one of the two partners can be at home taking care of the child.

In this chapter, we have hypothesized that parents with young children create less WTO in order to avoid the cost of child care, and maximize the amount of time that at least one of the parents can care. Therefore, we have included the interaction effect to see if there is empirical support for this hypothesis. It is not likely that the cost avoiding behavior applies in the case of informal child care, since the hourly prices are often 0 or very low and do not significantly influence the demand of informal child care. Surprisingly, we find that parents

with young children create relatively more WTO. These parents demand 0.2 hours more informal child care when they create 1 more hour of WTO. Parents with children older than 4 years old demand 0.04 hours more informal child care when the create 1 more hour WTO. An explanation is that parents use more informal child care when the children are relatively young because this care is usually given by grandparents or other family members.

We expected that the presence of young children would affect the demand for $formal$ child care through the parents' work timing behavior so that we would observe that parents create less WTO and/or use more informal child care. The empirical results do show that parents demand less formal child care when they make use of informal child care, but a work timing effect is not observed. Earlier, we hypothesized that parents minimize the cost of paid child care by their work timing behavior, but this hypothesis is not supported by the data.

Table 6.15: **The effect of work timing on the demand for informal child care**

			Percentiles	
$\widehat{IC}_{\Delta+1}$ - $\widehat{IC}_{\Delta}$	**Freq.**	**Mean**	**5 %**	**95 %**
All households with children	404	0.127	0.035	0.275
Households with child 0-4	216	0.200	0.322	0.056
Households with child $\geq$4	188	0.043	0125	0.313

6.5 Work timing behavior of parents in Belgium, Italy, and the Netherlands

It is interesting to place the work timing behavior of parents explicitly in a comparative framework to allow for cross-country differences.[13].

In a comparative study Carriero et al. (2009) examine the work timing behavior of dual-earner parents in Belgium, Italy and the Netherlands in 2005/2006. We rely on three distinct sources of time-use data. The Italian data were taken from the Time-use Survey carried out by ISTAT (Italian Statistical Institute); the data for the Belgian region of Flanders come from the Flemish Families and Care Survey (FFCS); and the Dutch data come from the NIPO Post-Initial Schooling Survey. Comparability between the three data sets was ensured by, first, selecting only two-earner households with children aged below 13 years old. Second, we recoded variables in order to obtain similar measures of the different (in)dependent variables. Finally, we recoded the time values into hourly measures. Although the use of three distinct data sources makes this study unique, the reader should bear in mind that the harmonization efforts to create one data set do not completely eliminate biases due to differences in data collection methods and the wording of the questions.

We find empirical support for work timing behavior in all three countries. The direction of this adjustment varies across countries. We find that, on average, Italian and Flemish dual-earner parents create more WTO, while Dutch parents create on average less WTO. The main explanation for this difference is that Dutch women work, on average, less paid labor hours than the Belgium and the Italian women, although the participation rates of the former group are higher. This means that Dutch women are more often part-time workers. The work timing estimate shows that these part-time workers not only work less hours, something we controlled for in the analysis, but also that Dutch parents on average create less WTO because Dutch women work part-time more often. When Belgium and Italian women work, they tend to work full-time and consequently they tend to create more WTO, presumably

[13]This section summarizes the result of a study performed by Carriero, Ghysels and Van Klaveren (2009)

to increase the amount of joint leisure time. In our study there was no information on the amount of joint leisure, so that we could not test the togetherness hypothesis for Belgium and Italian parents.

In addition, we simulated how the work timing estimate is affected when parents worked different working hours, holding all other variables that were used in the analysis constant. Interestingly, we find very similar results for all three countries. Dual-earner couples with both partners in full-time jobs are likely to synchronize their working time, while couples where a spouse is working part-time are likely to de-synchronize.

6.6 Conclusion

In this chapter we have examined the work timing behavior of spouses. With timing behavior we mean the behavior that results in the performance of paid labor at the same time that cannot be explained by factors other than the partners' potential to communicate on the timing of their work.

We find evidence for work timing behavior. More specifically, we find that couples create less work time overlap when there is a child present in the household and this effect is more pronounced the younger the children. Childless couples create, on average, 5 hours more work time overlap compared with parents with children aged between 0 and 4. These results are consistent with the idea that parents time their work hours so that the costs of paid child care are minimized.

The household types that create relatively more work time overlap are households with higher educated women, with a higher household income, with less children, and with spouses who are more in control of their own working times. This result is in line with the idea that these spouses have a relatively high preference for spending joint leisure time with their partner. The effects that we find correspond with the effects that are found in other empirical studies (see, for example, Hamermesh (1996, 2000), Hallberg (2003), Jenkins and Osberg (2005), Van Klaveren and Maassen van den Brink (2007) and Carriero et al. (2009).

When we examine how work timing behavior relates to the time that spouses jointly spend

on leisure, housework, and child care, we find the following. We find empirical evidence for a togetherness preference of spouses, as is also found in Hallberg (2003) and Van Klaveren and Maassen van den Brink (2007), but we only find this togetherness preference for childless couples. When spouses create 1 hour more work time overlap this results in 0.35 hours more joint leisure for childless couples and -0.06 hours less joint leisure for couples with a young child. Furthermore, we find that the joint time that spouses spend on household chores is significantly related to how couples time their working hours, but the correlation that is found is very small. We do not find evidence that the timing of work hours affects the time that parents spend jointly on child care.

When we examine how work timing behavior relates to the demand for child care, we find that work timing affects the demand for informal child care, but not the demand for formal child care. On average, parents demand 0.127 hours per month more informal child care when they create 1 more hour of work time overlap per month. This is what we would expect, since the creation of more work time overlap results in less time that one of the two partners can be at home taking care of the child. Parents with young children demand 0.2 hours more informal child care when parents create 1 more hour work time overlap. Parents who do not have young children, on the other hand, demand only 0.04 hours more informal child care when they create 1 more hour work time overlap.

Throughout this chapter, we have hypothesized that parents with young children create less work time overlap to avoid the cost of child care and/or to maximize the amount of time that at least one of the parents can care. However, in this study we find the opposite: parents with young children create relatively more work time overlap and demand more informal child care. This work timing behavior may be caused by the fact that the government subsidizes informal child care, such as that provided by the grandparents, in order to stimulate the labor participation (of women). In fact, the total expenditures of this subsidy were larger than was originally estimated, and one of the reasons was that the amount of child care provided by the informal sector was larger than was anticipated. In a policy revision in 2007 the subsidy was lowered but it is still 2.50 euros per hour per child.[14].

[14]See http://www.mik-online.nl/page.asp?id=658 (in Dutch).

It is interesting to continue the research of this chapter in several ways. An important extension would be to estimate a model where work timing and the labor supply decisions of both partners are studied simultaneously. Labor supply and work timing are then both considered as endogenous variables and this enables us to measure the effect of work timing on individual labor supplies. The outcomes of such a study are of importance for policy makers. Currently, government policies focus on increasing the labor supply of women, but the possible effects of work timing on labor supply are ignored. It may be that a policy that is more focused on work timing would be more effective and possibly even cheaper than a policy that results in subsidizing child care only.

Summary and Concluding Remarks

In this thesis we have studied how spouses allocate their time to paid labor, leisure and housework. We took into account that their decisions concerning consumption, expenditures, and the allocation of time to paid labor, leisure and housework are interdependent. To allow for this interdependency, we made use of the collective model of household behavior. One of the advantages of this model is that it takes into account that the household members of multi-person households can have different preferences, so that the intra-household allocation of welfare can be examined. The latter is important from a welfare economic perspective. Moreover, studies on the intra-household allocation of time and labor supply choices are relevant for policy makers because the household demand and labor supply may depend on who in the household is taxed or subsidized.

In the collective model, the household decision process is described as if the household maximizes a weighted sum of the individual utility functions. These functions represent the preferences of the household members. The utility weights represent the division of bargaining power between the household members, and these weights are positive and add up to 1. The core assumption of the model is that household decisions are Pareto efficient, which means that it is impossible to make one of the household members better-off without making another household member worse-off.

In Chapters 3 and 4, we empirically estimated a collective model and examined the allocation of time to labor, leisure, and housework. The early empirical approaches focused mainly on the development of theory and on testing the hypothesis that household members maximize one household utility function. The latter hypothesis is strongly rejected by

numerous empirical papers,[15] and as a consequence the collective model gradually found acceptance in the family economics literature. However, less attention has been given to the allocation of time where housework is taken into account.[16] Chapters 3 and 4 contributed to a better understanding of the (intra-)household decision process and the intra-household bargaining process.

We use two different data sources. In Chapter 3, we used a 2003-sample of British two-earner households. In Chapter 4, we used a Dutch 2001-sample of two-earner households, where it is possible to distinguish between Dutch, Turkish and Surinamese/Antillean households. The latter sample is interesting, as research on household labor supply in the Netherlands tends to neglect the labor supply decision of immigrant households. Insofar as they participate in surveys, members of those sub-populations are usually lumped together with the main population of Dutch descent.

The behavior of two-earner households is described by a structural model where preferences are assumed to depend on consumption, household production, and on the hours spent on leisure, paid labor, and housework. Because the individual expenditures of the spouses are not observed, we consider consumption as a public good, and the value of this good is approximated by the household income. Household production is defined as the sum of hours spent on housework, weighted by a parameter that represents the marginal productivity of the woman relative to that of the man. It follows that the arguments of the individual utility functions are the choice variables leisure, housework, and paid labor.

The model is estimated with an iterative two-step procedure. According to this procedure, we first use the method of Seemingly Unrelated Regression followed by a non-linear Maximum Likelihood procedure. We show that applying these estimation methods iteratively is sufficient to estimate and identify the model. The estimation procedure allows us to estimate the individual (ordinal) utility functions and the utility weights. Moreover, we can determine the (cross)-wage, child and non-labor income elasticities on the different time

[15] see, among others, Thomas (1990), Browning et al. (1994), Lundberg et al. (1997), Fortin and Lacroix (1997), Browning and Chiappori (1998) and Blundell et al. (2005)

[16] Exceptions are Apps and Rees (1997), Apps and Rees (1999), Rapoport, Sofer and Solaz (2005) and Couprie (2007)

expenditures of individuals.

Estimated ordinal utility functions[17]

The individual utility functions are assumed to depend on consumption, household production, and on the hours spent on leisure, paid labor, and housework. We found for the men that leisure and the household income are most important and their impact on utility is comparable for British, Dutch, Surinamese/Antillean and Turkish households.

For Dutch, Surinamese/Antillean and Turkish women, leisure is the most important variable in the utility function, followed by the household income and the household production. The significance of household production relates to the presence of children in the household. Since women are usually the child-care providers, these household production variables enter significantly in their utility function. For Surinamese/Antillean and Turkish women, the household production coefficients are higher because they have on average more children. For these women, the hourly wages are relatively low, and together with the high prices of child care, they may have an incentive to spend relatively less time on paid labor and relatively more time on housework. For British women the most important variables are leisure and the household income.

More generally we find that the ordinal utility functions of men and women, and consequently their indifference curves, are significantly different. This means that the preferences of men and women with respect to the variables that we distinguish in their utility functions are different.

Estimated utility weights

For all household types we find that the utility functions of men and women are about equally weighted in the household utility function. In other words, the weight given to the individual utility functions is about 0.5, and this means that men and women have an equal amount of bargaining power.

[17] 'Estimated ordinal utility functions' is a rather unfortunate terminology, as in reality we are only estimating and able to estimate the shape of indifference curves.

For British households we found that the utility weights depend only on the relative hourly wages. If a person's wage increases, then his or her utility function is weighted heavier in the household utility function. A similar effect is found for Dutch and Turkish households, although the wage effects are smaller than those found for the British households. For Surinamese/Antillean households we did not find that the utility weights are significantly influenced by the individual wages. This means that the behavior of these households can be described as if the household members maximize one household utility function.

The presence of children in the household increases the bargaining power of Dutch, Turkish and Surinamese/Antillean women. The effect is largest for children aged between 0 and 3 years old, and the child effect is larger for Surinamese/Antillean and Turkish women.

Moreover, we found for Dutch households that spouses have more bargaining power when they are older. If there is no age difference between the spouses, the bargaining power is evenly distributed, but if one of the spouses is older then the bargaining power is highest for the oldest spouse. Because the male partner is usually the oldest partner, this means that his bargaining power increases when the age difference increases.

Estimated ratio of the marginal productivity of housework

An additional hour of housework is more efficiently used by British, Dutch, and Turkish men than their partners. An explanation for this productivity difference is that women already spend more time on housework and hence men can be *marginally* more productive when performing household tasks. For Surinamese-Antillean households we found the opposite.

In practice, the estimated ratio of marginal productivity is a scaling parameter and thus this parameter may reflect not only the ratio of productivity but possibly also cultural backgrounds where different norms and values apply. It is, for example, well-known that gender roles are differently interpreted in the four ethnic communities considered. Hence, we should be careful when making a productivity statement based on the value of this scaling parameter.

Estimated (cross-)wage elasticities

For British households we found that when the hourly wage rate of one of the spouses increases, he or she will replace paid labor hours by leisure or housework hours, and the partner will do the opposite. In other words, the labor supply curve with respect to the person's own wage is backward-bending, and so the income effect dominates the substitution effect. The labor supply curve with respect to the partner's wage is forward-bending, which means that a person supplies more labor when the wage rate of the partner increases. For Dutch, Surinamese/Antillean and Turkish households, we found the opposite: with respect to a person's own wage the labor supply curve is forward-bending, and with respect to the partner's wage the labor supply curve is backward-bending.

Research on female labor supply conducted in the 1980s and 1990s generally found a labor supply curve that was forward-bending for the entire range of female wages (see Killingsworth and Heckman 1986). In a more recent meta-analysis of Evers, de Mooij and van Vuuren (2005), 239 wage elasticities from 32 empirical studies are considered for different countries. For the Netherlands they found that the average wage elasticities for men and women are 0.1 and 0.5, respectively. These wage elasticities suggest that the labor supply curves of men and women are forward-bending, and this is similar to what we found for Dutch, Surinamese/Antillean, and Turkish households. For British households, however, they found wage elasticities that are similar to the Netherlands, but in our study we found the opposite. It may be that the choice of our model causes the difference. However, the estimation results of the ordinal utility functions and the utility weights are rather similar between the two chapters, with the exception of the child effect in the utility weight. Another possibility is that (unobserved) cultural differences between the different sub-samples are driving the observed differences in wage elasticities. Unfortunately, cross-elasticities are almost never reported in empirical studies, and so it is not possible to relate our findings to those of other studies.

When we consider the (cross)-elasticities for the Netherlands, our findings suggest that a person will supply less paid labor when the partner's wage increases and more paid labor when the person's own wage increases. This is an interesting result from a policy perspective.

On the one hand, the elasticities show that a government subsidy may result in more paid labor supply by women, given that the subsidy is an indirect way of increasing the woman's wage rate relative to that of her partner's. On the other hand, the cross-elasticities suggest that the partner supplies less paid labor when the woman's wage rate increases. While the first effect is usually mentioned by policy makers to emphasize that subsidy helps to increase female labor supply, the latter effect is usually not mentioned.

It is, for example, believed that increasing the labor supply of women will reduce the future burden of ageing because of the extra benefits through income taxes. When we take into account the cross-elasticities, the men, who generally pay higher marginal taxes than their partner, supply less paid labor, and as a result the total benefits may be smaller than is expected by the government. Policy makers should acknowledge that (1) men's paid labor supply can react to a change in their partner's wage rate; and (2) cross-effects should be taken into account when policies are formulated, implemented, and evaluated. Because policy changes can affect the relative price of labor, i.e. wages, there are many other examples that can be thought of where cross-elasticities are important for policy evaluation and implementation, e.g. policy related to child care, fertility, taxes, social benefits, etc.

In Chapter 5 we allowed for the possibility that household members are not active in a paid job. This is important because the non-participation 'choice' is endogenous with the observed paid labor hours. Ignoring the fact that household members do not participate might result in a selectivity bias.

We used data from the British Household Panel Survey: a sub-sample of two-earner families and a sub-sample of households where only the man performs paid labor. Because of an insufficient number of observations, we did not consider households where only the woman performs paid labor.

The behavior of two-earner households is described by the structural model that was formulated in Chapter 3. The behavior of one-earner households is described by a structural model where we assume that the household maximizes a weighted sum of the individual

utility functions conditional on the zero job-hour choice of the woman. It implies that the non-participation decision may not be optimal for the household, as the zero job-hour choice may not be optimal, but forced upon the female by external circumstances. It may also be that non-participation is the result of an optimizing decision, i.e. we have voluntary unemployment. Unfortunately, we cannot observe from the data whether the woman's unemployment is voluntary or involuntary. Additionally, we formulated a model where we assume that two-earner households behave similarly to one-earner households, i.e. the household maximizes a weighted sum of the individual utility functions conditional on the *constant* job hours of the woman. By estimating these various models, we obtained more insights into how individual preferences and bargaining between spouses differ between one- and two-earner households. Moreover, we obtained information on how the individual utilities and the household utility are influenced by working an additional hour of paid labor. This is interesting as it gives more information on why women do or do not participate.

When we assume that labor supply choices may be non-optimal for two earner households, the results are remarkably similar compared with when we assume that job hours are optimally chosen: leisure and household income are the most important variables in the individual utility functions. For the non-participating women too, leisure and household income are the most important variables, but in addition household production is important. An explanation for the importance of household production is that women often do not work on the labor market because they are taking care of the children. This idea is confirmed by the data since there are, on average, more children in one-earner households than there are in two-earner households.

The utility function of the man is weighted less in the household utility function than that of his non-participating partner. This means that men have less bargaining power than women. If we assume for two-earner households that the optimal allocation of time is conditional on the *constant* job hours of the woman, we find that men have more bargaining power than women.

Compared with the earlier results in Chapter 3, where we found that the wages were

the most important variables in the utility weight function, we now observe that the most important change is caused by the presence of children in the household. We find that the presence of children lowers the weight that is given to the utility function of the woman who provides a positive amount of labor, while it increases the weight that is given to the utility function of the woman who provides zero labor hours. Again, these results are derived under the assumption that the labor supply choice of the woman may not be optimal. An explanation is that the women in two-earner households are at the same time the main child-care providers in the household. In this case, women are responsible for earning a substantial share of the household income, and the presence of (more) children increases the burden on these working women. Although this situation may be beneficial for the entire household, it seems not to be beneficial for the woman.

When we did not assume optimal labor supply of the woman, we found that older spouses have more bargaining power, and that an age difference between the two spouses is to the advantage of the older, usually male, spouse. These age effects were also found for Dutch couples in Chapter 4.

Given that women's labor supply may be non-optimal, we examined how an additional hour of female labor supply affects the utility of the household (U_h), the utility of the man (U_m), and the utility of the woman (U_f). In the table below we show, separately for one- and two-earner households whether the estimated utility of working one additional labor hour is positive (+) or negative (-).

The Marginal Utility of One Female Labor Hour

	One-earner	**Two-earner**
U_h	+	+
U_m	−	+
U_f	+	+

Note: All estimates are significantly different from zero at the 1% level.

For two-earner households, we found that it would be a Pareto improvement when the woman increases her labor supply. This follows from the fact that an increase in the labor supply

of the woman is beneficial for the the man, for the woman, and consequently for the entire household. For one-earner households, we found that an increase of the labor supply of the woman increases the household utility level and her own utility level, but it will negatively affect the utility level of the man. This is an interesting result, because it would mean that the non-working woman would be better-off getting a job. Of course this is an average result. Moreover, it is unclear whether the woman who would be happy with a job of one or a few hours would feel better-off with a job of 30 or 40 hours, although this is usually the realistic choice in the job market.

According to the table, the situation of the man would worsen if the non-working spouse starts working. Our estimation results suggest that, the women in one-earner households have more bargaining power than the men, and so we do not find that these women do not supply more labor due to less bargaining power. It may be that this result is caused by other factors that are not incorporated in our model, such as labor market participation constraints or the preferences of women to provide child care themselves.

Work Timing Behavior

In Chapter 6 we discussed the intra-household allocation of time from a different perspective than in the earlier chapters of this thesis, and focused on how the spouses of Dutch two-earner households *time* their work hours. By 'work timing' we refer to the amount of paid labor that is supplied by the spouses at the same time that cannot be explained by factors other than the partners' potential to communicate on the timing of their work hours. The work timing of spouses is measured by the hours that they work simultaneously per week, or, in other words, the work time overlap. In order to measure the spouses' work times accurately, we asked questions in the Post Initial Schooling Survey and these data were collected in December 2005.

When we observe that couples create more hours of work time overlap, this means that there are potentially more hours available to perform other joint activities, such as joint leisure. When couples create less work time overlap, this means that there is less time

available to perform joint activities, but, on the other hand, there is more time available so that at least one of the spouses can be at home to care for the child.

Measuring work timing is difficult, because it is hard to disentangle which part of the observed work time overlap is caused by the (non-observed) timing behavior of the spouses, and which part of the work time overlap is caused by the fact that persons with certain characteristics end up in certain jobs with associated working times.

The first contribution of this chapter is that we proposed a method by which the two underlying parts of the observed work time overlap can be distinguished (see also Van Klaveren and Maassen van den Brink (2007)). We simulated how the amount of work time overlap would vary if spouses do not have the possibility to time their work hours, and showed that this identifies the amount work time overlap that results from work timing behavior. In this simulation we matched couples to other identical couples in the sample, and then the couples that were matched switch partners. The average work time overlap of the couples that remains after the partner switch represents the control situation where spouses have similar characteristics but cannot time their work hours. Comparing this control outcome with the observed work time overlap of the spouses provided us with a work timing estimate.

The second contribution of this chapter is that we examined how work timing behavior is related to the demand for child care and to the time that spouses spend jointly on other activities, such as leisure, housework, and child care. This increases our understanding of why spouses time their work hours.

We found empirical support for the hypothesis that spouses time their work hours, and in particular we found that couples with children create less work time overlap and that the opposite happens for couples without children. Couples without children create 5 hours more work time overlap than couples with a child aged between 0 and 4. More generally, we find that the households that create more work time overlap are households where the woman is higher educated, with a higher household income, with less children, and with spouses who are more in control of their own working times.

When we examined how work timing affects the time that spouses spend jointly on leisure,

housework and child care we found the following. Work timing behavior has a substantial and significant effect on the amount of joint leisure. This means that spouses have a togetherness preference, a result which is also found in Hallberg (2003) and Van Klaveren and Maassen van den Brink (2007). An important difference between earlier studies and this study is that we found that only couples without children have a togetherness preference. The time spent jointly on child care is not influenced by work timing behavior. The time that spouses spend jointly on housework is significantly related to work timing but the effect is very small.

Finally, we found that the demand for informal child care is influenced by work timing behavior, but the demand for formal child care is not influenced by work timing behavior. When parents create one more hour of work time overlap they, on average, demand 0.127 hours more informal child care per month. For parents with young children, this is higher at 0.2 hours more informal child care per month, while for parents with older children this is only 0.04 hours more informal child care per month.

We hypothesized in Chapter 6 that parents with young children create less work time overlap so as to avoid formal child care costs and maximize the amount of time that at least one of the parents can devote to child care. However, we found the opposite: parents with young children create relatively more work time overlap and demand more informal child care. An explanation for this finding is that the government subsidizes informal child care, such as child care provided by grand parents, in order to stimulate the labor participation (of women). Because the demand for informal child care was underestimated, the expenditures of this subsidy of half a billion euros were far larger than planned. In a subsequent policy revision the amount of subsidy has been reduced from 3.75 to 2.50 euros per hour per child.[18] On the basis of our results, it seems that that a policy that is more focused on work timing may be more effective, and possibly even cheaper compared with a policy that subsidizes child care only. The importance of the relation between work timing and the demand for child care follows from the fact that policy makers might not have subsidized the informal child-care sector in this way if they had known the magnitude of the informal child-care sector and the importance of households whose members coordinate their work timing.

[18] see http://www.mik-online.nl/page.asp?id=658 (in Dutch).

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Nederlandse Samenvatting (Summary in Dutch)

Mensen verdelen elke dag hun tijd over vele verschillende activiteiten. In dit proefschrift proberen we meer zicht te krijgen op hoe personen van meerpersoonshuishoudens hun tijd verdelen tussen betaalde arbeid, vrije tijd en huishoudelijk werk. We bestuderen het gedrag van deze personen aan de hand van het collectieve model dat er vanuit gaat dat personen, op basis van het uurloon en de prijzen van consumptiegoederen, proberen de optimale tijdsverdeling te kiezen. Er wordt onderkend dat de man en de vrouw verschillende voorkeuren kunnen hebben en dat zij onderhandelen over welke tijdsverdeling er uiteindelijk gekozen gaat worden. De keuze voor een bepaalde tijdsverdeling van de man/vrouw hangt dus af van de voorkeuren van zowel de man als de vrouw evenals van de onderhandelingspositie binnen het gezin. Het collectieve model geeft daarom niet alleen meer inzicht in de manier waarop de taken binnen een huishouden verdeeld worden, maar maakt het tevens mogelijk om de verdeling van welvaart tussen de man en de vrouw te bestuderen. Dit laatste is van belang voor beleidsmakers, omdat de keuze voor een bepaalde verdeling van tijd, en daarmee de keuze voor een bepaalde hoeveelheid betaalde arbeid, beïnvloed kan worden door subsidies en belastingheffing. Een subsidie die gegeven wordt aan de vrouw kan bijvoorbeeld een andere impact hebben op het arbeidsaanbod van de man en de vrouw dan een subsidie die gegeven wordt aan de man of het huishouden.

Huishoudgedrag in het collectieve model wordt beschreven alsof het huishouden een gewogen som van de individuele nutsfuncties maximaliseert. De individuele nutsfuncties representeren de voorkeuren van de man en de vrouw. De gewichten die gegeven worden aan de individuele nutsfuncties worden positief verondersteld en tellen op tot één. Als het gewicht van de nutsfunctie van de man stijgt, moet noodzakelijkerwijs het gewicht van de nutsfunctie van de vrouw dalen en andersom. Zodoende representeren de gewichten de individuele onderhandelingsposities van de man en de vrouw. De basisveronderstelling die ten grondslag ligt aan het collectieve model is dat de keuze voor een bepaalde tijdsverdeling

Pareto efficiënt is. Dit betekent dat het niet mogelijk is een andere tijdsverdeling te kiezen die beter is voor een persoon binnen het huishouden en niet slechter is voor zijn of haar partner.

In hoofdstuk 3 schatten we het collectieve model op basis van data verzameld in 2003 voor Britse tweeverdieners. In hoofdstuk 4 schatten we eenzelfde model op basis van in Nederland wonende Nederlandse, Turkse en Surinaamse/Antilliaanse tweeverdieners op basis van data verzameld in 2001. We merken op dat een huishouden gekenmerkt wordt als Turks, Surinaams of Antilliaans als zowel de man als de vrouw minimaal één ouder hebben die afkomstig is uit Turkije, Suriname of de Nederlandse Antillen. In de regel worden deze immigrantenhuishoudens niet beschouwd in de diverse arbeidsaanbodstudies voorhanden. Door ook de tijdsverdelingen te beschouwen voor deze immigrantenhuishoudens kan worden onderzocht hoe deze varieëren naar etnische afkomst en dit geeft meer inzicht in de cultuurverschillen die ten grondslag liggen aan deze gekozen tijdsverdeling. Omdat de empirische modellen in de hoofdstukken 3 en 4 identiek zijn, wordt hieronder zowel het empirische model als de schattingsresultaten besproken van beide hoofdstukken.

Het gedrag van tweeverdieners wordt beschreven aan de hand van een structureel model. Er wordt verondersteld dat de individuele voorkeuren van de man en de vrouw afhangen van de collectieve consumptie van marktgoederen en de geproduceerde goederen binnen het huishouden én van de tijd die personen besteden aan betaalde arbeid, vrije tijd en huishoudelijk werk. Omdat de precieze individuele bestedingen van mannen en vrouwen niet geobserveerd worden, nemen we aan dat de consumptie van marktgoederen betaald worden van het collectieve huishoudinkomen ook al kan consumptie op individueel niveau plaatsvinden. Consumptie is dan als het ware een publiek goed en de waarde van dit publieke goed is gelijk aan het huishoudinkomen. Evenals de individuele bestedingen observeren we ook niet welke goederen er precies geproduceerd worden binnen het huishouden en wie deze goederen produceert. Met geproduceerde huishoudgoederen bedoelen we het schoonmaken van het huis, afwassen, de reparaties aan het huis, de zorg voor de kinderen, et cetera. We definiëren productie binnen het huishouden daarom als de gewogen som van de individuele tijd die besteed wordt aan huishoudelijk werk. Het gewicht representeert de marginale productiviteit van de man ten opzichte van de vrouw. We merken op dat consumptie een functie is van de betaalde arbeidsuren van beide partners en dat de productie van huishoudgoederen een functie is van de tijd die beide partners besteden aan huishoudelijk werk. Hieruit volgt dat betaalde arbeid, vrije tijd en de tijd besteed aan huishoudelijk werk de keuzevariabelen zijn in de individuele nutsfuncties.

In hoofdstuk 3 laten we zien dat het bovenstaande structurele model gedentificeerd is en

geschat kan worden met een iteratieve twee stappenprocedure. In de eerste stap schatten we de individuele indifferentiecurven, en in de tweede stap schatten we het gewicht dat gegeven wordt aan de individuele nutsfuncties. Deze beide stappen worden vervolgens herhaald totdat de modelparameters convergeren naar een stabiel evenwicht.

Op basis van de geschatte modelparameters verkrijgen we informatie over, ten eerste, de vorm van de individuele indifferentiecurven. Hieruit kunnen we afleiden hoe de consumptie van marktgoederen en geproduceerde goederen binnen het huishouden én de tijd die een persoon besteedt aan betaalde arbeid, vrije tijd en huishoudelijk werk gewogen worden in de individuele ordinale nutsfuncties. Dit betekent dat we niet alleen informatie verkrijgen over de voorkeuren van de man en de vrouw binnen een huishouden maar ook dat we kunnen vaststellen of deze voorkeuren verschillend zijn. Ten tweede, wordt de onderhandelingspositie van de man en de vrouw weergegeven door het gewicht behorende bij de individuele nutsfuncties. Doordat deze gewichten afhangen van verschillende huishoud- en persoonskenmerken kunnen we bovendien vaststellen hoe de individuele onderhandelingsposities variëren voor huishoudens met verschillende kenmerken. Ten derde, schatten we een parameter in het model die de marginale productiviteit van de man ten opzichte van de vrouw voorstelt. Dit geeft informatie over de mate van efficiëntie van mannen en vrouwen ten opzichte van elkaar wanneer zij huishoudtaken verrichten. Tenslotte, kunnen op basis van de modelschattingen de (gekruiste) loonelasticiteiten bepaald worden. Deze elasticiteiten geven weer hoe een verandering in het uurloon van de man of de vrouw het arbeidsaanbod van de man *en* de vrouw veranderen.

De kruiselasticiteiten worden vaak niet beschouwd omdat verondersteld wordt dat het arbeidsaanbod van mannen exogeen is. In de praktijk zien we weliswaar dat mannen veelal full time werken maar dit betekent niet dat hun arbeidsaanbod exogeen is. Deze observatie is namelijk geconditioneerd op het arbeidsaanbod van vrouwen die veelal part time werken. In het geval dat het arbeidsaanbod van vrouwen in uren blijft toenemen, kan het zo zijn dat, bij een bepaald omslagpunt, mannen minder betaalde arbeid gaan aanbieden. Door het arbeidsaanbod van mannen en vrouwen als endogeen te beschouwen laten we toe dat uurlonen invloed kunnen hebben op de tijdsverdeling van mannen en vrouwen. We zetten hieronder de bevindingen in de hoofdstukken 3 en 4 uiteen.

De individuele voorkeuren

De mannen van Britse, Nederlandse, Turkse en Surinaamse/Antilliaanse afkomst vinden het aantal uren vrije tijd en het niveau van het huishoudinkomen het belangrijkst. Bovendien is de grootte van het gewicht dat toegekend wordt aan deze factoren vergelijkbaar. De

schattingsresultaten voor vrouwen van Britse afkomst zijn vergelijkbaar met die van de mannen. De vrouwen van Nederlandse, Turkse en Surinaamse/Antilliaanse afkomst vinden het aantal uren vrije tijd het belangrijkst, gevolgd door het niveau van het huishoudinkomen en de productie van goederen binnen het huishouden. Het gewicht dat wordt toegekend aan huishoudproductie is gerelateerd aan of er kinderen aanwezig zijn binnen het gezin en dit is te verklaren omdat vrouwen veelal de zorg voor de kinderen op zich nemen. Het relatieve gewicht dat wordt toebedeeld aan huishoudproductie is relatief groter voor de Turkse en Surinaamse/Antilliaanse vrouwen. Dit kan verklaard worden doordat het loon van deze vrouwen gemiddeld lager ligt dan het loon van Nederlandse vrouwen en bovendien hebben zij gemiddeld genomen meer kinderen.

Wanneer we de indifferentiecurven van mannen en vrouwen vergelijken vinden we dat deze significant van elkaar verschillen. Zodoende verschillen de individuele voorkeuren van mannen en vrouwen van Britse, Nederlandse, Turkse en Surinaamse/Antilliaanse afkomst.

De individuele onderhandelingsposities

Het gewicht dat wordt toegekend aan de nutsfunctie van de man is vergelijkbaar met het gewicht dat wordt toegekend aan de nutsfunctie van de vrouw en deze bevinding geldt voor zowel Britse, Nederlandse, Turkse als Surinaamse/Antilliaanse huishoudens. Dit betekent dat mannen en vrouwen een even sterke onderhandelingspositie hebben.

In het schattingsmodel hangt het gewicht dat wordt toegekend aan de individuele nutsfuncties af van verschillende huishoud- en persoonskenmerken, zoals leeftijd, het uurloon, het inkomen uit niet arbeid, et cetera. Zodoende kunnen we nagaan hoe de onderhandelingspositie varieert naar deze kenmerken. De individuele onderhandelingspositie voor de Britse huishoudens wordt alleen beïnvloed door de relatieve verhouding van de uurlonen. Als het uurloon van een van de leden van het huishouden stijgt dan verbetert dit zijn of haar onderhandelingspositie. Een soortgelijk effect van het uurloon op de onderhandelingspositie wordt ook gevonden voor Nederlandse en Turkse Huishoudens, hoewel de effecten lager uitvallen. Voor Surinaamse/Antilliaanse huishoudens heeft het uurloon geen effect op de individuele onderhandelingspositie.

De aanwezigheid van kinderen verbetert de onderhandelingspositie van Nederlandse, Turkse en Surinaamse/Antilliaanse vrouwen. Bovendien is het effect groter naarmate de kinderen jonger zijn en is het effect het grootst voor vrouwen van Surinaamse/Antilliaanse afkomst.

Voor Nederlandse huishoudens vinden we dat een leeftijdsverschil leidt tot een verbetering van de onderhandelingspositie van de oudste partner. Omdat in een relatie de man meestal

ouder is dan de vrouw kan gesteld worden dat de onderhandelingspositie van de man sterker wordt naarmate het leeftijdsverschil tussen hem en zijn vrouw groter is.

De marginale productiviteit van de man ten opzichte van de vrouw
Wanneer mannen en vrouwen een extra uur aan huishoudelijk werk besteden dan vinden we dat Britse, Nederlandse, en Turkse mannen dit uur efficiënter invullen dan vrouwen, terwijl het omgekeerde het geval is voor Surinaamse/Antilliaanse huishoudens. We merken overigens op dat het verschil in efficiëntie klein is omdat de parameter dicht bij één ligt. Bovendien merken we op dat de parameter die de productiviteitsverhouding weergeeft tussen mannen en vrouwen ook de verschillen in normen en waarden kan weergeven tussen de verschillende huishoudens die we onderscheiden. De rolverdeling tussen mannen en vrouwen is bijvoorbeeld anders voor Turkse gezinnen dan voor Nederlandse gezinnen. Omdat we niet (kunnen) corrigeren voor verschillen in normen en waarden is voorzichtigheid geboden bij de interpretatie van deze parameter.

De (gekruiste) loonelasticiteiten
Wanneer het uurloon van een persoon van Britse afkomst toeneemt, zal deze persoon minder betaalde arbeid verrichten en meer tijd besteden aan vrije tijd en huishoudelijk werk. Dit betekent dat het inkomenseffect het substitutie-effect domineert. Als echter het uurloon van zijn of haar partner toeneemt, zal deze persoon meer betaalde arbeid verrichten wat ten koste gaat van de tijd die hij of zij besteedt aan vrije tijd en huishoudelijk werk.

Voor Nederlandse, Turkse en Surinaamse/Antilliaanse huishoudens vinden we het tegenovergestelde. Door een stijging van het uurloon zal een persoon meer betaalde arbeid verrichten, terwijl een uurloonstijging van de partner resulteert in minder uren betaalde arbeid.

De loonelasticiteiten die gevonden worden in de arbeidsaanbodliteratuur onderschrijven de loonelasticiteiten die we vinden voor de Nederlandse, Turkse en Surinaamse/Antilliaanse huishoudens, maar niet die voor de Britse huishoudens. Voor Britse huishoudens worden elasticiteiten gevonden die overeenkomen met de loonelasticiteiten van de Nederlandse huishoudens. Een mogelijke verklaring is dat de empirische specificatie zorgt voor deze verschillen. Echter, wanneer we de modelparameters vergelijken tussen Britse en Nederlandse huishoudens lijken deze vrij goed overeen te komen. Het is ook mogelijk dat deze verschillen ontstaan door niet geobserveerde (culturele) verschillen, waarvoor niet gecorrigeerd is.

De kruiselasticiteiten worden zelden gerapporteerd in de verschillende arbeidsaanbodstudies voorhanden. Wanneer we de (kruis)elasticiteiten voor Nederland nader bestuderen

vinden we dat personen minder betaalde arbeid verricht als gevolg van een uurloonstijging van de partner, maar meer betaalde arbeid verrichten als gevolg van een eigen uurloonstijging. Deze bevinding is vanuit een beleidsoogpunt interessant. Het betekent namelijk, enerzijds, dat een overheidssubsidie die het relatieve loon van de vrouw ten opzichte van haar partner laat stijgen, kan resulteren in meer betaalde arbeidsuren van de vrouw. Anderzijds leidt deze overheidssubsidie tegelijkertijd tot een daling van het aantal betaalde arbeidsuren van de man. Terwijl het eerste effect veelal wordt genoemd door beleidsmakers, bijvoorbeeld door te stellen dat vrouwen door overheidssubsidie meer uren betaalde arbeid zullen leveren, wordt het laatste effect zelden of nooit genoemd.

Dat het laatste effect relevant kan zijn voor beleidsaanbevelingen zullen we toelichten aan de hand van het nu volgende voorbeeld. Er wordt veelal gesteld dat een toename van de arbeidsparticipatie van vrouwen de toekomstige lasten van de vergrijzing zullen verlichten omdat de overheid dan meer inkomstenbelasting zal ontvangen. De kruiselasticiteiten laten zien dat een reactie van een stijging van het arbeidsaanbod van vrouwen mogelijkerwijs kan leiden tot een daling van het arbeidsaanbod van mannen. Bovendien vallen mannen in de regel met een groter gedeelte van hun inkomen in een hogere belastingschaal, mede doordat veel vrouwen in deeltijd werken en zodoende minder belasting betalen over hun verdiende inkomen. Zodoende kunnen de extra belastingopbrengsten als gevolg van een stimulering van de arbeidsparticipatie van vrouwen dus lager uitvallen dan verwacht. Bij het formuleren, implementeren en evalueren van beleid is het daarom van belang dat er rekening gehouden wordt met de mogelijkheid dat het arbeidsaanbod van mannen kan reageren op een verandering van het uurloon van de partner en andersom. Het bovenstaande voorbeeld gaat specifiek in op de vergrijzing, maar er zijn andere voorbeelden te noemen, zoals de werking van kinderopvangsubsidies, waarvoor geldt dat er rekening gehouden zou moeten worden met de kruiselasticiteiten.

In hoofdstuk 5 breiden we het schattingsmodel van de hoofdstukken 3 en 4 uit door de mogelijkheid toe te laten dat personen geen betaald werk kunnen hebben. Deze uitbreiding is belangrijk omdat de keuze om al dan niet te participeren in betaalde arbeid samenhangt met de geobserveerde betaalde arbeidsuren. Voor deze exercitie gebruiken we Britse data verzameld in 2003, waarbij we een steekproef beschouwen van tweeverdieners en een steekproef beschouwen van huishoudens waar alleen de man betaalde arbeid verricht. Door te weinig observaties was het niet mogelijk om huishoudens te beschouwen waar alleen de vrouw betaalde arbeid verricht.

Het model voor de tweeverdieners is gelijk aan het gebruikte model in hoofdstuk 3.

Voor huishoudens waar alleen de man betaalde arbeid verricht wordt het gedrag beschreven alsof het huishouden een gewogen som van de individuele nutsfuncties maximaliseert geconditioneerd op de nul betaalde arbeidsuren van de vrouw. De keuze om niet te participeren in betaalde arbeid kan niet optimaal zijn omdat het een gevolg is van externe factoren. We spreken dan van onvrijwillige werkloosheid. Het kan ook zijn dat het arbeidsaanbod van 0 betaalde arbeidsuren optimaal is en in dit geval spreken we van vrijwillige werkloosheid. Helaas is het aan de hand van de data die we gebruiken niet mogelijk om (goed) onderscheid te maken tussen vrijwillige werkloosheid en onvrijwillige werkloosheid. In een derde modelspecificatie nemen we aan dat het arbeidsaanbod van vrouwen in huishoudens waar zowel de man als de vrouw betaalde arbeid verricht niet optimaal kan zijn. In dit geval wordt het huishoudgedrag beschreven alsof het huishouden een gewogen som van de individuele nutsfuncties maximaliseert conditioneel op de *constante* arbeidsaanbodkeuze van de vrouw.

Door de verschillende specificaties te schatten verkrijgen we meer inzichten in hoe individuele voorkeuren en de onderhandelingsposities verschillend zijn tussen huishoudens waar beide personen betaalde arbeid verrichten en huishoudens waar alleen de man betaalde arbeid verricht. Bovendien onderzoeken we waarom vrouwen niet deelnemen aan het arbeidsproces, door na te gaan hoe de individuele nutsniveaus veranderen als de vrouw een uur betaalde arbeid meer zou gaan werken. De schattingsresultaten van Britse tweeverdieners die hun arbeid optimaal kiezen worden niet besproken, omdat deze overeenkomen met de resultaten in Hoofdstuk 3. Wanneer we dus refereren naar de schattingsresultaten van tweeverdieners bedoelen we de situatie waar het arbeidsaanbod van vrouwen niet optimaal kan zijn.

Met betrekking tot de individuele voorkeuren van tweeverdieners zijn de resultaten vrijwel gelijk aan de situatie waarin we veronderstellen dat de arbeidsaanbodkeuze van vrouwen optimaal is. Dit betekent dat de Britse vrouwen het aantal uren vrije tijd en het niveau van het huishoudinkomen het belangrijkste vinden. Voor Britse vrouwen die niet deelnemen aan het arbeidsproces vinden we eveneens dat het aantal uren vrije tijd en het niveau van het huishoudinkomen relatief belangrijk zijn, maar bovendien is de productie van huishoudgoederen belangrijk. Een belangrijke reden waarom vrouwen niet deelnemen aan het arbeidsproces is omdat ze voor de kinderen zorgen en zodoende vinden ze de productie van huishoudgoederen, oftewel zorg, belangrijk. Deze verklaring wordt ondersteund door de data waaruit blijkt dat het aantal kinderen in huishoudens waar de vrouw niet werkt gemiddeld hoger is dan in huishoudens waar de vrouw wel werkt.

Wanneer we de onderhandelingsposities binnen het gezin beschouwen vinden we

dat de onderhandelingspositie van vrouwen die niet deelnemen aan het arbeidsproces sterker is dan dat van de partner. Voor tweeverdieners waarbij het arbeidsaanbod van vrouwen niet optimaal kan zijn, geldt het tegenovergestelde: mannen hebben een sterkere onderhandelingspositie dan vrouwen. Wanneer we nagaan hoe deze onderhandelingsposities afhangen van persoonlijke- en huishoudkenmerken vinden we dat het uurloon nog steeds een prominente rol speelt: een stijging van het eigen uurloon betekent een verbetering van de onderhandelingspositie. Het potentïele uurloon van vrouwen die niet deelnemen aan het arbeidsproces beïnvloed de onderhandelingspositie niet, maar daar staat tegenover dat het niet arbeidsinkomen (de uitkering) de onderhandelingspositie verbetert, zij het dat het effect kleiner is dan het uurlooneffect.

Het hebben van kinderen verklaard een belangrijk deel van de variatie in de individuele onderhandelingsposities. De aanwezigheid van kinderen verbetert de onderhandelingspositie van vrouwen die niet deelnemen aan het arbeidsproces, terwijl het de onderhandelingspositie verslechtert van vrouwen die wel deelnemen aan het arbeidsproces. Een verklaring voor het laatste is dat de vrouwen met kinderen die betaalde arbeid verrichten zowel verantwoordelijk zijn voor het verdienen van een deel van het huishoudinkomen als verantwoordelijk zijn voor de zorg van de kinderen. De combinatie van zorg en betaalde arbeid met de bijbehorende verantwoordelijkheden kan weliswaar positief uitpakken voor het huishouden, maar op basis van de schattingsresultaten blijkt dat dit niet het geval is voor de vrouw zelf.

Evenals voor Nederlandse huishoudens vinden we een effect van het leeftijdsverschil op de onderhandelingspositie waarbij een groter leeftijdsverschil in het voordeel is van de oudste partner wat meestal de man is.

Op basis van de schattingsresultaten berekenen we vervolgens hoe een extra uur betaalde arbeid het individuele nutsniveau beïnvloedt. Voor tweeverdieners betekent dit dat we simuleren hoe het nut van de man, de vrouw en het huishouden in zijn geheel verandert als de vrouw haar huidige arbeidsaanbod met één uur zou verhogen. Voor huishoudens waar de vrouw niet deelneemt aan het arbeidsprocess betekent dit dat we simuleren hoe het nut van de man, de vrouw en het gehele huishouden verandert als de vrouw één uur zou werken in plaats van niet deel te nemen aan het arbeidsproces.

Voor tweeverdieners vinden we dat een stijging van het arbeidsaanbod van de vrouw een Pareto verbetering is, namelijk de vrouw, de man en zodoende het gehele huishouden zouden er op vooruitgaan. Wanneer de vrouw niet deelneemt aan het arbeidsproces geldt dat het aanbieden van één uur betaalde arbeid het nut van de vrouw en het huishouden verhoogt, maar het nut van de man verlaagt. Dit is een interessante uitkomst omdat het betekent dat het niet werken van de vrouw Pareto efficïent is, maar dat de vrouw er zelf

op vooruit gaat als zij betaalde arbeid aanbiedt. We merken op dat uit deze analyse niet volgt of deze vrouwen er ook op vooruit zouden gaan als ze 20, 30 of 40 uur per week zouden werken en deze hoeveelheden arbeidsaanbod zijn wellicht realistischere keuzes op de arbeidsmarkt. Wanneer de niet werkende vrouw één uur betaalde arbeid verricht betekent dit een daling van het nut van de man. Een voor de hand liggende verklaring is dat de man een sterkere onderhandelingspositie heeft waardoor de vrouw thuis blijft. Dit wordt echter niet ondersteund door de schattingsresultaten, omdat deze suggereren dat deze mannen juist een minder sterke onderhandelingspositie hebben dan hun vrouw. Het is mogelijk dat niet geobserveerde factoren, zoals arbeidsmarktbeperkingen of de voorkeur om zelf voor de kinderen te zorgen dit resultaat veroorzaakt.

De timing van betaalde arbeidsuren

In het tweede gedeelte van dit proefschrift belichten we, naast het aantal betaalde arbeidsuren van de man en de vrouw, een derde dimensie van het arbeidsaanbod, namelijk hoe personen de betaalde arbeidsuren op elkaar afstemmen. Tweeverdieners kunnen, enerzijds, zelf bepalen hoe ze hun arbeidsuren op elkaar afstemmen. Anderzijds liggen de tijden waarop gewerkt moet worden in vele beroepen redelijk vast zodat deze niet naar wens veranderd kunnen worden.

De eerste bijdrage van hoofdstuk 6 is de ontwikkeling van een methode waarmee we het onvrijwillige deel in de geobserveerde overlap in werktijden kunnen scheiden van het deel van de overlap in werktijden dat tot stand komt doordat personen deze op elkaar afstemmen. We doen dit door te simuleren hoe de overlap in werktijden zou verandert als personen niet in staat zijn om de werktijden op elkaar af te stemmen. Een maat voor de timing van werktijden wordt dan verkregen door de geobserveerde overlap in werktijden te vergelijken met de gesimuleerde uitkomst. De tweede bijdrage van hoofdstuk 6 is dat we de hoeveelheid overlap in de werktijden door timing relateren aan de vraag naar kinderopvang en aan de tijd die personen gezamenlijk besteden aan vrije tijd, huishoudelijk werk en de zorg van de kinderen. Zodoende kunnen we nagaan waarom personen hun werktijden op elkaar afstemmen.

In Hoofdstuk 6 gebruiken we Nederlandse data die verzameld zijn in 2005. In deze data is gedetailleerde informatie beschikbaar over het aantal uren die personen werken, op welke dagen deze personen werken en op welke tijdstippen dit gebeurt.

We vinden dat personen hun werktijden op elkaar afstemmen. Ouders passen hun werktijden aan door minder overlap in de werktijden te creëren, terwijl gezinnen zonder kinderen het tegenovergestelde doen. Een intuïtieve verklaring is dat ouders zonder kinderen

minder overlap in de werktijden creëren omdat er dan meer uren zijn waarop een van de ouders thuis voor het kind kan zorgen. Voor gezinnen zonder kinderen geldt juist dat zij waarschijnlijk meer overlap creëren omdat dit de hoeveelheid vrije tijd die gezamenlijk kan worden doorgebracht vergroot. We vinden verder dat gezinnen met hoger opgeleide vrouwen en een hoger huishoudinkomen meer overlap in hun werktijden creëren. Dit zijn natuurlijk ook de gezinnen met minder kinderen en met een waarschijnlijkere grotere voorkeur om vrije tijd met elkaar door te brengen. Wanneer personen meer zeggenschap hebben over op welke tijden zij werken dan vergroot dit de overlap in de werktijden. Dit is een logische bevinding omdat de personen die zeggenschap hebben over hun eigen werktijden de personen met 'betere' banen zijn (en dus meer inkomen hebben, hoger opgeleid zijn en minder kinderen hebben). Om de bovenstaande verklaringen te toetsen onderzoeken we of de overlap in de werktijden die ontstaat door timing samenhangt met de vraag naar kinderopvang en de tijd die personen gezamenlijk besteden aan vrije tijd, huishoudelijk werk en de zorg voor de kinderen.

We vinden dat de hoeveelheid gezamenlijke vrije tijd samenhangt met de hoeveelheid overlap in werktijden die ontstaat door timing, maar vinden dit effect alleen voor gezinnen zonder kinderen. Personen hebben dus een duidelijke voorkeur om samen te zijn wanneer er geen kinderen in het huishouden aanwezig zijn. De hoeveelheid gezamenlijke tijd die besteedt wordt aan de zorg voor de kinderen of aan huishoudelijk werk is niet of nauwelijks gerelateerd aan de hoeveelheid overlap in werktijden door timing.

De vraag naar informele kinderopvang hangt samen met de overlap in werktijden door timing, maar dit effect wordt niet gevonden voor de vraag naar formele kinderopvang. Wanneer ouders meer overlap in de werktijden creëren stijgt de vraag naar informele kinderopvang. We zouden verwachten dat ouders met jonge kinderen minder overlap creëren omdat ze op deze manier de kinderopvangkosten beperken of zelf voor hun kinderen kunnen zorgen. Echter, wij vinden het tegenovergestelde: ouders met jonge kinderen creëren relatief gezien meer overlap en vragen ook meer informele kinderopvang. Dit kan mogelijke komen doordat de overheid informele kinderopvang subsidieert om op deze manier de arbeidsparticipatie (van vrouwen) te stimuleren. Omdat de vraag naar deze informele kinderopvang onderschat werd waren de overheidsuitgaven 0.5 miljard hoger dan gepland. Hierop volgde een beleidsherziening waarin werd vastgelegd dat de subsidie aan de partij die de informele kinderopvang levert, verlaagd werd van 3,75 naar 2,50 euros per uur per kind.

Op basis van onze resultaten kunnen we stellen dat een beleid dat meer gericht is op het flexibeler maken van de arbeidstijden wellicht effectiever en goedkoper is dan een beleid dat slechts de kinderopvang subsidieert. Beleidsmakers hadden de informele kinderopvang

waarschijnlijk niet op deze manier geregeld als zij op de hoogte waren geweest van de omvang van de informele kinderopvang en het timing gedrag van ouders en dit toont de relevantie aan van de relatie tussen het afstemmen van de arbeidsuren en de vraag naar kinderopvang.

The Tinbergen Institute is the Institute for Economic Research, which was founded in 1987 by the Faculties of Economics and Econometrics of the Erasmus University Rotterdam, University of Amsterdam and VU University Amsterdam. The Institute is named after the late Professor Jan Tinbergen, Dutch Nobel Prize laureate in economics in 1969. The Tinbergen Institute is located in Amsterdam and Rotterdam. The following books recently appeared in the Tinbergen Institute Research Series:

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