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STUDIES ON HOUSEHOLD LABOR SUPPLY AND HOME PRODUCTION

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Author and the title of the thesis:
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Abstract
This thesis consists of four self-contained empirical studies on different topics in labor economics based on Swedish data. Short summaries on each paper are given below:
Paper [1]:
The aim is to construct models for predicting hourly wage rates and household labor supply for a dynamic microsimulation model, Sesim. The models are estimated using large Swedish register-based data. Wages are modeled utilizing the panel property of the data. In modeling labor supply, the complete tax and social security systems are taken into account. The motivation is to have a tool for analyzing the effects of changes in economic policies upon labor supply.
Paper [2]:
The purpose of the paper is to analyze the incentive effects created by the Swedish tax and transfer schemes. We focus on single mother households, and estimate a model that includes both labor supply and welfare participation decisions. We find that there is a significant stigma-effect associated with social welfare participation. The results from the implemented policy simulations show rather large average incentive effects. However, there are some substantial differences when comparing the incentive effects between the lowest and highest income deciles.
Paper [3]:
The paper analyzes Swedish time use data from 1993 within the household production theory framework. This study provides a continuation of an earlier study applying the 1984 data. The purpose is to analyze changes in household production of two-earner Swedish households. The stability of the results confirms that the previously suggested specification provides a powerful tool to identify and estimate household production. One of the main findings is that the household marginal productivity profiles have become more alike between females and males. Further, men's and women's household times are found to be q-substitutes.
Paper [4]:
The paper is a cross-country study on career interruptions due to parental leave of Danish and Swedish mothers. The aim is to analyze the effects that different family policy regimes have on mothers' job retention. Since there are comparable longitudinal data available we estimate parallel models across the two countries. Our results show that economic incentives affect the decision to resume employment. However, the parental leave mandates as such are very important determinants for the observed behavior.

Key words: Hourly Wage Rate, Random Effects, Labor Supply, Discrete Choice, Policy Simulation, Single Mothers, Welfare Participation, Fixed Costs of Working, Home Production, Household Productivity, Time Use, Parental Leave, Childcare, Family Policies, Career Interruptions.

JEL classification: D13, H24, H31, H71, I38, J1, J22, J31,

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Introduction and Summary

The thesis consists of four self-contained studies on wages, household labor supply, home production, and career interruptions. All of the papers are empirical studies on different topics in labor economics and are based on the Swedish (and in Paper [4] also Danish) data. Paper [1] considers the determination of wages and labor supply decisions for single- and two-adult households. These models for wages and household labor supply are constructed in order to be included in a dynamic microsimulation model[1]. Paper [2] focuses on single mothers' labor supply decisions and social welfare participation. Paper [3] is about home production and household productivity of two-adult households. The idea is to analyze changes in household production among two-earner Swedish households, and the results are compared to an earlier study based on the data from 1984. Paper [4] is a cross-country study on mothers' career interruptions due to childbirth. The study utilizes comparable data for Denmark and Sweden, and estimates parallel models for job retention.

The framework of the thesis is the economic theory of consumer behavior. Consumer behavior is presented in terms of preferences and possibilities, and it is assumed that families maximize their utility (from stable preferences) subject to a constraint on their resources (both time and income) and prices.

The economic approach has provided insight into and understanding of all kinds of behavior, not just the behavior related to material goods and wants, and not only to the behavior in the market sector. Although the economic approach stresses the familiar framework of allocation of scarce means to competing ends, it is more and more applied to non-standard situations. In recent years the systematic application of the consumer theory has greatly illuminated households' intractable behavior such as fertility, the uses of time, child-rearing, labor force participation and other decisions of families. Gary S. Becker (1976) argues that the economic approach is a comprehensive one that is applicable to *all* human behavior.

The assumptions of maximizing behavior, market equilibrium and stable preferences form the heart of the economic approach. However, adequate data is a crucial prerequisite for the testing

[1] SESIM, a dynamic microsimulation model developed at the Swedish Ministry of Finance, see, www.sesim.org

of economic theories. In Sweden, data have been collected systematically by different institutions over the decades for the purposes of researchers from different disciplines.

In the following, I describe first the data used in the studies of the thesis and then I give an overview of dynamic microsimulation which has played an important role while working as a researcher at the Ministry of Finance. Finally, a short summary of each paper will be presented.

Data

The role of theory in empirical analysis is, of course, fundamental. Theory serves the role of organizer of the data. But, it would be much more difficult to make inferences about economical issues without adequate data. In Papers [1] and [2] consumer theory is applied to a nonstandard situation, to labor supply decisions under a complex nonlinear budget constraints resulting from the Swedish tax and benefit systems. Labor supply of Swedish single-adult and two-adult households are studied utilizing the Longitudinal INdividual DAta (LINDA[2]) which provides us with a large and rich database. Making use of the good quality of the data, we are able to construct household budget sets with register-based information on incomes from different sources including the different tax schemes.

Paper [3] integrates the theory of the consumer with the theory of the firm. The theory of firm is used in that part of household decision making that is concerned with the efficient use of market goods (auxiliary goods), household time, and human capital as inputs in the production of utility-yielding, non-market goods (commodities). However, as might be expected, we cannot observe the household production processes no matter how good data we had. Since we only can observe a combination of some inputs, namely the household production time, but not any other inputs in the production process neither the output itself, many simplifying assumptions are made in order to be able to identify the household production function in the first place. However, following Kerkhofs & Kooreman (forthcoming) the household production function can be identified and estimated on the basis of household members' time inputs and the hourly wage rates only.

[2] LINDA is a joint endeavour between the Department of Economics at Uppsala University, the National Social Insurance Board (RFV), Statistics Sweden, and the Ministries of Finance and Labour.

The data used in Paper [3] are based on the 1993 Swedish Survey of Household Market and Non-market Activities (HUS[3]). The data contain information on a very large number of demographic and labor market characteristics of the individuals and their family members in addition to their home production activities. This data are collected by personal interviews in electronic form and telephone interviews, and some part of the information originates from administrative registers. The respondents are asked to report the time they spent on a large number of activities during one randomly selected day (24-hours recall diary).

Paper [4] considers career interruptions of women due to childbirth. It is a comparative study of Denmark and Sweden about the impacts of family policies on the decision to return to work after the childbirth. Our analysis takes advantage of the availability of comparable longitudinal data. These data allow us to estimate parallel models across the two countries in order to determine to which extent the different family leave policies affect women's retention. The impact of family policies and economic incentives on the probability of returning to the labor market is estimated with a flexible model of parental leave duration.

The data used in Paper [4] base on the Swedish LINDA database which is complemented with register-based information on parental leave periods and compensations (provided by the National Insurance Board, Sweden). For the Danish data we use the respective sources, the Danish Longitudinal Panel Database which are random register-based data provided by Statistics Denmark and additional register information from The Integrated Social Statistics. Since the data are longitudinal we are able to construct a model based on a continuous time duration.

Microsimulation

Microsimulation is a collection of tools that can be used in modeling and analyzing the behavior of individuals and other decision units in different economic, social and institutional circumstances. A microsimulation model can be seen as a set of rules which operates on a sample of micro units (individuals, households, firms). Such a model can be constructed to produce only the first order responses to a set of deterministic rules, which would be an example of static modeling. On the other hand, the model can be constructed in such a way that it encompasses the reactions or behavioral adjustments of decision units, which would make it dynamic

[3] For a detailed description of the HUS data, see Klevmarken & Olovsson (1993).

modeling. The essence of the microsimulation approach is, like the name suggests, first, the use of randomization in the assignment of values to the units studied, i.e. in prediction, and second, the use of individual units of analysis (Wolf, 2000).

The interest towards dynamic microsimulation has increased during recent years, and the growth in the number and variety of applications seems to increase. The approach has a diverse set of empirical applications in the social sciences, and it is now widely used in economics. Microsimulation has a short history as a methodology in economics. Although microsimulation has faced a lot of critique and skepticism, this approach has after the invention of the first microsimulation models in the US (Orcutt et al., 1961) been very successful during the past forty years. In fact, microsimulation models have become a standard tool for static analysis of tax and transfer policies and policy evaluation for proposed legislation in most Western governments. For example, the Swedish government uses a microsimulation model called FASIT, developed by Statistics Sweden and the Ministry of Finance. There are also international co-operation projects attempting to build simulation models for a common use, e.g. EUROMOD for the member states of EU. At the same time the approach has been less successful among academic economists who sometimes find it unacceptable to make compromises between theoretical and methodological rigor and to work on the basis of insufficient data and resources (Klevmarken, 1997 and 2001).

Microsimulation complements more traditional economic analysis. The fundaments of microsimulation are a good econometric model, data, and computer capacity. What makes the approach most valuable is that, for example, it could be used to analyze the impact of changes in economic and social policy on the distribution of target variables, not just the average effects. Further, it easily handles highly nonlinear relations and includes the true policy instruments, such as income tax schedules, eligibility rules and so on (Klevmarken, 1997 and 2001).

In Sweden there are some dynamic micro simulation model projects. The first models date back to early 1970s and they were developed for simulating the public pension system by the National Insurance Board (Eriksen, 1973). Other early efforts are the MICROHUS project by Klevmarken et al. which included both the tax and transfer systems and behavioral responses to policy changes, and yet another ambitious model SVERIGE[4] which is still an ongoing project. At the

[4] http://www.smc.kiruna.se

Ministry of Finance, a dynamic microsimulation project, SESIM, was set off in 1997, first for evaluating study allowances. This project has steadily been growing and to date SESIM entails the Swedish population in a micro scale and the associated behavioral socio-economic-demographic models over the whole life cycle.

The first paper of the thesis was written while I participated in the SESIM project in 2000. My objective was to implement in SESIM the models for hourly wages and household labor supply. The construction of models for SESIM does not differ from general econometric modeling, i.e., models are based on economic theory, high quality data (LINDA), and the models are tested using the statistical and econometric methods. In addition to the conventional descriptions of econometric modeling, Paper [1] presents some policy simulations applied to the labor supply models to test behavioral adjustments to policy changes. However, the most challenging part of the work is the implementation of the created modules into the model framework. Indeed, if the microsimulation output produces results that are unrealistic, there is no way out but to go back and try to re-specify the model. After all, dynamic microsimulation model offers very interesting and constructive approach towards evaluating and testing of estimated models.

Modeling Wages and Hours of Work

The labor market module plays an important role in a dynamic microsimulation especially when simulating long-term projections. The wage model and household labor supply models that are considered in Paper [1] are constructed for the purposes of SESIM. In order to serve the needs of dynamic microsimulation, models must be based on economic theory and they must be estimated using sound econometric inference methods.

Paper [1] considers the two most central issues in labor economics, the determination of hourly wage rates and households' labor supply. Although, both models are constructed in order to be included in SESIM, the models serve also as self-sufficient empirical studies based on recent the Swedish data. Using the estimated household labor supply models, we evaluate the elasticities of wage on labor supply for different groups in the Swedish labor market. We also carry out some policy simulations to evaluate the sensitivity of different groups to changes in income taxation schemes.

In the first part of the paper, we construct a model for predicting hourly wage rates. The starting point of the wage model is in the tradition of Mincer (1958), regressing the logarithm of wages on education, work experience and other characteristics that affect earning capacity. Since we have panel data, we suggest a random coefficient panel data model, where a part of the variation in wages is explained by the unobserved characteristics that are assumed to be time-invariant and individual-specific (e.g. ambition and motivation). Further, to account for the possible sample selection bias in the parameters of the wage model, we suggest a selection-correction model for the probability of observing a wage rate in a given year. The selection correction model explains the probability of being gainfully employed and it is modeled dynamically taking the previous year's employment status and other individual and family characteristics into account.

In the second part we construct household labor supply models for single- and two-adult households. In construction of the budget constraints, we utilize register-data and consider the complete tax and social security systems, which results in nonlinear budget constraints. Therefore, the household labor supply is modeled as a discrete choice problem. This approach has also some other important advantages compared to a continuous choice model. For example, there is no need to impose coherency conditions *a priori*.

The household labor supply is modeled assuming that preference for leisure and consumption can be described by a direct translog utility function. In the model specification we have taken into account fixed costs of working which might have an important effect on the decision to participate in the labor force. The models for labor supply are estimated separately for different types of households, for single mothers, single females, single males, and for cohabiting and married couples. The variation in preference for leisure is allowed to vary across households through the observed and unobserved characteristics.

Wage elasticities for different household types are assessed by simulations. Evaluated at the sample averages, values for the elasticities are found to range between 0.28 and 0.34. There are no noticeable differences in the estimated elasticities between the household types or between the sexes. In that respect, our results seem to be consistent with other recent findings. We also carry out two policy simulations considering new rules to income taxation. These tax-reducing reforms have a positive effect on the aggregate labor supply for each household type. The reforms imply positive incentive effects. Especially for males the labor supply responses are found quite large.

Labor supply and Welfare Participation of Single Mothers

One of the most widely discussed and controversial examples in almost all Western economies are the marginal effects caused by the interaction of the tax and benefit systems. In Sweden, a household that is eligible for social assistance, is also eligible for a number of other means-tested benefits such as free or heavily subsidized child daycare and housing allowance. Despite of the recognition of the vulnerable economic situation of these families, they are liable to income tax and a social security tax (the benefits are income-tested). According to a Swedish study (Eklind et al., 1997), a total marginal tax rate for an extra work effort for a non-working single parent is about 90 %. Thus, if the extra earnings bring the household over the welfare eligibility limit, the budget constraint has a sharp kink and the best choice for such a household will be either not to participate the labor market or not to increase the hours of work conditional on participation.

The question addressed in Paper [2] considers the incentive effects faced by single mother households in Sweden. The paper uses a similar econometrical framework as Paper [1], except that the welfare participation decision is incorporated to the labor supply model to allow for non-participation in welfare programs for eligible households. To examine the incentive effects we pursue some policy simulations. Specifically, we analyze the effects of changes in the gross wages, income tax system, child daycare payment schemes and social welfare eligibility limit.

To summarize the results, we find that there is a positive and significant stigma-effect associated with welfare participation. On the other hand, the estimated negative covariance between welfare participation and labor supply implies self-selection into welfare. Fixed costs of working have a negative impact on a single mothers' decision to enter the labor market. The policy simulations result in rather large average incentive effects, but these effects vary substantially over the income deciles. The evaluated reforms in the income taxation and social security systems result in substantial increases in hours of work for the lowest income deciles, whereas the effects are almost negligible for those belonging to the highest income deciles.

Household Production

Household production is an important part of economic activity, although generally ignored in national income accounting. The value of home production is estimated to account for 40 – 50 percent of the total production in Western countries, and in less advanced economies this fraction is presumably even higher (Bonke, 1992). A recent Swedish survey shows that, in total,

weekly time devoted to household work (126 million hours) is nearly the same as the time devoted to market work (128 million hours). The relative share of females in the household sector is 60 percent compared to males' 40 percent, while in the market sector the shares are shifted, males do 60 percent of the market work and females 40 percent (SCB, 2001).

By now the household production theory is an established part of economic theory. In the 1960s mainstream economists began to pay serious attention to household decisions, when Mincer's (1962, 1963) and Becker's (1965) pioneering work in New Home Economics imported quantitative methodologies to analyze household decision-making. This new approach was oriented toward the study of nonmarket commodities and the associated allocation of household time.

The estimation of household production is difficult when most of the inputs and the output are unobservable, and therefore the specification of the household production function plays an important role. The lack of information on specific household production inputs and production technology cause identification problems. Many earlier studies have failed in finding a satisfactory model, and even when they were solved analytically, the estimates were atheoretical. However, Kerkhofs & Kooreman (forthcoming) succeeded in their application of a specific parametric form for the production technology to Swedish time use data and their estimates showed satisfactory results.

Theoretically the household production in Kerkhofs & Kooreman was based on a Gronau model. In Gronau's (1977) model the amount of time spent on household production does not depend on the household utility function, conditional on household members having a paid job. The model Kerkhofs & Kooreman suggested allows also for joint production and describes household production by both spouses simultaneously. A household has one joint utility function which the partners intend to maximize.

The household production function is constructed on the efficiency conditions where the marginal productivity of work at home equals the wage rate. Therefore, the model is only identified to gainfully employed couples, which further raises the problem of sample selection. Hence the model is extended to take into account the possible selection bias. To overcome the identification problem caused by many unobserved inputs in the production process, the

estimated model is a quadratic specification of the net product value function with joint production and selection correction.

The idea in Paper [3] is to estimate a parallel model to Kerkhofs & Kooreman with more recent data. The overall stability of our results confirms that the applied specification provides a powerful tool to analyze household production. Our estimates satisfy the regularity conditions of utility maximization and are comparable with the previous study. In both studies, women's and men's home production time were found to be q-substitutes. The most outstanding result compared to the study for the 1984 data was that the productivity profiles of men and women have become more alike. For the 1993 data, the schedules of marginal productivity at home are more symmetric between males and females compared to the results for the 1984 data. The average value of one hour of home production has increased from 123 to 195 SEK

Career Interruptions due to parental leave

The work careers of women are often interrupted. During the period when women have children, some of them either withdraw from the labor market or work fewer hours. Parental leave mandates are associated with increases in women's employment, but with reductions in their relative wages if leave is of extended durations. According to many comparative studies, the impact of family policies on the mothers' (or fathers') return to work can be quite substantial. A large literature provides insights on how different policies result in different labor force attachments of women. Even though young children have a very strong negative effect on women's employment there is strong evidence that family leave coverage increases the likelihood that a woman will return to employment after childbirth. Ruhm (1998) investigates the economic consequences of paid parental leave in nine European countries and finds that a right to paid leave raises the employment rates of women. Even short durations of guaranteed work absence have a substantial effect on female employment.

We analyze in Paper [4] the impact of family policies of Denmark and Sweden on women's career breaks due to childbirth. These countries are culturally similar and share the same type of welfare state ideology, but differ remarkably in pursued family policies. This setting provides us with a fruitful point of departure to analyze explicitly the effects of different family policy regimes on job retention of Danish and Swedish mothers. We focus on mothers who had a partner and participated in the labor market and interrupted their careers due to childbirth during the 1990s.

Our analysis takes advantage of the availability of comparable longitudinal data and allows us to estimate parallel models across the two countries.

The timing of re-entry to the labor market is hypothesized to depend on a woman's full wage relative to her reservation wage. The probability of ending a career break and resuming employment is estimated using a Cox proportional hazard model. Our results show that the economic incentives are significant for the behavior of the mothers in both countries. However, the mere existence of different schemes and the maximum duration of the leave periods are very important determinants for the observed behavior of mothers.

If fathers were given longer periods of leave, would it shorten the career breaks of women? The role of the fathers seems to differ considerably between the two countries. In Sweden the fathers have much longer parental leave periods than Danish fathers have. Our estimations and policy simulations show that if Swedish fathers were encouraged (or given explicitly) to take more parental leave, it would promote the labor supply of women. For Denmark, we do not observe this substitution effect. One reason may be that the Danish paternal and parental leave schemes induce very few fathers to take longer leave periods, and therefore, we are not able to observe any substitution going on among the Danish parents.

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Modeling Wages and Hours of Work

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Abstract:
This paper consists of two separate parts. In the first part we introduce a wage model and in the second part we construct a household labor supply model. Both models are intended to be a part of the dynamic micro simulation model, SESIM, developed by the Ministry of Finance, Sweden. Hourly wage rates are explained by a random coefficient panel data model. To avoid the sample-selection problem a model explaining the probability of observing a wage rate is suggested. Labor supply of single- and two-adult households are modeled as a discrete choice problem. The household labor supply model is estimated assuming that preference for leisure and consumption can be described by a direct translog utility function. When constructing the households' budget sets the complete taxation scheme and the main social benefit programs are taken into account. The wage elasticities are estimated to about 0.3 for both females and males, irrespective of the household type. However, the responses to simulated tax reforms differ between sexes and household types.

Keywords: Hourly wage rate, Random effects, Panel data, Labor supply, Discrete choice, Policy simulation
JEL-classification: J22, J31, H24, H31, H71

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[1] The views expressed in the paper are the author's and do not necessary represent those of our employer

1 Introduction

This study is one part of the SESIM-project[2], managed by the Ministry of Finance, Sweden. SESIM is a dynamic micro simulation model developed by the Swedish Ministry of Finance in collaboration with researchers from different universities.

One important concern of the microsimulation project is to model individuals' earnings over the whole life cycle. Here we concentrate on labor market issues for individuals over seventeen and below the standard retirement age. The aim of the study is firstly to produce a wage model that is able to predict wage rates for those individuals who are employed, and secondly to construct a model that produces reliable estimates for household labor supply and labor force participation for different types of households.

A labor market module comprises a heart of a dynamic microsimulation model. The motivation in building up microsimulation models is to have a tool which could be used in analyzing the effects of changes in economic or institutional environment. In this sense labor market block lies in a center when examining the effects of changes, for example, in income tax and social security systems. And, the longer the range of the life histories a model attempts to simulate, the more central becomes the labor market histories of individuals.

In spite of the using these studies on wages and labor supply as a part of microsimulation model they serve other ends too. Determination of wages is an interesting issue itself. The latest Swedish data sources open new possibilities to study hourly wage rates. Also, studies on labor supply are of interest for a variety of reasons. The results can be used to test the predictions and implications of theoretical models. They may provide information on the sign and magnitude of effects about which theoretical models make no *a priori* assumptions. The empirical results are also an important tool when evaluating proposed government policies. How progressive income taxation and universal transfer programs influence households' labor supply is always a controversial issue among economists and policy makers.

The motivation for this study is threefold. First, we develop a labor market module in SESIM by creating the models explaining hourly wage rates and household labor supply. Second, to provide insight into the overall patterns in labor supply behavior. The influence of governmental programs on people's decisions of hours of work is often a critical consideration in the design of

[2] See www.sesim.org

policies. The primary objective of many recent reforms in both tax and welfare programs has been to encourage the labor force participants to increase their work effort. Therefore, understanding labor supply behavior is crucial in formulating proposals that invoke work incentives. The third motivation is to try to explain the factors underlying the changes in employment patterns that have occurred in recent decades. The main trends in the Swedish labor market consist of a strong rise in the female labor force participation rate and a slight long run decline in both hours of work and participation rates of men. Most time-series studies attribute both these effects to rising real wages (see, for example, Smith &.Ward, 1985).

The study is divided into two self-sufficient parts. In the first part we construct a wage model. Hourly wage rates are explained by a random coefficient panel data model. To correct for a possible sample selection bias, a structural model is suggested. The probability of being employed in a given year depends on the labor force participation in the previous year, and a set of other individual and family characteristics.

In the second part of the study we construct a household labor supply model. To estimate the optimal labor supply for microsimulation purposes, a behavioral model in terms of earned and unearned income is required. The accessible data allow us to construct realistic and detailed budget set for each household in the sample. Due to nonlinearities in the budgets sets caused by the interaction of the tax and benefit systems, we suggest a flexible discrete choice model for the household labor supply. Preferences for consumption and leisure (hours of work) are described by a direct translog utility function. This approach is based on the principle that a household chooses the outcome that maximizes the utility gained from that choice.

The estimates of the labor supply model are then used to examine the effects of changes in economic variables on labor supply decisions for different types of households. The measures for the elasticity of wage are assessed by simulations for different household types. To test the sensitivity of behavioral responses, the following policy experiments are implemented, a doubling of the amount of the basic tax exemptions and abolishing the progression in the income taxation. To properly evaluate the incentive effects of the tax reforms we would need to analyze the responses in different income brackets. Changes in the labor supply are not only due to changes in participation rates but also due to changes in hours worked among participants.

Both studies are based on the Longitudinal Individual Data for Sweden (LINDA) which are rich representative data of the Swedish population. Since all information about different income types

and taxes in LINDA is based on registers we can expect to get more reliable results from these models. As was shown in Ericson & Flood (1997), estimates of the parameters in labor supply models are very sensitive to measurement errors in economic variables, which is usually the case when using other than register-data.

The outline of the paper is following. The first part of the study begins with the formulation of the wage model that is given in Sections 2 and 3. Section 4 introduces the data that are used in the estimation. The results from the first part of the paper are discussed in Section 5. The second part starts with the presentation of the framework and motivation of the labor supply model in Section 6. In Section 7 we specify the labor supply model for four different types of households. The database and descriptive statistics are presented in Section 8. Finally, in Section 9 we present the results from the model estimations and policy simulations. The concluding section sums up the results and discusses the possible future developments of the labor market module in SESIM.

2 Wage Model

The purpose of the wage model is to be able to predict or simulate hourly wage rates for the agents in the dynamic micro simulation model SESIM. Thus, the specification of a model must precede microsimulation. However, all information about the individuals in SESIM is either generated by different models, or sometimes just by simple transition matrices. A consequence is that information about the characteristics of the agents is meager, which perhaps restricts the explanatory power of the model. So, even though there exist rich external data sources available that could be used in determining individuals' wage rates, it is of no use if the same variables are not found in the microsimulation environment. This means that in the estimation we have to restrain the explanatory variables to those that are compatible with our microsimulation model.

We begin the study of wages by constructing a structural wage equation where the prediction of wage rates is modeled in conjunction with a separate dynamic discrete panel data model, which corrects for the possible sample selection bias. In the estimation, the large panel data, LINDA, covering the period 1992 - 1996 are used. The data are described in more detail after the model specification in the next Section. Section 5 discusses the estimation results of the structural wage equation.

3 Empirical Specification

An empirically important issue when calculating optimal labor supply is first to assess a wage variable for all those individuals who might participate in the labor force. However, there are various difficulties associated with the procedure of predicting wage rates for those not participating in the labor force. Another concern arises from the empirical definition of the wage rate variable. Typically, we do not have information about the hourly wage rate variable that is measured independently of hours of work. Most commonly, the wage rate is calculated by dividing annual earnings by annual hours. This method usually leads to a downward bias in the estimated wage elasticity as long as there are measurement errors in the observed hours of work. Due to the definition of the wage rate, a spurious negative correlation between hours of work and the wage rate is created. This problem of the so-called division bias is recognized in the literature, see, for example, Borjas (1980) and Ericson (2000).

Here we are able to circumvent the problem of division bias because the LINDA data have an incremental data set for monthly wages and hours of duty. This additional data source provides us with reliable register-based information of the two most important variables, the wage rate and

hours of work. Monthly earnings are given in the data for everyone as if one were working full-time. Hourly wage rates are calculated by dividing monthly earnings by the "standard" full-time rate of 165 hours per month. Annual hours of work are then calculated by dividing the annual labor income by the wage rate. Hence, the definition of hours of work is based on paid hours, not on actual hours worked.

Yet another problem that may arise when predicting wages is a selection bias in parameters. In the estimation, we use a sub-sample of individuals participating in the labor force. The wage rate is missing on some of the observations in a systematic way, because it is unobserved for those who are not working. One solution to this selection problem is to use type 2 Tobit model approach, which we apply here. The structural model for hourly wage rates is based on the value of a latent variable (D_{it}^{*} in our model) such that the wage rate will be observed only when the latent variable exceeds a certain value (zero). The idea of a latent variable is that there is an underlying propensity to work that generates the observed state (theoretical considerations in Heckman, 1981, and in Maddala, 1987).

Since we have longitudinal data available, we use a panel data approach in modeling wages. In the empirical specification we make use of the panel property of the data by allowing for individual specific random effects. The random effects estimator is expected to capture time invariant unobserved heterogeneity that affects productivity (reflected in wage rates). To correct for selection bias in predictions we build a structural wage model, specifically:

$$W_{it} = \begin{cases} \beta' x_{it} + u_{it} + \alpha_i & if \;\; D_{it}^{*} > 0 \\ 0 & if \;\; D_{it}^{*} \leq 0 \end{cases}$$

$$D_{it}^{*} = \begin{cases} \gamma' z_{it}^{2} + \rho D_{i\,t-1} + v_{it} & if \;\; t > 1 \\ \delta' z_{it}^{1} + v_{it} & if \;\; t = 1 \end{cases} \qquad \text{i = 1,...,N, and t = 1,...,5} \tag{3.1}$$

where $D_{it} = 1$, if $D_{it}^{*} > 0$, and
$D_{it} = 0$, otherwise.

In the first equation, W_{it} denotes the logarithm of an hourly wage rate and $\boldsymbol{x}_{it}$ a vector of observed variables for the i^{th} individual in period t. α_i is a stochastic variable capturing the unobserved individual-specific effect, which is assumed to be constant over time. Regarding the

random effects, we assume that they follow a normal distribution. It is assumed that the wage rate, W_{it}, is observed only when D_{it}^{*} is positive.

A latent variable D_{it}^{*} is used to explain the observed outcome D_{it} ($D_{it} = 1$ if a person has a paid job and $D_{it} = 0$ if he or she has not). The probability of observing a wage rate is modeled as a dynamic discrete panel data model. The employment status in the preceding period, i.e. the lagged observed outcome, $D_{i\,t-1}$, and some other individual and family characteristics determine the current probability of observing a wage rate. The distribution of D_{it}^{*} is assumed to differ between the first observation (t = 1) and the rest of the observations (t >1) for individuals. Since the error term is distributed normally by assumption, the equation for D_{it}^{*} specifies a probit part of the structural model where $D_{it} = 1$ (if $D_{it}^{*} > 0$) and W_{it} constitute the observed sample.

To estimate the model, we further assume that the error terms of the structural equations are normally distributed, such that $u_{it} \sim N(0, \sigma_u^2)$, $v_{it} \sim N(0, \sigma_v^2)$, and $\text{cov}(u_{it}, v_{it}) = \sigma_{12}$. If the covariance between the error terms, σ_{12}, is zero, selection bias will be no problem. However, the inclusion of the selection correction model might increase the efficiency when estimating the parameters in the wage equation (Heckman, 1981).

The selection equation for the first observed year (t =1) is different from the rest (t >1) of the periods of observation, since we do not have information about the employment status of an individual from the previous period when the equation for the first year is estimated. Because the value for D_{it} is missing for the period t = 0, we have a so-called initial condition problem (Heckman, 1981), which is solved by constructing a separate equation for the initial period. Instead of using the lagged value ($D_{i\,t-1}$) which is missing, three additional interaction variables are included to the first year's selection equation. The common variables for both selection equations are gender, age, age squared, number of children, and dummy variables for education levels, having a partner, place of residence, and nationality.

As mentioned before, we can only include a restricted set of explanatory variables to the wage equation (the restriction does not concern the selectivity equation). The wage equation includes the following variables, age, age squared, the level of education, gender, and a random coefficient which captures the unobserved individual-specific characteristics.

The likelihood function of the structural wage model is given by:

$$L = \prod_{0} P(D_{it}^{*} \leq 0) \prod_{1} f(W_{it} \mid D_{it}^{*} > 0)\ P(D_{it}^{*} > 0) \qquad (3.2)$$

where $\prod_0$ and $\prod_1$ stand for the product over those *i* for which $D_{it} = 0$ and $D_{it} = 1$, respectively, and $f(W_{it} \mid D_{it}^{*} > 0)$ denotes the conditional density of W_{it}, given $D_{it}^{*} > 0$.

The parameters of the structural model are estimated by the maximum likelihood technique. The results from the wage model are given in Table 2 (Appendix).

4 Data

For the empirical application of the wage model we use large Longitudinal Individual Data for Sweden (LINDA[3]). LINDA is register-based longitudinal representative data of the Swedish population. The data consist of a large panel of individuals and their household members (since 1968). There are also incremental register data for monthly wages and hours of duty (recorded as a fraction of full-time working hours). This additional database contains information about all those who are working in the public sector and approximately half of those working in the private sector. In total, the panel database contains information of about 300 000 households annually, which constitutes a large sample for our purposes.

The panel sample is taken from five years, from 1992 to 1996, so that every individual is followed over the whole period of time. The sample consists of 49 040 individuals who are 18 - 64 years old. Since the sample is balanced, the sample include 245 200 observations (N) in total.

The sample consists of both those who are not labor force participants and those who are gainfully employed provided that they had recorded values for monthly wages. This means that a part of those who are working in the private sector was excluded because of the unobserved monthly wages. Otherwise, the selections are made only on the basis of age, so that each individual would be in his or her working age during the observation period, which means that the sample consists of individuals between the age of 18 and 64. Observations that appeared to

[3] LINDA is a joint endeavor between the Department of Economics at Uppsala University, The National Social Insurance Board (RFV), Statistics Sweden, and the Ministries of Finance and Labour.

have excessive values as their hourly wage rates are excluded. The monetary values of the economic variables were deflated to prices in 1996[4].

An example of the sample statistics is shown in Table 1.1 (year 1992) and in Table 1.2 (year 1996) (Appendix). The sample consists of 49 040 individuals altogether and 41 % of them are men. About 75 % of them are either employed or self-employed. Their mean hourly wage rate is 103 SEK and the annual hours of work is 1 432 on average (calculated as a mean value of all individuals in the sample).

The dependent variable for the wage equation is (logarithm of the) hourly wage rate that is calculated by dividing the observed monthly earnings by the ”standard” full-time rate of 165 hours per month. And, for the selection equation the dependent variable is an indicator for the observed employment status.

In the structural wage model the key variables are age, education, gender, number of children, place of residence, and nationality (not all of the variables are available for the wage model due to restrictions in characteristics of the SESIM-population). Education is measured by categories corresponding to the highest attained degree of education. The four classes are primary school degree (not more than 2 years of high-school education), high-school degree (more than 2 years of high-school), bachelor's degree (not more than three years of education after high-school), and university degree (more than three years of education after high-school). The dummy variables for the place of residence are measured by the size of the city where an individual is living. These municipalities are divided into three groups accordingly (big cities, small towns, and countryside). Nationality is measured with dummy variables indicating an individual's native region. Countries of origin are grouped to four classes, the first representing the native Swedish, the second Nordic countries, the third Western countries, and the fourth refugee countries.

5 Results from the Wage Model

The results from the estimations of the structural wage model are presented in Table 2 (Appendix). Below the estimation results are discussed in more detail.

[4] Annual average, (Årsgenomsnittet), supplied by Statistics Sweden.

The estimated parameters of the wage equation show expected signs and are statistically significant. Hourly wage increases at a decreasing rate with age (a proxy for work experience), and increases with the level of education. As anticipated, men have higher wage rates than women. For the individual specific effect we estimated a standard deviation to be twice as high as the estimated standard deviation of the classical error term, which supports the relevance of a panel data model approach. We also allowed for correlation between the wage rate and the employment status. If we could capture a covariance between the error terms for the equations it would thus signal a selection bias. It appears, however, that the selection bias is not a problem here since the estimated covariance is not significantly different from zero.

The parameter estimates for the selection equations for the first year (the initial condition) and for the other years ($t > 1$) share the same signs in most cases. There is a significant and strong positive effect of having a wage in the current period if the person was gainfully employed in the preceding period, implying that a person employed in a certain period has a very high probability of being employed in the subsequent period. The other estimated effects show expected signs too. The probability of being employed clearly increases with age and the level of education (the lowest level being the reference). Having a foreign background decreases the likelihood of being gainfully employed. The parameter estimate for gender implies that males are less likely to be in employment. This might be explained by the fact that half of the private sector employed (where the males dominate) is excluded from our sample due to missing information on wages and since the observations of excessive values were excluded as well.

To summarize, our aim was to construct a wage model that could provide us with trustworthy parameter estimates for the simulation of hourly wage rates for individuals in the SESIM model. One way to explore this trustworthiness is to compare the wage rates produced by the model to the observed ones. We noticed that the predicted wage rates resulted in accurate values. Even though we only could use a restricted number of characteristic variables in the prediction, the model was able to predict reliable measures of wage rates. Moreover, the probit model for participation could capture well the employment status of the individuals. Thus, we can conclude that this model can serve the needs of the microsimulation, the outcome is a rather simple model for wage determination which bases on economic theory and uses sound econometric inference methods that are the prerequisites for microsimulation modeling.

6 Household Labor Supply

Labor earnings constitute a major part of the lifetime income for most of the households. Modeling of household labor supply behavior is therefore a central part of dynamic micro simulation models. Our intention is to construct a household labor supply model that produces reliable estimates for the labor supply behavior of single- and two-adult households for the SESIM model. The idea is to build up a model that suits well for extensions in various directions. For example, these extensions would allow us to study some important aspects of household labor supply, such as the effects of taxes and social security benefits and the effects of constraints imposed by the demand side of the labor market.

Modeling household labor supply bases on the idea of a static neoclassical model with one joint household utility function in which consumption and leisure of both partners appear as choice variables. For single-adult households the decision is analogous. Individuals make decisions over their hours of work (leisure time) and consumption by maximizing their utility subject to a specific budget and time constraints.

In our basic framework we emphasize the separation of income into different categories and the correct representation of net income at all levels of gross income. This is reasonable because we have an access to the register-based LINDA data. Households' budget constraints are calculated realistically by taking the tax systems and the most important social benefit programs into account, and by trying to construct as complete budget sets as possible. However, in many cases this results in nonlinear budget constraints. The Swedish progressive tax and social security systems cause non-convexities in the budget sets, which in turn can make the estimation of labor supply more difficult with traditional methods.

The traditional way to model labor supply assumes that the decision variable – hours of work – is continuous and unconstrained. Since our motivation is to have a tool which could be used to analyzing the effects of tax and transfer systems on labor supply, we have to abandon the assumption of a linear budget constraint of the traditional neoclassical model and take a more realistic view of the constraints faced by households. The kinked budget constraints create two difficulties that have several interesting aspects. One difficulty is that changes in tax and transfer schedules can have unexpected effects that can be exactly opposite in sign to those expected from economic theory. The second difficulty relates to the implications of kinked budget constraints for the estimation of utility functions. Such constraints make estimation quite difficult for reasons that are often closely related to the economic theory and to the nature of economic

behavior of individuals (coherency conditions are discussed in Moffitt, 1990). To avoid imposing restrictive conditions we can treat the labor supply decision as a discrete choice problem instead. In this framework, it is straightforward to include the complete taxation scheme and social benefit programs. We assume that individuals can choose their hours of work among seven different discrete working states, ranging from non-participation to a maximum of 3 000 hours of work annually (by 500-hour steps). An important advantage of the discrete specification compared to the continuous is that the coherency conditions do not have to be imposed *a priori,* but can be tested *ex post* (see, van Soest, 1995).

The neoclassical approach can be criticized about its simplistic assumptions about the rational consumers who are free to vary the hours of work in order to maximize their welfare. In reality, the hours of work are not at the complete discretion of the worker. This means that households sometimes have to make a second best choice. As some studies have reported, there are groups of workers who experience some form of rationing. An important group for whom this type of rationing may be a fair approximation consists of secondary workers in the households, particularly married or cohabiting women. Many potential second workers choose not to work. According to labor force surveys, a greater proportion of females would have been willing to work part-time had such jobs been available (further discussion of hours constraints in Sweden, see Sacklén, 1996).

The hours restriction is relaxed here even though the labor market in Sweden shows some signs of rationing. We can argue that workers can choose their hours freely by choosing between different jobs (at least in the long run). One can also argue that the problem of rationed workers is not that severe because of the fact that there are part-time jobs available, especially in the public sector.

Another restraining assumption of utility maximizing behavior concerns the budget constraints that the individuals face. As was pointed out in Klevmarken et al. (1995), people do not usually have a full knowledge about their budget sets. The tax and social transfer programs are so complex in most Western countries that most people do not know all the details of these programs and subsequently would not be able to adjust to each of them. Of course, it can be assumed that modest changes in taxation do have an influence on people's decisions over their hours of work.

There are more assumptions and restrictions placed on the labor supply behavior when we examine the problem within a family context. In a two-adult household labor supply model we need to acknowledge the preferences of both individuals and the complex set of incentives that the household faces resulting from the full tax and social welfare programs. There are alternative ways to model household decision in these circumstances. The standard neoclassical approach assumes that the husband is a so-called primary worker and ignores the labor income of his wife. Another approach considers the spouses in a symmetrical way, the income from all sources is combined into a single income measure, which implies that the source of income is irrelevant to labor supply decisions within the family. Yet another approach is to find a solution to the two-adult decision problem within a collective labor supply model that seeks solutions from efficient bargaining theory. (Blundell & MaCurdy, 1998)

The approach chosen here is to treat spouses in symmetric way. The Swedish income taxation is built to promote individual work effort, yet, most of the social policy measures base on family income.

Four different household labor supply models are estimated for different household types, for single mothers, single females, single males, and for cohabiting and married couples. First, we describe how the budget sets of the households are built. In Section 6.2 a model for predicting wages is suggested for those not having an observed value. The wage equation will be estimated separately for the different household types. Section 6.3 introduces the empirical specification of the labor supply model. In Section 7, the LINDA data, which are used in the estimations, are presented together with the descriptive statistics. Results from the labor supply models are presented in Section 8. In Section 9, we explore the effects of changes in wages and income on the labor supply of different households by using simulations. Section 10 concludes.

6.1 Budget Set

When trying to predict labor supply behavior it is essential to calculate the disposable income as accurately as possible. Thus, we consider here the effects of abandoning the linear budget constraint of the neoclassical model and take a more realistic view of the constraints faced by the households. The budget sets are calculated by taking the complete taxation scheme and the most important social benefit programs into account. Specifically, the budget set for a two-adult household can be written as:

$$C = C_h + C_w + B \tag{6.1}$$

The components of the budget set are given as:

$$C_i = W_i h_i + Y_i + V_i - t(I) \qquad i = h, w \tag{6.2}$$

where C is the disposable income, W is wage per hour, h is hours of work, Y is taxable non-labor income, V is non-taxable transfers, and the function $t(.)$ determines the total amount of taxes after the deductions has been made. B denotes the three major transfer programs (separated from V) that are targeted to families, i.e. housing allowance, social assistance and the publicly subsidized child daycare. The index i (= h, w) is denoting an individual, or a member of a household (husband and wife).

The budget sets are evaluated at 7 and 49 discrete points of hours of work for single- and two-adult households, respectively. The budget set of a household comprises the potential labor income and non-labor income the household is entitled to given the hours of work choice. For two-adult households the budget is defined as the sum of each spouse's net non-labor and labor income. The wage rate is observed for almost two thirds of the individuals in the LINDA data, but for non-participants we use predicted wage rates in the calculations. In particular, the three major transfer programs, social assistance, housing allowance, and publicly subsidized child daycare (private or public) costs, as well as the tax-system are considered in detail.

The rules determining the eligibility for social assistance is rather complicated and they also differ across municipalities. Here we calculate a maximum level of disposable income to qualify for the benefit, a so-called "norm", based on the information about the state average level. As a result, the amount of social assistance a family gets is simply the difference between the norm and the household's disposable income.

Housing allowance is determined by nationwide rules and is mainly directed to families with children. The net household income, housing expenditures, number of children, and the ages of parents determine the amount of the benefit a household is entitled to.

In Sweden, the childcare services are publicly subsidized and fees vary with the municipality, household's income, and number and the ages of the children (the rules in 1996). Here we

construct a daycare payment scheme that depends on the number of hours worked (i.e. the demand for the service) and the number and ages of the children. We simplify the rules somewhat and use a system based on the average cost of the municipalities.

Typically in labor supply studies the child daycare costs are embedded in child dummy variables in the labor supply function. However, in addition to the effects of childcare costs, the dummy variables also capture the effects of the mother's preferences. Since it is not obvious how one should interpret these estimates, an explicit recognition of childcare costs and the effects of the presence of children are preferred. Therefore, we include a variable for the number of children and a dummy variable for the presence of a young child to the labor supply model for single mothers and two-adult households. One reason for considering the effects of the number and the age structure of children is that both the childcare costs and the mother's preferences may differ accordingly (for a further discussion of the modeling of childcare in labor supply, see Ilmakunnas, 1996).

In the calculation of the budget sets we use a modified version of a static microsimulation model FASIT (provided by Statistics Sweden) which includes the detailed rules on taxes and social benefits. The budget set is constructed for each household with varying hours of work in order to be able to derive the possible behavioral responses to changes in economic variables. Any change in these variables implies a change in the budget set, which in turn might cause a behavioral adjustment in hours of work. In Section 9 we evaluate the behavioral responses to an increase in wages and income. The sensitivity measures for wage changes (wage elasticities) and the incentive effects of changes in income tax regulation are calculated by a simulation method.

6.2 Wage Predictions

One of the basic and most consequential explanatory variables in labor supply models is hourly wage rate.[5] For our model wage rates are needed for each individual and we only have it for those who are employed (or actually for two thirds of them) but not for those who do not participate in the labor force. We have only observations on that part of the sample satisfying the reservation wage condition, which is by no means a random or representative selection. In the literature the problem is known as sample-selectivity problem. As a consequence, we cannot straightforwardly regress observed wages on the personal characteristics of those who work, when we make

[5] A more detailed discussion about the issue in Andersson et al. (1993).

inferences about the complex distribution of wage rates (discussed also in Section 3). To take into account the possible sample selection bias, we use Heckman's (1979) approach in predicting the wage rates.[6] This method involves a two-stage procedure. In the first stage we estimate a probit model for labor force participation. Based on this estimation, a correction term, the inverse of Mill's ratio, is constructed. This correction term is then included in the second-stage OLS-estimation as an independent variable in the wage equation. Hence, the independent variable determining the participation in the labor force exerts an indirect influence through the participation rate on the mean of the observed wage distribution and other factors that influence the decision (Heckman, 1979).

The LINDA data that we use contain information about the monthly wages and (a share of full) hours of duty. Thus, the hourly wage rates and hours of work are calculated using this register information by dividing the monthly wage by the standard full-time hours (165 hours/month). The wage equation is estimated separately for the four household types and the missing values will be replaced by the predicted wage rates. In the probit- and OLS-estimations we use a wide variety of individual and family characteristics, such as age, number of children, regional unemployment rate, level of education, place of residence, having young children (less than seven years old), and nationality. The estimation results are shown in Table 4.1 - 4.5 (Appendix).

6.3 Empirical Specification of the Labor Supply Model

As discussed earlier, we choose a discrete choice approach in modeling household labor supply because it is flexible and allows for non-convexities in the budget sets. Moreover, there is no need to impose coherency conditions *a priori*, but can be tested *ex post*. This is an advantage compared with the continuous choice model suggested by Burtless & Hausman (1978). In the continuous approach a number of simplifications must be imposed to the tax and transfer systems, and it also necessarily presupposes certain parameter restrictions in order to be statistically coherent. The coherency problem is further discussed in MaCurdy et al. (1990) and van Soest (1995).

For the empirical specification we assume that preference for leisure and consumption can be described by a direct translog utility function. This type of econometric model is used in van Soest (1995) and also in Flood et al. (1999). Individuals make decisions over their consumption,

[6] Since this study is separate from the first part of the study we do not intend to use the wage model received there.

C, and leisure time, *T* - *h*, by maximizing their utility subject to a budget constraint and the total time endowment, *T*. The specification is the following for the single-adult households:

$$U(C,h) = \beta_C \log(C) + \beta_h \log(T-h) - \beta_{FC} DW + \\ \beta_{CC} (\log(C))^2 + \beta_{hh} (\log(T-h))^2 + 2\beta_{Ch} \log(C) \log(T-h) \quad (6.3)$$

And, for the two-adult households:

$$U(C,h_h,h_w) = \beta_C \log(C) + \beta_h \log(T-h_h) + \beta_w \log(T-h_w) - \beta_{FCw} DW_w - \beta_{FCh} DW_h + \\ \beta_{CC} (\log(C))^2 + \beta_{hh} (\log(T-h_h))^2 + \beta_{ww} (\log(T-h_w))^2 + \\ 2\beta_{Ch} \log(C) \log(T-h_h) + 2\beta_{Cw} \log(C) \log(T-h_w) + 2\beta_{hw} \log(T-h_h) \log(T-h_w) \quad (6.4)$$

The utility function is assumed to be increasing with consumption, *C*, and decreasing with respect to hours of work, *h*. For two-adult households, the utility is assumed to be a function of three arguments: hours of work of husband, h_h, hours of work of wife, h_w, and family consumption, *C*. Commodities are consumed jointly rather than separated into two bundles. Even if such a separation were possible in principle, the separate consumption bundles are usually unobservable, unlike the labor supply of each spouse.

The total time endowment, *T*, is set to 4 000 hours per year. Normally, the full-time work is considered to be 2 080 hours per year (40 hours per week). The discrete choice of labor supply considers seven choices of hours of work: ranging from 0 to 3 000, in 500-hour steps, for single-headed households. Correspondingly, for the two-adult households there are now two individuals making the decision among the same amount of discrete choices, so that there are altogether 49 (= 7∗7) different employment states.

We make an assumption that if a person works, she (or he) incurs a fixed working cost, and if she does not work, she does not incur the cost. A fixed entry cost acts like a tax on working and reduces the probability to participate in the labor force. The fixed costs are incorporated in the utility function with a dummy variable, DW_i, so that it captures the effect of the cost only if a person is working. Since the utility is increasing with income, positive fixed costs decrease the utility of working but do not affect the utility if one is not working. Consequently, these costs make working less attractive and decrease the probability of working.

Another assumption that is made is related to the intra-household decision-making. We assume that the labor supply decisions are made jointly in two-adult households. We further assume that leisure time of spouses may be complements as well as substitutes. Typically, the household work time of husband and wife (denoted here as leisure) are substitutable when it comes to, for example, looking after children, while complements when sharing the leisure time.

To be able to estimate the models, the nature of heterogeneity in the households' preferences and the stochastic disturbances are specified. Preference variation across households through observed and unobserved characteristics can be incorporated in the parameters (the β's below). Heterogeneity in the preference for leisure in the two-adult case (and accordingly in the single-adult case) is introduced as:

$$\beta_h = \sum_{i=1}^{k} \beta_{hi} x_{hi} \quad \text{for husbands, and} \qquad \beta_w = \sum_{i=1}^{k} \beta_{wi} x_{wi} \quad \text{for wives} \tag{6.5}$$

where the *x*-variables consist of observed individual and family characteristics: age, education and the number and the ages of the children. The intercept represents unobserved characteristics that affect the preference for leisure. The interpretation of this unobserved heterogeneity parameter is straightforward: the higher its value the higher the preference for leisure.

Adding an additive error term to the household utility function, assumed to be extreme value distributed, results in a conditional logit model. The contribution to the likelihood function for a given household becomes:

$$L_h = \frac{\exp(U_{i'j'})}{\sum_{i,j} \exp(U_{ij})} \tag{6.6}$$

In the equation above *i* and *j* indicate hours of work for husband and wife, respectively, and L_h indicates a household (accordingly for the single-headed households). We assume that a household chooses the labor-supply-state for which the utility is the largest. The expression (6.6) denotes the probability that the utility in the observed state (*i'j'*) is the highest amongst all possible combinations of hours of work.

The main disadvantage of the discrete choice approach is the introduction of a classification error in hours of work due to the discrete classification of hours. In the specification of measurement errors (or classification error in this case), we follow MaCurdy (1990), and assume a multiplicative error structure. Let H_h and H_w denote observed hours and h_h and h_w optimal discrete hours, the multiplicative classification error specification is given as:

$$H_i = h_i e^{\varepsilon_i} \qquad \text{with } \varepsilon \sim N(-\tfrac{1}{2}\sigma_i^2, \sigma_i^2) \qquad \text{for } i = h, w \tag{6.7}$$

Thus, zero hours are observed with certainty but when optimal hours are positive they differ from observed hours by a factor of proportionality. Hence, in presence of the classification errors, the contribution to the likelihood function is given by:

$$L_h = \frac{\exp(U_{i'j'})}{\sum_{i,j}\exp(U_{ij})} * g_h * g_w \tag{6.8}$$

where g_h and g_w are densities for the classification error for the husband and wife, respectively. The assumptions made about the classification error implies that:

$$g_i = \begin{cases} 1 & \text{if } H_i = 0 \text{ or } h_i = 0 \\ \dfrac{1}{\sigma_i}\phi\left(\dfrac{[\log(H_i) - \log(h_i)] + \tfrac{1}{2}\sigma_i^2}{\sigma_i}\right) & \text{otherwise} \end{cases} \qquad \text{for } i = h, w \tag{6.9}$$

7 Data and Descriptive Statistics

For the estimations of the household labor supply models we use the LINDA database which is presented in the next section. Section 7.2 describes the samples for different household types and presents the summary statistics. The labor supply model is estimated for the four different household types, and the results will be presented in Section 8.

7.1 Data

The accessible and most appropriate dataset for our purposes is the LINDA data (Longitudinal Individual Data for Sweden). Here we use a cross section of the data drawn from the year 1996. LINDA is a register-based longitudinal representative data of the Swedish population. For

LINDA there are also incremental register data for monthly wages and hours of duty (fraction of full working hours). This information is available for all those who are working in the public sector and for about half of those who are working in the private sector. In total, the database contains information on about 300 000 individuals and their household members annually, which constitutes a large sample for each four type of a household in interest: single mothers, single females, single males, and two-adult households.

Since all information on income from various sources and different taxes in LINDA is based on registers, it is possible to calculate realistic budget sets and to overcome some typical shortcomings in labor supply studies. Andersson et al. (1993) find that in surveys people usually underreport some crucial income components. Evidently, all the variables that are needed to define disposable income are important and the estimated parameters will be sensitive to errors in these variables. Ericson & Flood (1997) demonstrate that measurement errors in the independent variables can cause severely biased parameter estimates. In general, a proper treatment of complicated nonlinear budget constraints is essential, not only in order to receive consistent parameter estimates, but also from the policy analysis point of view.

The problem with register-based data is, however, that they do not contain as many useful characterizing variables as survey data usually do. Thus, some of the variables of interest have to be imputed by various methods. For example, when constructing the budget sets we needed a measure for the housing costs. The variable is imputed by a minimum distance method with the help of another database, HINK (the Swedish Household Income Survey, supplied by Statistics Sweden), which contains survey data for the housing costs.

The LINDA data are organized according to the information on each individual separately, which means that the families are selected by combining the family members to constitute a household. In this study the sample of two-adult households consists of those with the traditional family composition: two adults - a female and a male - and possibly children if they were under 18 years of age.

The explanatory variables that are used in the wage model are created by effectively using the information from the data source, but in the labor supply model we can only use the variables that are also available in SESIM, which is very restricted in characters. Education is measured by four dummy variables corresponding to the highest attained degree: primary school, high school, bachelor's degree, and university degree. Place of residence is categorized to three classes

according to the population. Classes for nationality are grouped according to the country of origin: Sweden, Nordic countries, Western countries, and so-called refugee countries. The regional unemployment rate was chosen for an explanatory variable to capture the differences in wage rate and in participation probability. To account for the effects of the presence of children, variables for the number of children and an indicator for a young child (< 7 years) are created.

7.2 Descriptive Statistics

Samples for the four different household types are selected from the LINDA database (1996) such that they would best represent the household type of interest and so that they would be able to respond to the changes in the economic environment, which means that household members are either voluntarily unemployed or are employed and have observed values for wages and hours of work. Most of the latter work in the public sector. To focus on the central questions of the study, the early retired, full-time students, long-term unemployed, and those on parental leave were excluded. A more detailed description of the household samples is given below and the summary statistics of each sample is presented in Tables 3.1 - 3.4 (Appendix).

The sample of single mothers consists of 10 533 households (having children under 18 years of age). In 58 % of these households there are young children (less than seven). In the sample, 78 % of the single mothers are working, having 92.37 SEK as their mean hourly wage rate. They work 1 585 hours and their labor earnings are on average 148 489 SEK. The descriptive statistics is given in Table 3.1. Of all the single-mother households in the sample, 16 % receive social assistance and 69 % housing allowance, whereas 21 % and 89 % of them, respectively, were actually eligible to these allowances according to the eligibility rules and when compared with their household income. The difference between the eligibility and the receipt figures can be explained partly by the lack of information about eligibility and the possibilities to apply for those benefits. Also, as some studies have suggested, this might be due to the so-called stigma effect (Moffitt, 1983). Empirical results received, for example, by Kalb (1998) and Flood et al. (1999) indicate that there is evidence of disutility associated with welfare participation

The summary statistics of single female households is shown in Table 3.2. The sample consists of women who live alone and have no children under the age of 18. There are 13 530 households in the sample and 79 % of the single women are working having 93.58 SEK as a mean hourly wage rate. Those who are employed, work 1 765 hours on average, and their mean labor income is 168 055 SEK. In comparison with the sample of single mothers, the single females receive much

less social benefits. Only 7 % and 6 % of the households receive social assistance and housing allowance, respectively (at least at some point of the year). And, according to the eligibility rules and our calculations, 19 % and 10.5 %, respectively, were entitled to those benefits. These lower figures are due to the fact that both of the benefits mentioned are means-tested, and that the eligibility depends also on the family composition.

The sample of single male households consists of those men living alone without a partner, but they may have children to take care of. There were 17 647 such households in the sample and about 5 % of those, 983 households, have 1 - 4 children. 69 % of the men in the sample are working, having 105.80 SEK as a mean hourly wage rate. They work 1 975 hours and their labor income is 211 200 SEK on average. About 10 % of the households receive social assistance and housing allowance, whereas 17 % and 27 %, respectively, were eligible for these benefits according to their economic and family situation. The sample statistics is shown in Table 3.3.

The sample of two-adult households consists of the traditional families. There are 33 440 families of that type in the sample after the selections were made (mentioned above). In the two-adult household sample, 85 % of the females and 82 % of the males are working. The participation rates are higher than those of the single-headed households. About 60 % of the households have children and about half of those have children under seven years old. Only 4 % of the households in the sample are welfare participants and 13 % are receiving housing allowance. About 9 % of these households would have been eligible for social assistance according to our calculations. The sample statistics is shown in Table 3.4.

8 Results from the Labor Supply Model

In the following, the estimation results from the wage model and the labor supply models are discussed. Section 8.1 presents the results from the Heckman two-stage wage model. In Section 8.2 we discuss the results from the labor supply model. The obtained parameter estimates from the labor supply model will be used to simulate the behavioral responses to changes in income taxation and wage rates for different household types.

8.1 Wage Predictions

In order to assign a wage rate for everyone for the labor supply model, we have to predict wages to that part of sample who are not employed. Since "sample selectivity" may bias the parameters

in the wage equation, the selectivity-correcting Heckman-method is used to model the wages. The model has a probit part for predicting the labor force participation and an OLS-part including a correction term as an explanatory variable. The predicted wage rates are then used in the estimation of the labor supply models along with actual hourly wage rates for those who had an observed wage rate.

Wages are predicted separately for each household type. The results from the wage models are presented in Tables 4.1 - 4.5 (Appendix). The parameter estimates of the key explanatory variables exhibit expected signs in most of the cases. The variables determining the labor market participation and wage rates are age, education level, number and ages of children, country of origin, place of residence, regional unemployment rate, and the ”Lambda”-term for correcting the possible selection-bias in the wage equation. The variables that are used in the estimations differ between the household types. Below we sum up the most general features of the estimation results.

Both, age and a higher level of education increase the probability to participate in the labor force. Whereas having children decreases it. Further, having young children has an additional negative effect on the participation of women. These results are typical and are produced by many other studies, too (see, for example, Kalb, 1998 and Ilmakunnas, 1997). Foreign background has a negative effect on the probability to participate in the labor force. The higher regional unemployment rate has also a slight negative effect upon the probability, as could be expected.

Also, the estimation results from wage equations seem to be in line with earlier studies. The wage rate rises with a decreasing rate with age (interpreted to reflect work experience). The effect of the level of education on wages is noticeable. Finally, regional differences in wage rates seem to be significant. In bigger cities the wages tend to be much higher. Also, nationality seems to explain the hourly wage level, there is a slight negative effect on wage rates if a person comes from a refugee country.

8.2 Labor Supply Estimation Results

Tables 5.1 - 5.4 (Appendix) present the parameter estimates of the utility function for the different types of households.

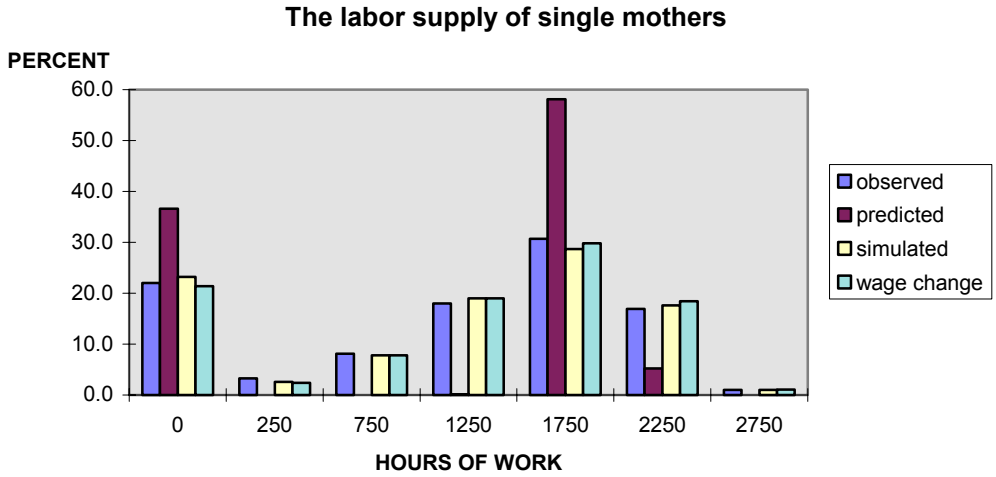
The effects of individual and other characteristics on preference for leisure can be seen in the first set of the estimated parameters in the tables, denoted by β_h. The variables explaining the preference for leisure are education and age measured in levels and for those households having children we have added a variable for number of children and an indicator for having a young child in a family. In general, the results look much alike when comparing the estimates between the different types of households. It seems that preference for leisure decrease with age and the same is true with the level of education. The more a person has invested in education the more he or she prefers to work in the market. Exceptions are cohabiting or married males for whom the preference for leisure goes reversed way with age.

The presence of children has a strong and positive effect on women's preference for leisure (here leisure consists of non-working time in the market, i.e. both pure leisure and household work). All parameters related to children have this effect on mothers irrespective whether there is a partner or not. There is a positive and significant effect when the number of children in the family increases, and when a mother has a child younger than seven years of age. The presence of children may reduce the likelihood to participate if it changes a parent's preferences between work and leisure. Children also bring about daycare costs, which may further reduce the participation probability (discussed earlier in section 6.1). For some reason the effect of the number of children is opposite for cohabiting and married males. This might be due to endogeneity of the decision of having children. The probability of having a child increases with a household's income which in turn increases with husband's hours of work. Another interesting result is the sign of the cross term of a wife's and husband's leisure time in the two-adult households. The positive sign indicates that spouses' leisure times are q-complements.

The estimated parameters for fixed costs of working show significant and strong positive effect for all of the cases (note the negative sign in the estimated utility function). Thus, fixed costs of working strongly decrease the probability to participate in the labor force.

What we want from labor supply models is that they would be able to predict the labor market participation and hours of work as well as to be able to explain the changes in them as a response to changes in the economic or environment. The success of these models must be judged according to their ability to explain and enhance our understanding of the changes in participation and hours of work (Blundell & MaCurdy, 1998). To test whether we succeeded in this, we examine in the following the goodness of fit of our model predictions.

The distribution of hours of work for the observed sample together with distributions obtained from the model estimates and by simulations are presented in Figures 8.1 - 8.5 (Appendix). The figures also show the effect of a wage increase upon the hours of work distribution. We have increased the gross wage rates by 10 % and simulated the effect to the hours of work for each household type (wage elasticities are examined in the next section). As an example, the figure below shows the respective distributions for single mothers.



In the figure above one can notice the typical problem related to labor supply models. The model is not able to capture the variation in hours of work that well. Many females work part-time when they have children (see the figure above and 8.4 in the Appendix), which is the case especially among single mothers. The distribution of the predicted hours of work typically results in two peaks, in non-participation and full-time work. Therefore, in the policy simulations later we use the simulated hours of work as a reference.

Table 6 (Appendix) shows the summary statistics of the mean values for hours of work for each household type received by the respective methods described above. The Figures 8.1 - 8.5 (Appendix) present the overall fit of each model showing the distribution of hours of work visually. Our model succeeded somewhat better in predicting the female than male labor supply since there is more variation in the predicted hours of work.

This is actually a well-known problem that the predicted hours distribution typically does not describe the observed hours distribution very well. This seems to be the case with our model too. Even though there are various methods to capture unobserved heterogeneity in individuals'

preferences, it does not always improve the fit of the model that much. Here we have used a dummy variable to capture the effects of fixed working costs, which improves the fit. It can be also argued that we should have had fewer discrete classes for labor supply, especially for the upper part of hours of work and especially for males. However, recent studies show that it would not make much of a difference. Van Soest (1995) and Kalb (1998) conclude that a larger number of labor supply points might become more important if the data consisted of a larger number of part-time workers. As we have noticed, there are not that many part-time workers among males.

One way of illustrating the implications of the results found here is to calculate the elasticities of labor supply of wage and income. In the next section we examine the effects of changes in gross wage rates and in income taxes for different household types using simulations.

9 Policy Simulations

Our labor supply framework allows us to test whether and how much individuals would adjust their labor supply behavior as a result of a change in their economic environment. We use the estimated parameters to compute the behavioral responses for different household types. To investigate how their labor supply decisions are affected by these exogeneous changes, the mean values and hours of work distributions are calculated for the household types of interest.

Changes in the economic variables may cause changes in behavior, but beforehand it is difficult to see how a certain reform might affect the labor supply. The neoclassical theory underlying the determinants of hours of work is well known. Its basic prediction is that an increase in the wage rate creates two opposing effects on the labor supply. The income effect, provided that leisure is normal, increases the demand for leisure, thus decreasing the number of hours supplied to the market, while the substitution effect makes the individual substitute away from leisure and increase the hours of work. However, the total effect is indeterminate, and the question is whether the substitution or the income effect dominates.

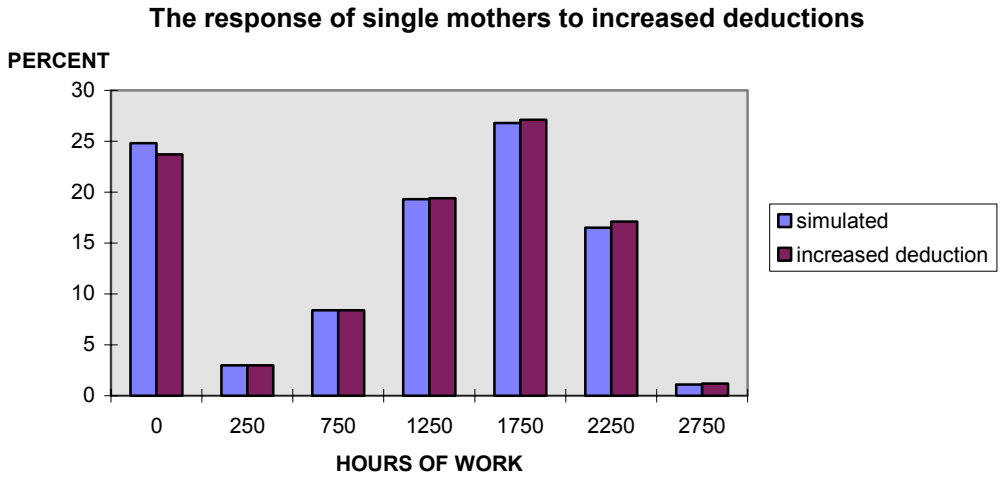
The first experiment is to find out the effects of a 10 percent's increase in wage rates. The results in Table 7 (Appendix) show that the labor supply behavior of each group is quite insensitive to this change. The elasticity of wage on labor supply depends on the wage level, but the average elasticities are positive and quite small in each group. The average wage elasticities are 0.28 percent for cohabiting males, 0.30 for cohabiting females, 0.32 for single mothers, 0.34 for single females, and 0.34 for single males.

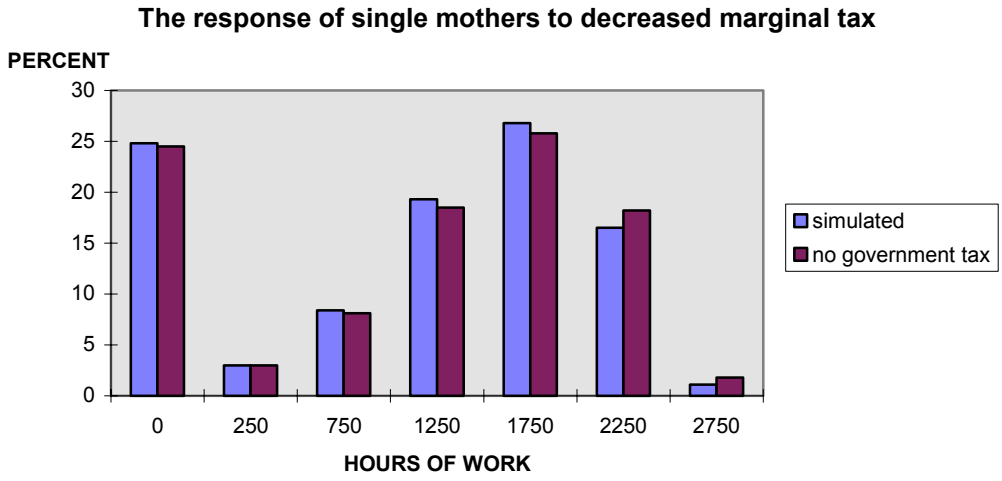
Typically, women have higher elasticity of wage than males, but here we do not see the pattern. Recent labor supply studies based on the Swedish data give evidence of a diversity of results in estimated elasticities, just like recent international studies do. Agell et al. (1995) find for Sweden that for prime-aged cohabiting and married men the estimated income elasticities are ranging from -0.1 to 0 and compensated wage elasticities from 0.08 to 0.25. For cohabiting and married women the range of the results is wider. Income elasticities are found between -0.03 and 0.24 and compensated wage rate elasticities between 0.22 and 1.07. Of course, different studies show variation in results depending on the specification of a model, the econometric methods, and the data used.

The policy experiments that are conducted consider changes in the income tax schedules. The effects of policy changes are tested for single mother households and two-adult households. Firstly, the individual tax exemptions are doubled, i.e. the threshold before paying any taxes is raised by a factor of two. Secondly, the progressive part of the income taxation is abolished, i.e. there are no government taxes, which leads to a flat tax rate of about 30 %.

Behavioral responses to these two policy changes for single mother and two-adult households are seen in Figures 9.1 - 9.5 (Appendix) which summarize the results comparing the hours of work distributions before and after the two policy changes. Below are shown the single mother households' labor supply responses to the pursued tax reforms (the two figures below).

Those most affected by the changes in tax systems are expected to adjust their hours of work the most. The first policy reform (an increased amount of tax exemptions) is supposed to have the largest influence on those in the lowest segments of hours of work. According to the simulated responses it looks like the participation rate increases in each case, 1.1 - 2.1 percentage points. The other reform (neglecting the progression in the income taxation) is expected to have the largest effect on those further up in the income distribution, and again obtained results seem to support this. These tax reforms produce incentive to increase the labor supply and they do increase the average hours of work for both household types under the study.





The total net effect of both tax reforms appears to be clearly positive for both household types. Alleviation in the income tax structure produces incentive effects upon the labor supply, the participation rate increases somewhat in each case. Some individuals seem to join the labor force as a result of these changes. It is possible though, that the reforms have an opposite effect to those in the lower regions of hours of work. On average, both single and cohabiting females increase their hours of work as a result of the reforms, whereas the cohabiting and married males increase their hours of work even more. Thus, the total net change in the hours of work is positive for both household types and for both sexes.

The results from these two policy simulations are also presented numerically in Table 8 (Appendix) where the average net effects of the tax reforms to hours of work are shown for the different household types. Typically, married women are believed to be more responsive to tax changes than other groups. However, although the average hours of work increases in all groups

by a reasonable amount, the average increase in hours of work is almost twice as high for males (46 – 47 hours' increase) than for females (22 – 35 hours' annual increase).

Deeper analysis of the behavioral changes in the labor supply would be needed to properly evaluate the effects. There are two groups that require a closer examination: decisions upon hours of work of those individuals already participating the labor force and of those who may be encouraged to enter by such a reform. Further, it is important to acknowledge also the distributional effects, a reform might produce substantial effects to some specific income groups (these studies will be carried out in SESIM).

The flexibility of the adopted household labor supply model allows for forward and backward bending labor supply curves. Changes in tax rates alter both the net wage and net labor income so that the income effect of tax changes will have an extra component compared with a change in wage. Whether labor supply curves are backward bending in practice, and if so, for what kind of workers, are major empirical questions. They are of obvious practical relevance, for example, for analyzing the incentive effects of income taxation. Simulations of the tax reforms show that reforms might have a large influence on the total labor supply and tax revenues.

10 Conclusions

The intention of the study was to construct two models that are able to predict wages and household labor supply for the dynamic microsimulation model, SESIM. In the first part of the study we constructed a wage model that predicts the hourly wage rates for those participating in the labor market. In the second part, we constructed a labor supply model incorporating both participation and hours of work decisions for different household types. These models will be used as parts of the labor market module in SESIM.

The intention is to build a model that is able to predict hourly wage rates for those who are participating in the labor force. However, we must take into account the restriction that the microsimulation population does not have many characterizing variables attached to its members. With this restriction in mind and having an access to high-quality longitudinal data we construct a structural model for wage determination. Hourly wage rates are explained by a random coefficient panel data model and to correct for a possible sample selection bias a model predicting a probability to have an observable wage rate is suggested. The selection correction model is specified as a dynamic discrete panel data model containing an explanatory variable for

the employment status in the previous period. In the empirical estimation of the wage model we use the longitudinal data, LINDA, covering the years 1992 - 1996.

In the second part we constructed household labor supply models for single- and two-adult households. In construction of the budget constraints, a special attention is devoted to the calculation of the detailed and realistic budget sets for households taking into account the complete tax and social security systems. However, this results in many cases nonlinear and complex budget constraints, and therefore, the labor supply of single- and two-adult households is modeled as a discrete choice problem. This approach has some important advantages compared to a continuous choice model. For example, it allows for non-convexities in the budget set, and there is no need to impose coherency conditions *a priori* but they can be tested *ex post*.

To be able to examine the incentive effects for individuals in different circumstances we favor a more flexible model, which allows for forward and backward bending labor supply curves. The household labor supply modeled assuming that preference for leisure and consumption can be described by a direct translog utility function. For two-adult households we assume that household utility depends on joint household consumption and leisure of both partners. In the model specification we have taken into account fixed costs of working which might have an important effect on the decision to participate in the labor force.

For the empirical estimation we use data for 1996 which are drawn from the LINDA database. The models for labor supply are estimated separately for different types of households, for single mothers, single females, single males, and for cohabiting and married couples. The variation in preference for leisure is allowed to vary across households through observed and unobserved characteristics.

Wage elasticities for different household types are assessed by simulations. Evaluated at the sample averages, values for the elasticities were found to range between 0.28 and 0.34. There are no noticeable differences in the estimated elasticities between the household types or between the sexes. In that respect, our results seem to be consistent with other recent findings.

The labor supply model that we suggest here is also able to capture important features in household labor supply behavior from a policy point of view. The usefulness of our approach was illustrated by applying it to analyze the possible labor supply effects when changing the income tax scheme. We carried out two policy simulations, by pursuing new rules to income

taxation. As we saw, these tax-reducing reforms have a positive effect on the aggregate labor supply for each household type, the reforms imply positive incentive effects and bring about increases in the labor supply of single mother and two-adult households. Especially for males the labor supply responses were found reasonably large.

To analyze the incentive effects of government tax and transfer programs, a detailed specification of individual responses is absolutely necessary. Changes in the labor supply are not only due to changes in hours worked among participants but also to changes in participation rates. The average number of hours of work has declined during the past couple of decades, while the labor force participation rates have increased substantially among single and cohabiting women. For both micro- and macroeconomic reasons it is important to examine the determinants of labor supply to know which groups have entered and which leaved the labor force.

Plans for future research involve model development for the dynamic micro simulation model, SESIM. In modeling individuals' labor supply behavior, one needs, for example, a deeper analysis of non-labor income of households. Enlarging proportion of the non-labor income in the households' budget sets has an effect on the participation and hours of work decisions. Capital income might have a much greater influence than ever before. An increasing share of a capital income may significantly decrease the supplied hours of work and thus raises new challenges for governments whose aim is to increase the households' work effort.

For future research, we might expect to develop models for life cycle labor supply. The static nature of the model remains restrictive since many aspects of household labor supply are inherently dynamic in nature. Education and retirement, for example, are two important aspect of labor supply that is hard to analyze and comprehend using static models alone. Dynamic models permit for a more realistic view to household decision-making. For a better understanding of the choices made by households and to make the micro simulation model more useful as a tool for policy analysis, we need to widen our perspective to incorporate the whole life cycle.

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Appendix

THE SAMPLE STATISTICS AND THE RESULTS OF THE WAGE MODEL (Sections 4 and 5) TABLES 1.1 – 1.2 and 2.

Table 1.1
The sample statistics of the wage model (N=49 040). Year 1992.

Variable	Mean	Minimum	Maximum
THE YEAR 1992			
Age	42	18	59
Number of children	0,73	0	9
Education, the highest			
- Primary school	0,63	0	1
- High school	0,08	0	1
- Bachelor's degree	0,14	0	1
- University degree	0,15	0	1
Place of residence			
- living in a big city	0,33	0	1
- living in a medium sized city	0,48	0	1
- living in countryside	0,19	0	1
Gender, male=1 / female=0	0,41	0	1
Cohabiting	0,62	0	1
Working, yes=1 / no=0	0,75	0	1
The hourly wage rate (SEK)	102,50	62,95	249,71
Hours of work per year	1 390	0	7 874

Table 1.2.
The sample statistics of the wage model (N=49 040). Year 1996.

Variable	Mean	Minimum	Maximum
THE YEAR 1996			
Age	46	22	63
Number of children	0,60	0	10
Education, the highest			
- Primary school	0,61	0	1
- High school	0,08	0	1
- Bachelor's degree	0,15	0	1
- University degree	0,16	0	1
Place of residence			
- living in a big city	0,33	0	1
- living in a medium sized city	0,48	0	1
- living in countryside	0,19	0	1
Gender, male=1 / female=0	0,41	0	1
Cohabiting	0,60	0	1
Working, yes=1 / no=0	0,75	0	1
The hourly wage rate (SEK)	103,34	54,55	248,88
Hours of work per year	1 432	0	7 286

Table 2. The estimates of the wage model.

	Variable	Estimate	Std error
t > 1	Intercept	- 2,981	0,414
	Dummy for obs. Wage, (t-1)	4.811	0.0695
	Age	0.0534	0.0196
	Age Squared / 100	- 0.0791	0.0231
	Education, the highest		
	- High school	0.356	0.0225
	- Bachelor's-degree	0.680	0.0441
	- University	0.944	0.0593
	Place of residence		
	- Medium sized city	- 0.0487	0.0696
	- Countryside	0.126	0.0527
	Nationality		
	- from Nordic countries	- 0.0599	0.0819
	- from Western countries	- 0.301	0.187
	- from Refugee countries	- 0.502	0.101
	Cohabiting	0.0333	0.0648
	Male	- 0.215	0.0593
	Number of children	0.0251	0.0326
t = 1	Intercept	- 2,175	0.291
	Age	0.155	0.0158
	Age squared / 100	- 0.204	0.0201
	Education		
	- High school	0.379	0.0775
	- Bachelor's degree	0.913	0.0604
	- University degree	1.365	0.0795
	Place of residence		
	- Medium sized city	0.164	0.0561
	- Countryside	0.0783	0.0381
	Nationality		
	- from Nordic countries	- 0.397	0.0875
	- from Western countries	- 1,0109	0.109
	- from Refugee countries	- 1.237	0.0802
	Cohabiting	0.299	0.0573
	Male	- 0.413	0.0613
	Number of children	- 0,1005	0.0249
	Male * highest education	0.123	0.0995
	Male * cohabiting	0.196	0.0819
	Big city * highest education	- 0.281	0.103
Wage eq.	Intercept	3,963	0.0225
	Age	0.0201	0.00102
	Age Squared / 100	- 0.0181	0.00116
	Education, the highest		
	- High school	0.105	0.00837
	- Bachelor's degree	0.144	0.00599
	- University degree	0.383	0.00511
	Male	0.176	0.00479
	Std error of the random effect	0,169	0,00199
	Standard error	0.0676	0.000381
	Covariance	0.0301	0.0335

DESCRIPTIVE STATISTICS OF THE HOUSEHOLDS (Section 7.2)
TABLES 3.1 – 3.4

Table 3. 1
Description of the sample of the Single mother households. (N=10 533)

Variable	Mean
Age	36,5
Number of children	1,7
Education (the highest)	
- Primary school	66 %
- High school	7 %
- Bachelor's degree	16 %
- University degree	11 %
Place of residence	
- Big cities	38 %
- Medium sized cities	44 %
- Countryside	18 %
Nationality	
- Sweden	86 %
- Nordic countries	5 %
- Western countries	1 %
- Refugee countries	8 %
Working	78 %
Wage per hour SEK	92,37
Hours of work (annual)	1 585
Labor income	148 489
Disposable income	145 492

Table 3. 2
Description of the sample of the Single female households. (N=13 530)

Variable	Mean
Age	38,0
Number of children	0
Education (the highest)	
- Primary school	57 %
- High school	13 %
- Bachelor's degree	16 %
- University degree	14 %
Place of residence	
- Big cities	40 %
- Medium sized cities	44 %
- Countryside	16 %
Nationality	
- Sweden	89 %
- Nordic countries	4 %
- Western countries	2 %
- Refugee countries	5 %
Working	79 %
Wage per hour SEK	93,58
Hours of work (annual)	1 765
Labor income	168 055
Disposable income	110 220

Table 3. 3
Description of the sample of the Single male households.
(N=17 647)

Variable	Mean
Age	36,0
Number of children	0,08
Education (the highest)	
- Primary school	61 %
- High-school	15 %
- Bachelor's degree	13 %
- University degree	11 %
Place of residence	
- Big cities	38 %
- Medium sized cities	44 %
- Countryside	18 %
Nationality	
- Sweden	87 %
- Nordic countries	4 %
- Western countries	2 %
- Refugee countries	7 %
Working	69 %
Wage per hour, SEK	105,80
Hours of work (annual)	1 975
Labor income, SEK	211 200
Disposable income, SEK	119 572

Table 3. 4
Description of the sample of the Two-adult households.
(N=33 440)

Variable	Wife	Husband
Age	43,0	46,0
Number of children	1,44	1,44
Education (the highest)		
- Primary school	53 %	48 %
- High school	7 %	13 %
- Bachelor's degree	20 %	15 %
- University degree	20 %	24 %
Place of residence		
- Big cities	31 %	31 %
- Medium sized cities	49 %	49 %
- Countryside	20 %	20 %
Nationality		
- Sweden	86 %	87 %
- Nordic countries	4 %	3 %
- Western countries	2 %	2 %
- Refugee countries	8 %	8 %
Working	85 %	82 %
Wage per hour, SEK	98,44	128,57
Hours of work (annual)	1 699	2 107
Labor income, SEK	144 564	224 160
Disposable income, SEK	123 636	168 794

THE RESULTS FROM THE PARTICIPATION AND WAGE EQUATIONS FOR EACH HOUSEHOLD (Section 8.1)
TABLES 4.1 – 4.5

Table 4. 1
Estimated parameters of the probit model of
The labor force participation and the wage equation for single mothers.
(N=10 533)

Variable	Estimate	Standard error
PARTICIPATION EQ.		
Intercept	- 4,074	0,280
Age	0,277	0,016
Age Squared / 100	- 0,339	0,021
Number of children	- 0,212	0,018
Dummy for young child	- 0,226	0,041
Education, the highest degree		
- Bachelor's degree	0,560	0,049
- University degree	0,594	0,060
Nationality		
- Western countries	- 0,789	0,139
- Refugee countries	- 1,213	0,047
WAGE EQUATION (log-wage)		
Intercept	4,287	0,062
Age	0,007	0,003
Age Squared / 100	- 0,004	0,004
Education, the highest degree		
- High school	0,024	0,007
- Bachelor's degree	0,076	0,006
- University degree	0,224	0,007
Place of residence		
- Living in a small city	- 0,027	0,004
- Living in countryside	- 0,033	0,005
Nationality		
- Refugee countries	- 0,047	0,014
Lambda	- 0,038	0,019
R^2	0,28	

Table 4.2
Estimated parameters of the probit model of the labor force participation and the wage equation for single females. (N=13 530)

Variable	Estimate	Standard error
PARTICIPATION EQ.		
Intercept	- 3,013	0,148
Age	0,220	0,007
Age Squared / 100	- 0,258	0,009
Education, the highest degree		
- High school degree	0,431	0,040
- Bachelor's degree	0,575	0,043
- University degree	0,708	0,050
Place of residence		
- Living in a big city	- 0,110	0,032
Nationality		
- Nordic countries	- 0,378	0,062
- Western countries	- 1,217	0,092
- Refugee countries	- 1,309	0,052
Regional unemployment rate	- 0,031	0,010
WAGE EQUATION (log-wage)		
Intercept	3,885	0,043
Age	0,028	0,002
Age Squared / 100	- 0,028	0,002
Education, the highest degree		
- High school	0,048	0,006
- Bachelor's degree	0,096	0,006
- University degree	0,226	0,006
Place of residence		
- Living in a small city	- 0,049	0,016
- Living in countryside	- 0,051	0,004
Nationality		
- Refugee countries	- 0,055	0,005
Lambda	0,026	0,020
R^2	0,34	

Table 4.3
Estimated parameters of the probit model of the labor force participation and the wage equation for single males.
(N=17 647)

Variable	Estimate	Standard error
PARTICIPATION EQ.		
Intercept	- 2,646	0,104
Age	0,165	0,006
Age Squared / 100	- 0,196	0,007
Education, the highest degree		
- High school degree	0,300	0,030
- Bachelor's degree	0,637	0,035
- University degree	0,760	0,040
Nationality		
- Nordic Countries	- 0,466	0,053
- Western Countries	- 1,069	0,072
- Refugee Countries	- 1,211	0,041
WAGE EQUATION (log-wage)		
Intercept	3,867	0,057
Age	0,032	0,002
Age Squared / 100	- 0,034	0,003
Education, the highest degree		
- High school	0,053	0,007
- Bachelor's degree	0,101	0,009
- University degree	0,261	0,010
Nationality		
- Refugee countries	- 0,117	0,020
Lambda	0,021	0,025
R^2	0,25	

Table 4.4
Estimated parameters of the probit model of the labor force participation and the wage equation for cohabiting and married females. (N=33 440)

Variable	Estimate	Standard error
PARTICIPATION EQ.		
Intercept	- 3,195	0,210
Age	0,228	0,010
Age Squared / 100	- 0,276	0,011
Number of children	- 0,125	0,011
Young child (under 7 years)	- 0,163	0,028
Education, the highest degree		
- High school degree	- 0,150	0,034
- Bachelor's degree	0,499	0,028
- University degree	0,668	0,030
Place of residence		
- Living in a big city	0,082	0,027
- Living in a small city	0,158	0,025
Nationality		
- Nordic countries	- 0,223	0,046
- Western countries	- 1,068	0,065
- Refugee countries	- 1,601	0,029
WAGE EQUATION (log-wage)		
Intercept	4,108	0,038
Age	0,015	0,002
Age Squared / 100	- 0,014	0,002
Education, the highest degree		
- High school degree	0,060	0,007
- Bachelor's degree	0,108	0,003
- University degree	0,266	0,003
Place of residence		
- Living in a big city	0,054	0,003
- Living in a small city	0,012	0,003
Nationality		
- Refugee countries	- 0,069	0,012
Regional unemployment rate	- 0,003	0,001
Lambda	- 0,007	0,015
R^2	0,32	

Table 4.5
Estimated parameters of the probit model of the labor force participation and the wage equation for cohabiting and married males. (N=33 440)

Variable	Estimate	Standard error
PARTICIPATION EQ.		
Intercept	- 1,451	0,207
Age	0,127	0,009
Age Squared / 100	- 0,162	0,010
Number of children	- 0,075	0,009
Education, the highest degree		
- High school degree	0,279	0,026
- Bachelor's degree	0,608	0,029
- University degree	0,801	0,026
Place of residence		
- Living in a big city	0,071	0,025
- Living in a small city	0,147	0,023
Nationality		
- Western countries	- 0,774	0,056
- Refugee countries	- 1,543	0,028
WAGE EQUATION (log-wage)		
Intercept	4,027	0,061
Age	0,026	0,002
Age Squared / 100	- 0,024	0,003
Education, the highest degree		
- High school degree	0,124	0,006
- Bachelor's degree	0,140	0,009
- University degree	0,341	0,010
Place of residence		
- Living in a big city	0,108	0,005
- Living in a small city	0,018	0,005
Nationality		
- Western countries	- 0,051	0,018
- Refugee countries	- 0,147	0,031
Regional unemployment rate	- 0,007	0,001
Lambda	- 0,038	0,037
R^2	0,29	

THE RESULTS FROM THE LABOR SUPPLY MODEL (Section 8.2)
TABLES 5.1 – 5.4

Table 5.1
Estimated parameters of the labor supply model for single mother households. (N=10 533)

Variable	Coeff.	Estimate	Standard error
Intercept	β_{h0}	11,0622	0,258
Number of children	β_{h1}	0,527	0,0383
Dummy for young child	β_{h2}	1,555	0,132
Education, the highest degree			
- High school degree	β_{h3}	0,165	0,0835
- Bachelor's degree	β_{h4}	- 0,720	0,0836
- University degree	β_{h5}	- 0,891	0,0921
Age, dummy for each group			
- 18 - 24 years old	β_{h6}	2,078	0,155
- 25 - 34 years old	β_{h7}	0,529	0,124
- 35 - 44 years old	β_{h8}	0,0599	0,0778
- 45 - 54 years old	β_{h9}	- 0,176	0,235
Fixed costs of working	β_{FC}	2,792	0,0556
Consumption	β_{C}	4,622	0,760
Consumption squared	β_{CC}	0,999	0,297
Hours squared	β_{hh}	- 7,0436	0,143
Hours * consumption	β_{Ch}	- 1,00219	0,228
Classification error	ε	0,188	0,00141
Log of Likelihood Function		15458,63	

Table 5.2 Estimated parameters of the labor supply model for single female households, N=13 530.

Variable	Coeff.	Estimate	Standard error
Intercept	β_{h0}	9,198	0,112
Education, the highest degree			
- High school degree	β_{h1}	- 0,702	0,0343
- Bachelor's degree	β_{h2}	- 0,959	0,0642
- University degree	β_{h3}	- 1,152	0,0478
Age, dummy for each group			
- 18 - 24 years old	β_{h4}	1,706	0,0802
- 25 - 34 years old	β_{h5}	- 0,325	0,0278
- 35 - 44 years old	β_{h6}	- 0,627	0,0459
- 45 - 54 years old	β_{h7}	- 1,100	0,0437
Fixed costs of working	β_{FC}	3,769	0,0587
Consumption	β_{C}	2,371	0,0629
Consumption squared	β_{CC}	0,787	0,0222
Hours squared	β_{hh}	- 5,691	0,0911
Hours * consumption	β_{Ch}	0,0115	0,00252
Classification error	ε	0,148	0,00102
Log of Likelihood Function		15199,78	

Table 5.3 Estimated parameters of the labor supply model for single male households, N=17 647.

Variable	Coeff.	Estimate	Standard error
Intercept	β_{h0}	6,735	0,253
Education, the highest degree			
- High school degree	β_{h1}	- 0,424	0,0541
- Bachelor's degree	β_{h2}	- 0,826	0,0564
- University degree	β_{h3}	- 0,756	0,0656
Age, dummy for each group			
- 18 - 24 years old	β_{h4}	1,205	0,0700
- 25 - 34 years old	β_{h5}	- 0,401	0,0595
- 35 - 44 years old	β_{h6}	- 0,181	0,0656
- 45 - 54 years old	β_{h7}	- 0,398	0,0640
Fixed costs of working	β_{FC}	5,721	0,0819
Consumption	β_{C}	0,335	0,262
Consumption squared	β_{CC}	1,196	0,108
Hours squared	β_{hh}	- 6,257	0,137
Hours * consumption	β_{Ch}	0,445	0,117
Classification error	ε	0,120	0,000765
Log of Likelihood Function		17089,1	

Table 5.4
Estimated parameters of the labor supply model for two-adult households, N=34 440.

Variable	Coeff.	Estimate	Standard error
HUSBAND:			
Intercept	β_{h0}	6,314	0,1098
Number of children	β_{h1}	-0,0965	0,00712
Education, the highest degree			
- Primary school degree	β_{h2}	0,343	0,0214
- High school degree	β_{h3}	0,0638	0,0186
- Bachelor's degree	β_{h4}	- 0,243	0,0411
Age, dummy for each group			
- 18 - 24 years old	β_{h5}	- 0,731	0,0485
- 25 - 34 years old	β_{h6}	- 0,760	0,0365
- 35 - 44 years old	β_{h7}	- 0,628	0,0363
- 45 - 54 years old	β_{h8}	- 0,479	0,0352
Fixed costs of working	β_{FCh}	9,739	0,0774
WIFE:			
Intercept	β_{w0}	10,740	0,115
Number of children	β_{w1}	0,448	0,020
Education, the highest degree			
- Primary school degree	β_{w2}	0,941	0,0415
- High school degree	β_{w3}	1,411	0,0761
- Bachelor's degree	β_{w4}	0,384	0,0348
Age, dummy for each group			
- 18 - 24 years old	β_{w5}	0,469	0,0544
- 25 - 34 years old	β_{w6}	- 0,522	0,0593
- 35 - 44 years old	β_{w7}	- 1,143	0,0570
- 45 - 54 years old	β_{w8}	- 1,0593	0,0545
Fixed costs of working	β_{FCw}	3,699	0,0334
Consumption	β_{C}	- 0,514	0,0528
Consumption squared	β_{CC}	2,0277	0,0414
Husband's hours squared	β_{hh}	- 9,651	0,0848
Wife's hours squared	β_{ww}	- 8,513	0,0675
Husband's hours * consumption	β_{Ch}	0,667	0,0262
Wife's hours * consumption	β_{Cw}	- 0,0980	0,00579
Husband's hours * Wife's hours	β_{hw}	1,145	0,0264
Classification error, husband	ε_{h}	0,0838	0,000354
Classification error, wife	ε_{w}	0,132	0,000543
Log of Likelihood Function		44209,59	

THE ACTUAL, PREDICTED AND SIMULATED AVERAGE HOURS OF WORK FOR EACH HOUSEHOLD TYPE (Section 8.2), TABLE 6

Table 6
The actual, predicted, and simulated hours of work for single- and two-headed households.
And, an average hours of work after 10 % increase in wage rates.

	VARIABLE	MEAN	MIN.	MAX.
SINGLE MOTHERS (N = 10 533)				
	Actual annual hours of work	1 236	0	2 960
	Predicted annual hours of work	1 135	0	2 250
	Simulated hours of work	1 230	0	2 750
	Simulated annual hours of work due to the 10 % wage increase	1 269	0	2 750
SINGLE FEMALES (N = 13 530)	VARIABLE	MEAN	MIN.	MAX.
	Actual annual hours of work	1 387	0	2 996
	Predicted annual hours of work	1 461	0	2 250
	Simulated hours of work	1 403	0	2 750
	Simulated annual hours of work due to the 10 % wage increase	1 451	0	2 750
SINGLE MALES (N = 17 647)	VARIABLE	MEAN	MIN.	MAX.
	Actual annual hours of work	1 362	0	3 000
	Predicted annual hours of work	1 337	0	2 250
	Simulated hours of work	1 367	0	2 750
	Simulated annual hours of work due to the 10 % wage increase	1 414	0	2 750
COHABITING AND MARRIED FEMALES (N = 33 440)	VARIABLE	MEAN	MIN.	MAX.
	Actual annual hours of work	1 460	0	3 000
	Predicted annual hours of work	1 537	0	2 750
	Simulated hours of work	1 455	0	2 750
	Simulated annual hours of work due to the 10 % wage increase	1 499	0	2 750
COHABITING AND MARRIED MALES (N = 33 440)	VARIABLE	MEAN	MIN.	MAX.
	Actual annual hours of work	1 763	0	3 000
	Predicted annual hours of work	1 929	0	2 750
	Simulated hours of work	1 764	0	2 750
	Simulated annual hours of work due to the 10 % wage increase	1 814	0	2 750

THE ELASTICITY OF WAGE ON LABOR SUPPLY CALCULATED FOR EACH HOUSEHOLD TYPE, AND
THE RESULTS OF THE POLICY SIMULATIONS:
THE LABOR SUPPLY RESPONSE OF SINGLE MOTHERS AND TWO-ADULT HOUSEHOLDS TO TAX REFORMS (Section 9)
TABLES 7 and 8

Table 7.
The wage elasticities for different household types.
An average percentage change in hours of work as wage increases by 10 %.

HOUSEHOLD TYPE	WAGE ELASTICITY
SINGLE MOTHERS	0,317
SINGLE FEMALES	0,342
SINGLE MALES	0,344
COHABITING FEMALES	0,302
COHABITING MALES	0,283

Table 8.
The results from policy simulations.
The average change in hours of work after
- an increase in tax exemptions
- relaxing the government tax

HOUSEHOLD TYPE	INCREASED EXEMPTIONS	DECREASED MARGINAL-TAX
SINGLE MOTHERS	+ 22	+ 31
COHABITING FEMALES	+ 24	+ 35
COHABITING MALES	+ 46	+ 47

THE DISTRIBUTION OF HOURS OF WORK FROM THE OBSERVED SAMPLE AND DISTRIBUTIONS OBTAINED BY PREDICTION AND SIMULATION. THE EFFECT OF A TEN PERCENT WAGE INCREASE TO THE DISTRIBUTION OF HOURS OF WORK (Section 8)
FIGURES 8.1 - 8.5.

Figure 8.1

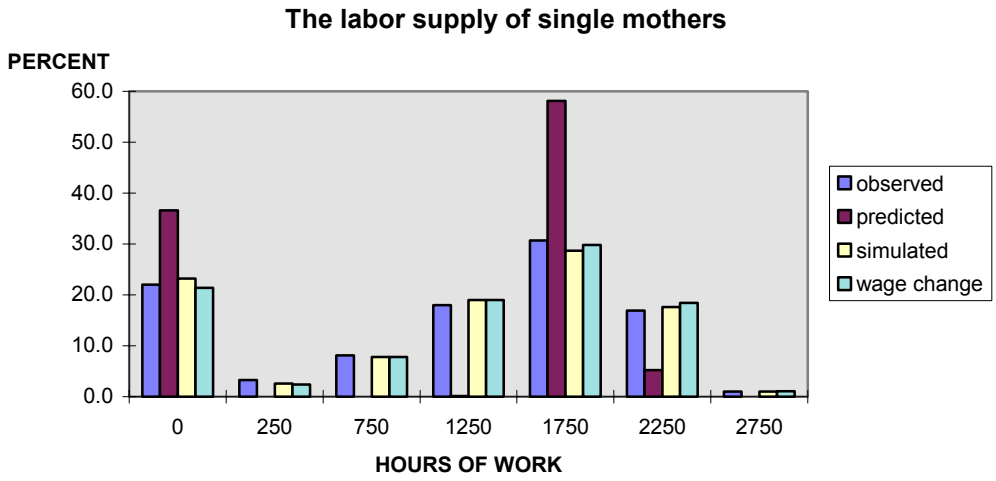


Figure 8.2

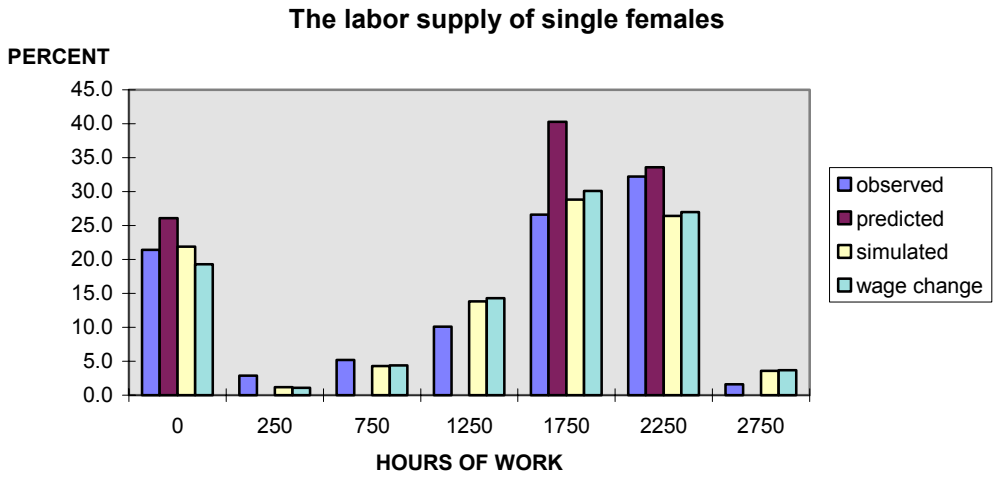


Figure 8.3

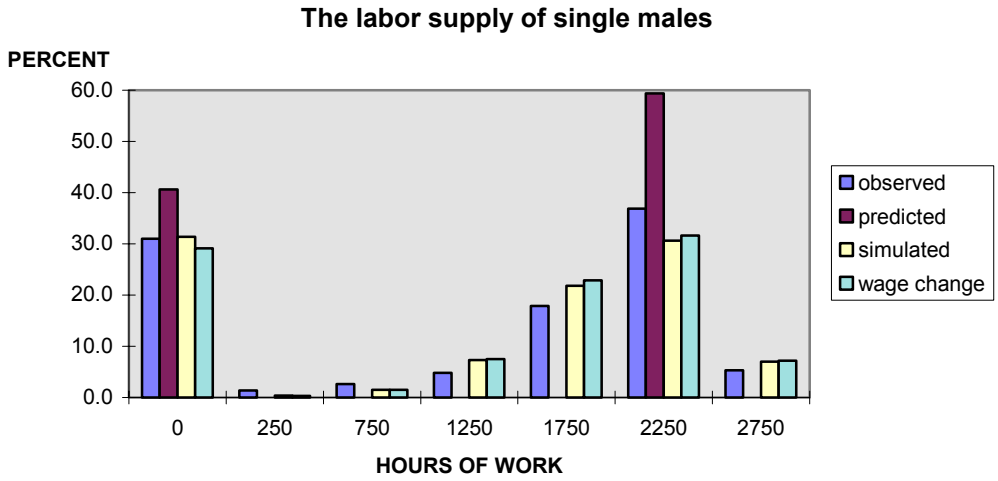


Figure 8.4

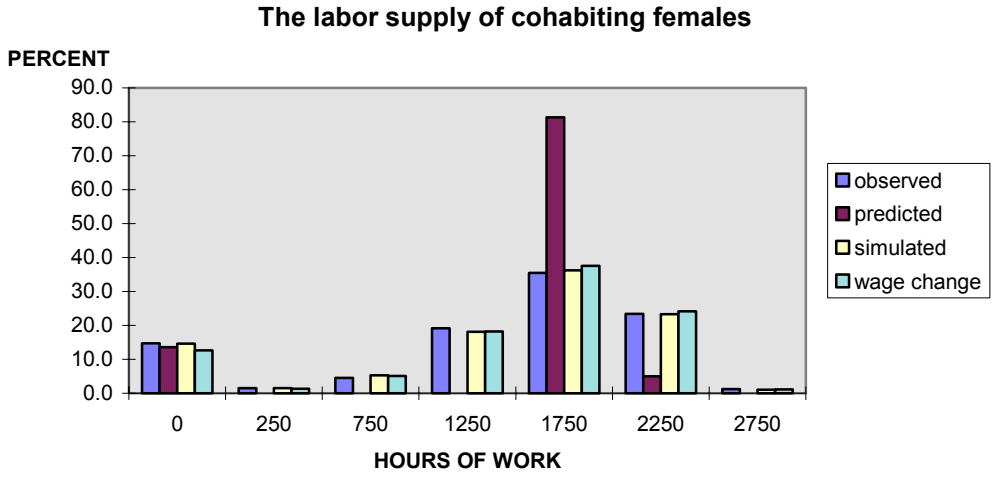
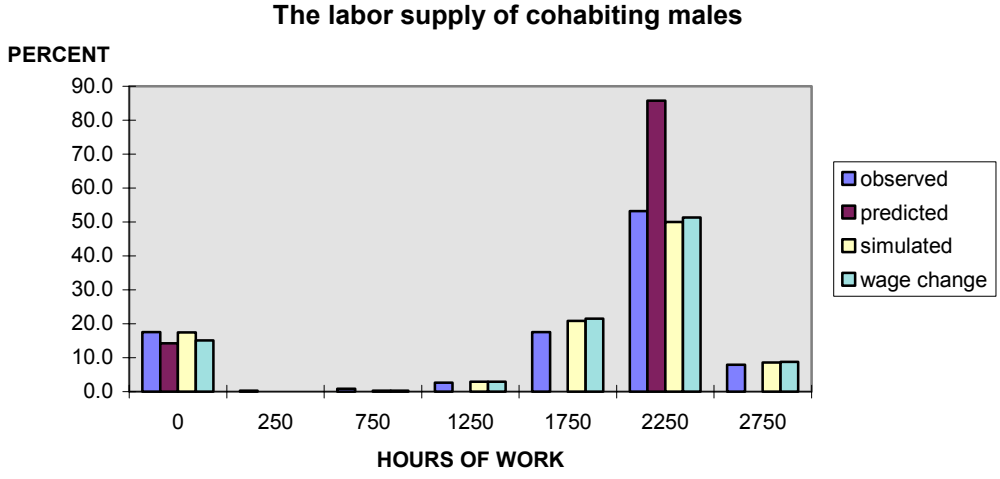


Figure 8.5



THE RESULTS FROM THE POLICY SIMULATIONS FOR SINGLE MOTHER AND TWO-ADULT HOUSEHOLDS (Section 9)
FIGURES 9.1-9.6

Figure 9.1

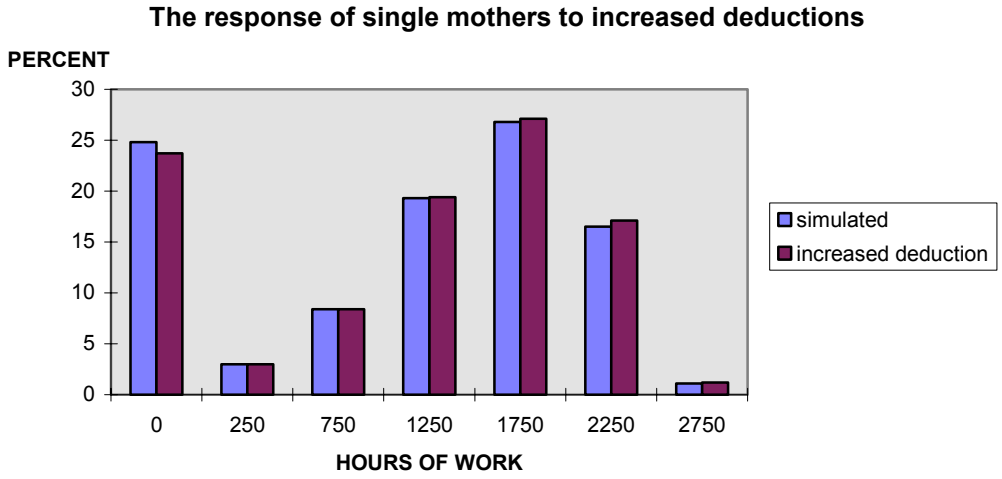


Figure 9.2

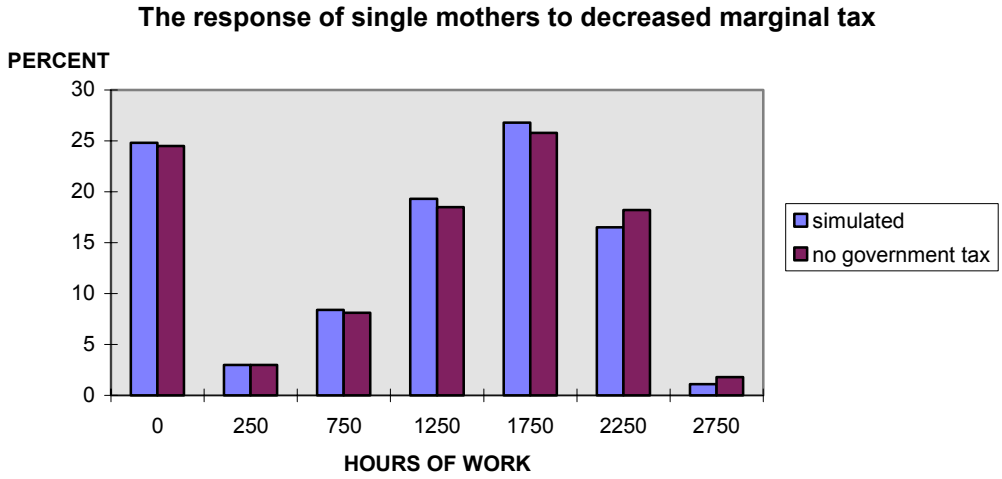


Figure 9.3

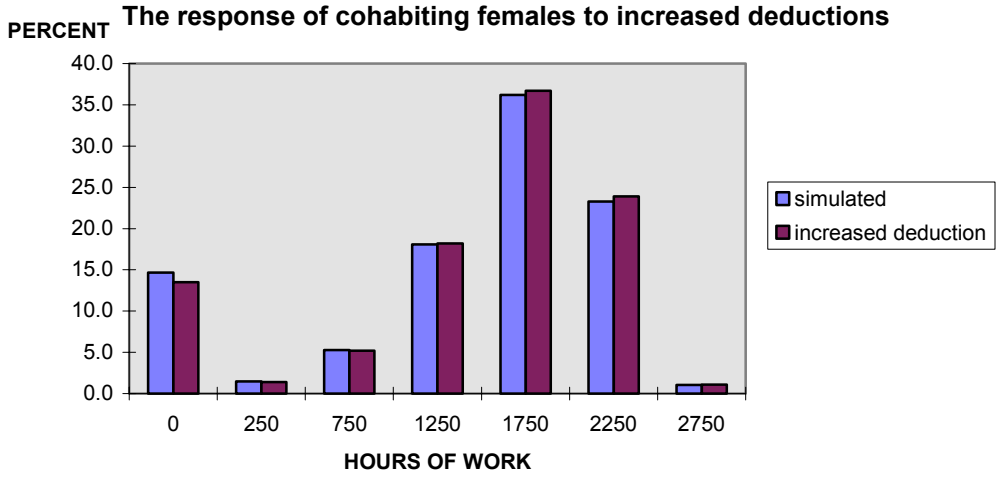


Figure 9.4

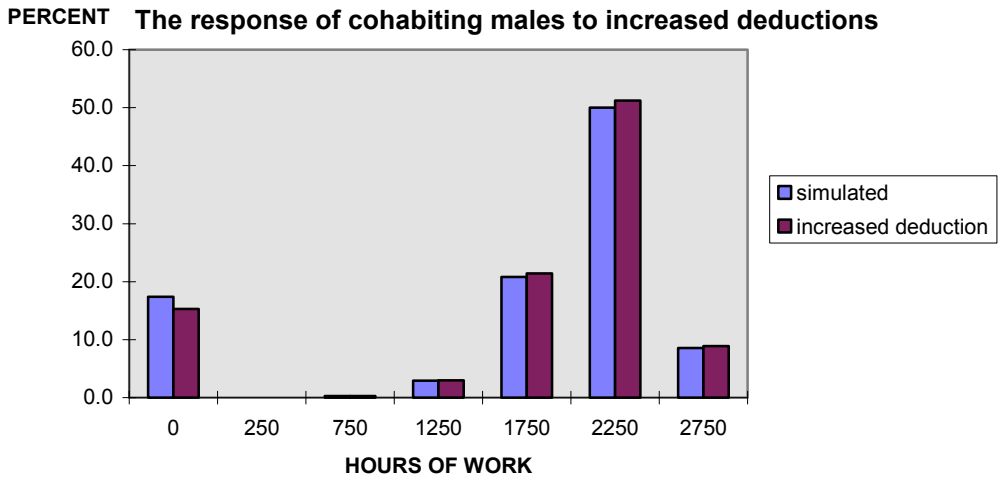


Figure 9.5

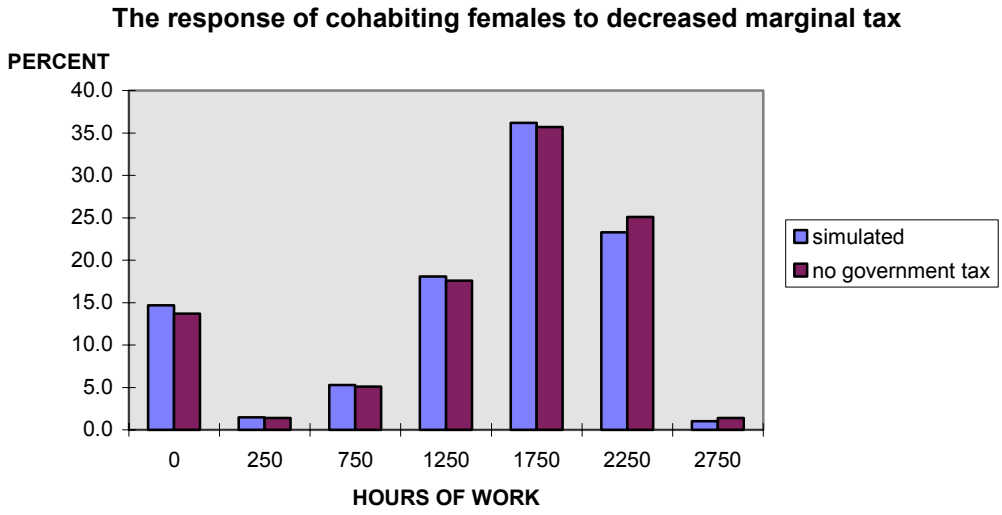
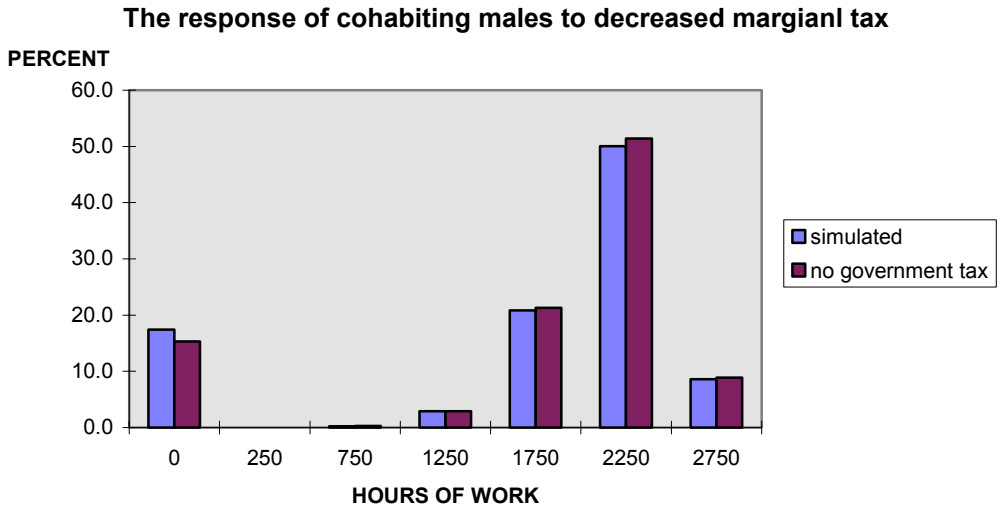


Figure 9.6



Labor Supply and Welfare Participation of Single Mothers in Sweden

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Revised, October 2002

Abstract:
In Sweden there is a growing concern about marginal effects caused by the interaction between the tax and social security systems. Typically, tax and benefit systems are nonlinear with marginal rates rising with income, such that some particular groups may find it unprofitable to increase their work effort. Our aim is to examine the size of the incentive effects for single mother households who are assumed to be the most sensitive to changes in economic environment. We estimate a discrete labor supply model incorporating welfare participation decision using the Swedish LINDA data set from 1996. Our results show that there is a positive and significant stigma-effect associated with welfare participation and that fixed costs of working has a negative impact on single mothers' decision to enter the labor market. We find a negative covariance between social welfare participation and labor supply, which implies self-selection into welfare. On average, our results indicate relatively large incentive effects, but we also report a substantial variation over households' income: higher effects for the low-income households and smaller effects for high-income households.

Key words: Single Mothers, Labor Supply, Welfare Participation, Unobserved Heterogeneity, Fixed Costs of Working, Tax Simulation.
JEL Classification: J22, I38

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1 Introduction

High marginal effects caused by the interaction between the tax and social security systems characterize Sweden, as well as many other welfare states. For non-working single parents the net benefit from a slight increase in hours of work is almost negligible. According to a report from the Swedish Ministry of Finance (Eklind et al., 1997), the net replacement rate for this group is about 90 %. The question addressed in this paper is, how large are the incentive effects for individuals facing such high marginal effects in Sweden. To answer this question, we first estimate a labor supply model incorporating the welfare participation decision for single mothers, and then we pursue some policy simulations. Specifically, we analyze the effects of changes in the gross wages, income tax system, child daycare payment schemes and social welfare eligibility limit. Two recent papers addressing similar questions in the US and the UK are Hu (1999) and Duncan & Giles (1998).

The data used for this study are the 1996 wave from the Swedish LINDA database. These data are completely based on register information and provide us with a large sample together with unusually high quality of tax and income data. Another advantage of these data is that even hourly wage rates are obtained from the registers.

One distinctive feature of this study is that budget sets are constructed such a way that they incorporate the most relevant tax and benefit systems. Not surprisingly, this results in non-convex budget sets. However, these non-convexities are taken into account in the analysis. We assume that individuals choose their hours of work from seven different discrete working states, ranging from not working to a maximum of 3 000 hours per year. An important advantage of the discrete approach compared to the continuous specification is that the coherency conditions do not have to be imposed *a priori* (van Soest, 1995).

Special attention is devoted to the fixed costs of working related to the labor market participation (e.g. costs of commuting and childcare). When individuals make a decision to participate in the labor force they face certain entry costs. Obviously, these costs have an effect on the decision to participate and on hours of work. The fixed costs increase the reservation wage and reservation hours, which is observed by the fact that very few work more than zero hours but less than 750 hours per year.

To summarize the results, we find that there is a positive and significant stigma-effect associated with welfare participation. On the other hand, the estimated negative covariance between welfare participation and labor supply implies self-selection into welfare. Fixed costs of working have a negative impact on a single mothers' decision to enter the labor market. The policy simulations result in rather large average incentive effects, but these effects vary substantially over income deciles. The evaluated reforms in the income taxation and social security systems result in substantial increases in hours of work for the lowest income deciles, whereas the effects are almost negligible for those belonging to the highest income deciles.

The paper is organized as follows. Section 2 provides an overview to the economic status of single mothers in Sweden. Section 3 describes how the budget sets are constructed and gives a description of the relevant benefit programs. Section 4 presents the econometric model, and Section 5 introduces the data. In Section 6 we present the results, and finally, concluding remarks are given in Section 7.

2 Single Mothers in Sweden

The motivation for studying labor supply decisions of single mothers is, first of all, the fact that the number of single-headed households has significantly increased in Sweden. Today, almost 25 % of all households with children are one-parent households, and about 90 % of them are female-headed. Secondly, the main trends in the Swedish labor market consist of a strong rise in the female labor force participation rate and a slight long-run decline in both hours of work and participation rates of men (Nyberg, 1997). Especially during the recent years, the labor force participation among single mothers has been higher (85 %) than among cohabiting mothers (79 %), and also a slightly higher than among cohabiting and married fathers (81 %). However, one half of the mothers with young children are working part-time. Thirdly, since single mothers are the net receivers of transfer benefit payments, they are the most vulnerable group when there are cuts in the benefit system, implying that they are also the most sensitive in their labor supply responses (SCB, 1997).

A large part of the total disposable income of single-parent households consists of different social benefits, on average 30 %. Also, most of the publicly provided social services (for example, childcare) are offered for free or at discounted rates to these low-income households. In Sweden, the major family benefit programs are housing allowance, parental allowance, child allowance and social assistance. More than 70 % of single mothers received housing allowance and almost one

third received social assistance in 1996. Of all social welfare participants, 15 % were single mothers. In the group of single mothers, the young, the immigrants and the mothers with only a low level of formal education have the lowest income (Socialdepartementet, 1996).

Even though the single parent families are relatively poor compared to other types of households in Sweden, they are much better off in an international comparison. About 4 % of the single mother households in Sweden lie below the poverty line (having less than half of the median income), whereas in the US, Great Britain and Germany the figures are 60 %, 14 % and 22 %, respectively (Hobson & Takahashi, 1996).

Often single mothers have a more precarious position in the labor market than married mothers. During the economic recession, starting in the beginning of the 1990s, single mothers suffered more from unemployment than any other group in the labor market. In 1995, 39 % of single mothers who had young children were unemployed, which is twice as high as before the recession. Considering temporary employment and underemployment, single mothers are usually in less favorable position compared with non-single mothers (Björnberg, 1997). Another indicator of the economic hardship of this group is given by income information from Statistics Sweden. From 1989 to 1997 the median disposable income for single parents decreased by more than 10 % (SCB, 1999).

3 Budget Constraint

The analysis of single mothers' labor supply takes as a starting point a static model of labor supply. It is assumed that individuals make decision over their hours of work (or leisure time) and consumption (disposable income) by maximizing a utility function U(h, C), subject to the following budget constraint:

$$(1) \qquad C = W^{*}h + Y + V - t\,(I) + B$$

where C is the income after taxes, W is the gross wage per hour, h is hours of market work per year and Y and V are taxable and non-taxable non-labor income per year, respectively. Income taxes are determined by the tax function $t\,(\cdot)$, where the argument is taxable income including the taxable social transfers. The last term in the budget constraint, B, is the amount of household specific income-tested subsidies.

The three major programs included in *B* are housing allowance, social assistance and public childcare. Housing allowance is determined by nationwide rules and is mainly directed to families with children. The amount of housing allowance a household is entitled to is determined by the net household income, housing expenditures, number of children and age of a parent.

The rules determining social assistance are based on a rather complicated system and they also differ across municipalities. For each municipality and each family type, we calculate a Welfare Eligibility Limit (WEL, the maximum of disposable income to qualify for social assistance) based on the information provided by the Swedish municipalities. The amount of social assistance a family receives is simply the difference between the WEL and the household's disposable income.

Child daycare payment schemes vary across municipalities. In most of the municipalities fees depend on the utilized number of hours, household's income and number and ages of the children (the rules in 1996). The average cost was about 2 500 SEK per month for a single-adult household having an average income and two children under 7 years of age using public childcare (Skolverket, 1999).

Since the empirical model of labor supply that is applied here is a discrete model of hours of work, the budget sets are calculated for every household at each discrete point of hours of work. The program for calculating taxes and transfer benefits is a modified version of FASIT, a tax-benefit program developed by the Statistics Sweden and the Ministry of Finance. FASIT includes most of the municipalities and their payment schemes for childcare. For municipalities that are not included, different methods of imputation have been used. Since the costs of childcare vary with the utilization we have also made assumptions regarding the use of childcare given different hours of work.

Figure 1 (Appendix) illustrates non-convexities of the budget set for a typical low-income household with two children. The budget set for the household is evaluated at seven discrete points ranging from 0 to 3 000 hours of work per year. Non-convexity of the budget set at lower hours of work is visible. There is no return at all from an increase in labor supply from 0 to 500 hours, as is clearly seen in the upper panel. The reason for this is a 100 % reduction in social assistance for the earned income. Only a very few employed mothers in our sample are eligible for social assistance. Thus, the effect of social assistance is basically on the decision to work only a few hours or not to work at all. A second kink can be observed at the point of 1 500 hours of

work. This kink is primarily caused by housing allowance that is ceased at this point and to some extent the increased tax rate. Income taxes are of course important, but for the low-income households the income taxation does not contribute much to the non-convexity of the budget set. The Swedish tax system is shown in Figure 2, and, as shown, the main progressive part of the income tax is due the increase in earnings at about 200 000 SEK.[2] There are not many single mothers obtaining such high annual income.

Referring to Figure 1, costs of childcare is an important component in households' budgets since the costs typically increase steadily over the whole hours of work interval, although there are differences in the payment schemes across municipalities. The most typical scheme is one in which the fees increase progressively with income, which might cause further non-convexities.

To summarize, the main source of non-convexities in budget sets is the sharply decline in benefits designed to equalize the income distribution. Also, the progressive income taxes cause non-convexities, but they are not as large as those produced by the social transfer systems.

4 Economic Model and Empirical Specification

The analysis of single mothers' labor supply and welfare participation is based on a static model of labor supply. Individuals choose their hours of work (or leisure) and consumption by maximizing a utility function, $U(C, h)$, subject to their budget constraint.

The econometric model applied here closely follows the model used in van Soest (1995, 2000) and in Flood et al. (1999). Preferences for disposable income (proxy for consumption) and leisure are described by a direct translog utility function, specifically:

$$(2) \qquad U(C,h) = \beta_{CC}\log(C) + \beta_{h}\log(TE-h) + \beta_{CC}[\log(C)]^2 + \beta_{hh}[\log(TE-h)]^2 + 2\beta_{Ch}\log(C)\log(TE-h) - \varphi d + u$$

We assume that every individual maximizes her utility choosing the hours of work, h, disposable income, C, and welfare participation, d (d=1, if the household receives welfare, 0 otherwise), subject to the specific budget constraint (1) and the total Time Endowment, TE, which is set to 4 000 hours per year. The utility function is assumed to be increasing in consumption, and

[2] In August 2002 1 Euro ≈ 9,2 SEK.

decreasing with respect to hours of work and welfare participation, i.e. there is a negative side effect associated with receiving social assistance. The disutility from welfare participation, *d*, is assumed to be separable to allow for non-participation among eligible households. If the disutility from welfare participation is assumed to be separable, it affects the decision to participate in social welfare, but not the labor force participation decision conditional on welfare receipt. Further, we assume that the unobserved preference component, *u*, in the utility function has an extreme value distribution.

Labor supply decision is modeled as a discrete choice over seven classes of hours of work and for each option a detailed budget set is calculated taking into account the taxes and social transfers the household is entitled to. The question of the effects of different types of government transfer payments on labor supply has been examined in many studies, for example, in Moffitt (1983, 1992); Hagstrom (1996); Hoynes (1996); and Keane & Moffitt (1999).

Fixed costs of working (*FC*) are incorporated in the utility function. We assume that the argument $\log(C_i)$ in the utility function for employed individuals should be replaced by $\log(C_i) - \log(FC_i)$.[3] Since the utility increases with income, positive fixed costs decrease the utility of the employed but do not affect the utility of those not employed. The level of fixed costs is modeled to depend on individual and family characteristics. Following van Soest (2000), we model the costs log-linearly: $\log(FC_i) = \gamma_0 + \gamma_1 z_1 + \gamma_2 z_2 + \ldots + \gamma_k z_k$.

The flexible specification of the utility function (2) does not automatically fulfill the quasi-concavity conditions. However, these conditions can be tested *ex post*. This contrasts a continuous labor supply model in which the quasi-concavity has to be imposed *a priori* in order to guarantee the coherency of a model.

In order to implement the model, we have to specify the nature of heterogeneity in household preferences and the stochastic disturbances. Heterogeneity in preferences for leisure is introduced as

$$\beta_h = \sum_{i=1}^{k} \beta_{hi} x_i + \theta \qquad (3)$$

[3] An alternative would be to correct for fixed cost in levels but this led to a nonzero probability of negative income, which is not allowed by our translog utilty function.

where the x-variables consist of observed individual and family characteristics. θ represents unobserved variables that affect preferences for leisure. It is reasonable to assume that an important source of population heterogeneity in terms of preferences for leisure is unobserved. In order to take this into account, we formulate a finite mixture model, which allows for unobserved heterogeneity in a very flexible way without imposing a parametric structure. The idea of incorporating unobserved heterogeneity this way, originates from Heckman & Singer (1984), and there is a number of applications in duration data (Ham & Lalonde, 1996), count data (Deb & Trivedi, 1997), and labor supply (Hoynes, 1996). Heckman & Singer (1984) also show that estimation of a finite mixture model might provide a good discrete approximation even if the underlying distribution was continuous.

To be specific, we assume that there are M different θ-parameters that determine the preferences for leisure. Each one is observed with probability π_j (where $\pi_j > 0$ and $\Sigma\pi_j = 1$). The interpretation of these unobserved heterogeneity parameters is straightforward, a high value simply implies a high preference for leisure.

The specification of welfare participation takes the form:

(4) $\varphi = \mu + \sigma\theta_j \quad j = 1,\ldots, M$

where μ and σ are parameters to be estimated. We define μ as a linear function of age, education, place of residence, and having young children. The parameter σ is included to allow for correlation across alternatives (leisure and welfare participation). This idea is based on a factor loading technique (see, for instance, Ham & Lalonde, 1996).

The contribution to the likelihood function for a given household (*i'*, *k'*) becomes:

(5) $$(p \mid \theta)_{i'k'} = \frac{\exp(U_{i'k'})}{\sum_{i,k}\exp(U_{ik})}$$

where *i* indexes hours of work category and *k* welfare participation. This expression simply denotes the probability that the utility in the observed state is the highest amongst all of the possible hours of work and welfare participation combinations.

In our specification of classification errors in hours of work, we follow MaCurdy et al. (1990) and

Hoynes (1996) by assuming a multiplicative error structure. Let *H* denote the observed hours of work and *h* denote the optimal (discrete) hours of work received by the optimization of the model, the multiplicative classification error specification is given as

$$(6) \qquad H = he^{\varepsilon} \qquad \text{with} \quad \varepsilon \sim N\left(-\tfrac{1}{2}\sigma_{\varepsilon}^{2}, \sigma_{\varepsilon}^{2}\right)$$

Thus, zero hours are observed with certainty, but when optimal hours are positive they differ from observed hours by a factor of proportionality.

In the presence of unobserved heterogeneity and classification errors, the contribution to the likelihood is given by:

$$(7) \qquad l = \sum_{j=1}^{M} \pi_{j} \left((p \mid \theta_{j})_{i'k'} g \right) \delta_{i'k'}$$

where $\delta_{i'k'}$ is an indicator for the observed hours of work and welfare participation state for a household, and *g* is the density for the classification error, which is written from (6) as

$$(8) \qquad g = \begin{cases} 1 & \text{if } H = 0 \text{ or } h = 0 \\ \frac{1}{\sigma_{\varepsilon}} \phi \left(\dfrac{\left[\log(H) - \log(h)\right] + \frac{1}{2}\sigma_{\varepsilon}^{2}}{\sigma_{\varepsilon}} \right) & \text{else} \end{cases}$$

5 Data

The empirical analysis of single mothers' labor supply bases on a cross-section of the *Longitudinal Individual Data* (LINDA) for Sweden drawn from 1996. LINDA is a register-based longitudinal representative data of the Swedish population (since 1968). The data consist of a large panel of individuals and their household members. In total, data for 1996 contain information on approximately 300 000 individuals, which provides us with a large sample of single mothers. There are also incremental register data for monthly wages and hours of duty (a fraction of full-time hours).

Our sample of single parent households consists of females who have at least one child, 1-12 years old living with them. Early retirees, students, mothers of infants and mothers under the age 18 or above 60 are excluded from the sample. Sample statistics are shown in Table 1 (Appendix).

The selected sample includes 7 171 single-mother households. The mean age of the mothers is 35 and they have 1.83 children on average. In the sample, 88 % of the mothers are native Swedes, 5 % are immigrants from other Nordic countries, while 1 % and 6 % originate from other Western countries and refugee countries, respectively.

Hours of work and hourly wage rates are constructed using information from the supplementary register mentioned above. However, this information is not available for the full sample. We have information on wages and hours of duty for all of those who work in the public sector, but only for about half of those working in the private sector. Thus, this might introduce a selectivity problem in our data and we have not tried to correct for this in the estimation, instead, we have re-selected a random sample taking this into account. In effect, this might be a smaller problem in our sample of single mothers. A comparison of earnings for the publicly and privately employed exhibits only a small difference, and the same is true when comparing the hours of work. Since the missing values for employed females reduce the sample of working single mothers, we adjusted the sample of non-working single mothers to keep the participation rate unchanged. This was accomplished by randomly deleting a sub-sample of non-working single mothers.

Hourly wage rates for the employed are calculated dividing monthly full-time earnings by the "standard" monthly full-time hours of work, i.e. 165 hours. Annual hours of work, h, is then defined as total labor earnings divided by the hourly wage rate. Thus, our definition of hourly wage rate is quite different from the commonly used which is obtained by dividing observed earnings by observed hours, and thus has a tendency to incur measurement errors. The definition that is used here is not subject to the same problem. A characteristic feature of the wage rate used in this study is that the variation is small. As a consequence of this, there is no need to truncate extreme values. As shown in Table 1 (Appendix), the mean hourly wage rate is 90 SEK (ranging from 56 to 411 SEK) and mean annual hours of work is 1 283.

A remaining problem is, as usual, that wage rates are missing for non-working individuals. Therefore, we predict them using a standard Heckit-approach to estimate hourly wage rates for the whole sample. The estimation results are shown in Table 2 (Appendix). To sum up, the wage increases with the level of education and at a decreasing rate with age (the marginal effects), while it decreases with the number of children and if having immigrated. As expected, in bigger cities the wage level is higher than in smaller towns. Eventually, our labor supply model is estimated using these selectivity-corrected predicted wage rates for non-workers and actual wage rates for

workers.

The total income of a household consists of labor and non-labor income. Main components of non-labor income are income from capital and public transfers, such as unemployment benefits and other social security allowances. Non-labor income is further divided into two parts, taxable and non-taxable. Taxable non-labor income consists of occupational car or expense allowances, job-related injury compensation, rehabilitation compensation, allowance for labor market training, unemployment benefits, cash labor-market support etc. The major part of the non-taxable non-labor income consists of child allowance, which every family with a child below 16 years of age is entitled to.

Tax exemptions consist of several components, such as deductions for business expenses, deductions for voluntary retirement insurance and for periodical supports, and capital loss related deductions. The precision in this variable is a good illustration of the advantages of using register data. It is difficult to obtain a reliable measure of deductions from a survey. Since all errors in the income variables lead to errors in calculated budget sets, it is crucial to have income data of high quality.

Housing allowance is determined by nationwide rules and it is mainly directed to families with children. The amount of benefit received by a household is determined by economic and demographic factors such as net household income, housing expenditures, number of children and ages of the spouses. Unfortunately, there is no information about housing expenditures in LINDA. Therefore, the cost of housing is imputed using information from an alternative data source, the Swedish *Household Income Survey* (HINK) supplied by Statistics Sweden. In the imputation of the costs of housing, we have used the method of minimum distance using age, number of children, earnings, place of residence and citizenship as classification variables.

As mentioned earlier, single-mother households are heavily supported by the public sector. Both monetary transfers and publicly provided services are to a large extent targeted to low-income households. About 16 % of the households in the sample received social assistance, and about 70 % received housing allowance.

Unfortunately, we do not know exactly which households in our sample use municipal (publicly subsidized) childcare. In spite of this, the cost of childcare can still be assessed, since the rules are known. Thus, the budget sets are constructed assuming that every mother uses municipal

childcare and the demand depends on a mother's hours of work. The costs of childcare are determined further by a household income and the number and ages of children participating in public childcare.

The key explanatory variables in the model are the presence of young children in the household, mother's education (measured in levels), age (and age squared), and place of residence. The presence of young children in a household is expected to decrease the preference for market work, and the younger the children are the lower the preference is expected to be. Also, the more a woman has invested in education the more she prefers to work, presumably. For the other explanatory variables the effect is less obvious, except that fixed costs of working are expected to decrease the preference for work.

6 Results

Two different specifications of the economic model are estimated. Model 1 considers both observed and unobserved heterogeneity in preference for leisure, and consumption as well as welfare participation without heterogeneity. Model 2 is a more general specification which, in addition, takes into account heterogeneity in welfare participation and fixed costs of working. Further, Model 2 allows for a correlation between preference for leisure and welfare participation. The results are presented in Table 3 (Appendix).

As discussed above, the utility function was not restricted in the estimation to be quasi-concave, instead, the concavity was tested after the estimation (for more details, see van Soest, 1995). Approximately 1 500 individuals violate the Slutsky-condition in Model 1 and about 500 in Model 2. The results from the policy simulations are based on individuals' satisfying the Slutsky-constraint. Note however, that it might well be the case that individuals, who do not violate the constraints before the policy change, may do so after the applied change.

The results of Model 1 show that, all variables reflecting observed heterogeneity in the preference for leisure are significant. As expected, there is a strong and positive effect of younger children on the preference for leisure. Compared to the highest level of education, which is used as the reference, both of the lower educational levels also has a strong positive effect. Age has a negative and age squared a positive effect on the preference for leisure. Finally, living in a big city has a negative effect. When considering the effect of welfare participation the model indicates that there is a stigma effect associated with welfare participation.

Considering Model 2, the results look much the same as the results from Model 1. However, fixed costs of working seem to play an important role in households' decision making. An increase in these costs has a pure income effect on the labor supply, which therefore increases the hours of leisure (assuming that leisure is normal good). The estimated intercept indicates that these costs decrease the preference for market work. Other arguments in FC have mixed effects. The negative sign for the presence of young children in a family implies stronger preference for work. These variables might also capture the effects of free or heavily subsidized public childcare which was better available for employed parents. The preference for market work increases with age at a decreasing rate. The positive effect of living in a big city might reflect higher travel time and cost. Compared with the highest level of education, the effect of having a primary school or high-school degree decreases the preference for market work.

The estimated two support points and the accompanying probabilities for Model 1 provide the estimates for unobserved heterogeneity in individuals' preferences. From the estimated support points, we can see that the first estimate of θ indicates a relatively strong preference for leisure. The corresponding π-parameter suggests that about 17 % of the individuals belong to this group (compared to the sample information that 19 % are not working). Likewise, the second group is identified as having a lower preference for leisure. For Model 2 we were able to estimate three support points. Thus, there are three groups in the sample representing different preference for leisure.

The welfare equation contains only a constant in Model 1, while Model 2 includes a constant and some background characteristics. Adding heterogeneity allows us to explore the significance of the stigma-effects on different types of households. The estimates of both specifications indicate that there is, in fact, a positive and significant stigma-effect associated with welfare participation. Our results support the fact that not all households take up the benefits for which they are eligible. Model 2 implies that the stigma-effect is weaker in the young and in the low educated groups of single mothers. Furthermore, the effect is higher among those who have young children and are residing in a big city.

The estimated covariance in Model 2 (the 2nd last row in the table) shows a negative correlation between welfare participation and unobserved elements of work effort. Similar results are reported in Hoynes (1996) and Flood et al. (1999), where the estimated correlation is higher for

the work effort of women than of men. A negative covariance between welfare and preference for leisure implies self-selection into welfare, the higher the preference for leisure the smaller the influence of the stigma-effect.

A well-known problem of labor supply models is their poor ability to fit the observed distribution of hours of work. One way to improve the fit of these models is to include controls for fixed costs of working, as in Kapteyn et al. (1990) and van Soest (1995). The discrete unobserved heterogeneity approach serves another way to improve the fit. In our model, fixed costs of working, the estimated support points and the additive error term in the utility function produce predictions that closely resemble the observed distribution of hours of work.[4] Figure 3 (Appendix) compares the frequency distribution of the observed hours of work with the predicted ones. As one can see, Model 1 and Model 2 only slightly overestimate the zero hours of work categories, but otherwise the models provides a distribution similar to the observed data.

The method of predicting hours of work, conditional on unobserved heterogeneity, is calculated in the following way. The estimated parameters in the utility function are used to calculate a probability for each discrete choice, 1 - 14 (seven classes for hours of work times two for the welfare participation choice). The maximum value of the probability then gives the predicted choice of hours of work and welfare participation. If the maximum probability falls among the first seven alternatives, no welfare participation is predicted. Similarly, welfare participation is predicted for the household if the probability falls among the last seven alternatives.

The procedure described above is repeated for all values of θ. Thus, for each individual, as many as there are values for θ, equally many predicted alternatives of hours of work and welfare participation statuses are obtained. Then one of those is chosen. In order to choose the group, weighted values are calculated as

$$r_j = \frac{p_j \pi_j}{\sum_i p_i \pi_i} \quad j = 1, 2, \text{ (and 3, in Model 2)}$$

where p_j is the maximum probability of all 14 alternatives evaluated at θ_j, and π_j is the estimated probability of a group j (j = 1, 2, 3). The predicted group is chosen by max (r_j). Thus, if r_1 is the maximum, the individual is predicted to belong to the group 1 (Model 1: a small preference for

[4] If the extreme value distributed error term is not used in calculations of the predictions then considerably lower incentive effects are obtained.

work). Finally, once an individual has been assigned to a group, she always belongs to that group.

We conduct four policy experiments applying them to both specifications. These policy experiments are a 10 % wage increase, adopting a new childcare payment scheme, tax reduction, and 25 % decrease in the WEL (the max. of household income to apply for social assistance). In the following we describe shortly the policy reform and the resulting changes in behavior.

The idea with the first simulation is to examine the incentive effects of a 10 % increase in gross hourly wage rates. The results (Table 4 in the Appendix) indicate relatively high incentive effects. Model 2 predicts an increase of 9 % in the hours of work, while Model 1 predicts an increase of 5 %. Further, the share of those who change an hours of work category is 7.5 % in predictions from Model 1 and 30 % according to the Model 2. Other changes that are considered are the mean disposable income which increases by about 5 - 8 %, and housing allowance that drops remarkably by 12 - 15 %, depending on the specification. The wage increase has a drastic effect on social welfare participation, Model 1 predicts that the participation rate drops by 58 %, while Model 2 predicts a drop by 10 %. As a result of the wage increase, cost of childcare increases by about 14 - 15 % and tax liabilities by about 16 – 21 %. Finally, the welfare effects are calculated using Equivalent Variation (EV) as a measure. EV is the amount of money added or subtracted from a household's disposable income before a reform is applied, in order to make the household indifferent between the situation before and after the reform. As such, EV summarizes the change in net welfare of a household associated with the behavioral responses due to the reform. Here, the level of compensation varies from 4 500 to 11 000 SEK.

Table 5 reports the simulated effects of a recently suggested reform regarding the payment schemes of the publicly provided child daycare. This reform reduces the costs of childcare for households by introducing an upper ceiling for fees. For one child the maximum monthly cost is 1 150 SEK, or 3 % of household income, for the second child the corresponding cost is 767 SEK, or 2 % of household income, and for the third the cost is 383 SEK, or 1 % of the income. The results show that the reform has a moderate effect on hours of work. Again, about 8 % and 30 % change the hours of work category, while the increase in hours of work is about 5 – 9 %. Not surprisingly, the main effect is the reduction in the households' childcare cost by up to 29 – 31 %. The reduced fees for childcare result in increased disposable income of around 3 – 5 %. There are small changes in housing allowances and taxes reflecting the small change in hours of work. EV results in quite small average effects of about 2 700 – 8 700 SEK.

The third policy experiment is a simple tax reform, which reduces the progression in the income tax scheme. The maximum marginal tax rate is decreased down to the level of the municipal tax rate (on average, a slightly above 30 %), i.e. the break point at a yearly taxable income of around 200 000 SEK (see, Figure 2) is abolished. The main effects of the tax reduction are an increase in hours of work of about 5 – 8 %, and an increase in disposable income of about 3 – 5 %. There is an expected decrease in tax revenues according to Model 1, but due to the increase in hours of work, this reduction is small. Model 2 predicts that the increase in hours of work outweighs the tax reduction considering the state revenues. Since the housing allowance and social allowance receipts decrease while the costs of childcare increase, the total effect on the government revenues is positive. The EV measure implies a small welfare increase (about 2 - 7 000 SEK on the average level) as a result of the tax reform.

The fourth policy experiment is a change in the welfare eligibility limit. The WEL is decreased by 25 %, which implies that the number of households eligible for social assistance must decrease. The reform causes an increase in labor supply that is quite high. There is 5 – 10 percent's increase in hours of work depending on the model specification. Another interesting effect is the change in social assistance. There is a drop of almost 30 % in social welfare participation according to Model 1, whereas Model 2 predicts only 18 percent's drop. Since almost all of the social assistance recipients are not working, Model 1 produces a grater drop because of the overprediction of the class of non-workers. However, the average disposable income is not about to decrease, but is increased by 2 – 5 % due to the increase in work effort. The EV-measure is now very small for the Model 1, only about 1 000 whereas for Model 2 it is almost 9 000 SEK.

In the discussion above, we have concentrated only on the average effects, while the distributional effects have not been considered at all. Even though the reported mean values are quite large, there might be diverse effects for various income groups. As an illustration, we continue examining the distributional effects of the WEL and childcare reforms more closely by using the results received from Model 2. When the WEL was reduced 25 % the estimated average increase in hours of work for all the households was about 10 % per year. However, this reform has a remarkably diverse impact on different households depending on which income bracket they belong to. Ordering the households into income deciles according to the predicted disposable income before the reform, it reveals that the strongest increase in hours of work take place in the lowest deciles compared to the highest income deciles in which there is only a negligible change in hours of work. Consequently, the reform would increase the work effort for those who did not work before the policy change.

A closer look at the distributional effects of the childcare payment scheme reform shows a similar result compared with the WEL reform. The predicted increases in hours of work are again largest in the lowest income deciles and have almost no effect on those belonging to the highest income deciles. Thus, there are quite large incentive effects for the households lying below the median income level.

To conclude, the micro simulation approach used here enables us to consider both the average and distributional effects of a change in the income tax system and social welfare regimes. The implemented policy simulations reveal some interesting results. The results indicate quite large average incentive effects, but examining the distributional effects more deeply we find much larger effects for those belonging to the lowest part of the income distribution compared to the highest part of the distribution.

7 Conclusions

The purpose of this study is to analyze the size of the incentive effects for individuals facing high marginal effects. We use a sample of Swedish single mother households utilizing the LINDA database containing detailed information on their incomes and social transfer benefits. We formulate a model where labor supply and welfare participation are determined jointly. The decisions over hours of work and welfare participation are treated as a discrete choice problem, and we assume that these choices follow a simple conditional logit rule. In addition, we allow for unobserved individual-specific effects and these effects are also allowed to correlate across choices over hours of work and welfare participation. These unobserved effects are assumed to be drawn from a discrete distribution, and the correlation across alternatives is modeled using factor-loading techniques. Classification error in hours is allowed for by using a multiplicative classification error specification. We also take into account the effects of fixed working costs that are related to the labor market participation.

Two different specifications of the model are estimated. The first model is estimated allowing heterogeneity in preference for leisure but without heterogeneity in the welfare participation. To the second specification we include heterogeneity in the welfare participation decision and we also include fixed costs of working. In the latter specification we also allow for correlation across preference for leisure and welfare participation.

To find out the sizes of incentive we test the effect of different policy changes on single mothers' labor supply decisions. Four policy simulations are applied to the different specifications of the model. These policy experiments are a 10 % wage increase, reduction in child daycare fees, income tax reduction, and 25 % decrease in the social welfare eligibility limit.

We find that there is a positive and significant stigma-effect associated with welfare participation. Further, there is a negative covariance between social welfare participation and labor supply, which implies self-selection into welfare. Fixed costs of working seem to be an important factor for single mothers when they decide whether to enter the labor market. The received results from the policy simulations show rather large average incentive effects. However, when examining the effects along the whole income distribution, we find quite diverse effects for different income groups. The effects are largest especially for those belonging to the lowest income groups, while there are no effects at all for those belonging to the highest income deciles. The predicted increases in hours of work are extensive for the poorest single mother households.

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Appendix

Table 1. Description of the Sample of the Single Mother Households (N=7 171).

Variables	Mean	Min	Max
Age	35	18	60
Education (the highest attained) %			
- Compulsory school	0.26	0	1
- High school	0.65	0	1
- University	0.10	0	1
Hours of work (per year)	1 283	0	5 351
Participating the labor market	0.81	0	1
Hourly wage rate (SEK)	89	56	411
Taxable non-labor income (SEK per year)	18 929	0	290 706
Non-taxable non-labor + net capital income	19 468	0	859 543
Tax deductions (SEK per year)	3 058	0	143 528
Number of children: 1-12 years old	1.83	1	4
Place of residence, %			
- Big city	0.37	0	1
- Medium sized city	0.45	0	1
- Rural city	0.19	0	1
Nationality, %			
- Swedish	0.88	0	1
- Nordic countries	0.05	0	1
- Western countries	0.01	0	1
- Refugee countries	0.06	0	1
Welfare participant	0.16	0	1
Social assistance (SEK per year)	4 276	0	159 108
Housing costs (SEK per month)	4 734	1 374	8 337
Receiving housing allowance (%)	0.71	0	1
Housing allowance (SEK per year)	14 830	0	46 800

Table 2. The Estimated Parameters of the Probit Model of the Labor Force Participation and the Wage Equation for Single Mothers.

VARIABLE	Parameter Estimate	Standard error
PARTICIPATION EQUATION:		
Intercept	-1.4701	0.8066
Age	0.1912	0.0321
Age squared / 100	-0.2416	0.0356
Education: compulsory school	-1.7034	0.6203
Education: high-school	-0.4733	0.6039
Number of children	-0.0959	0.0244
Medium sized city	-0.0979	0.0428
Rural town	-0.1348	0.0532
Having a 1-year-old child	-0.7339	0.0834
Having a 2-5 year old child	-0.1682	0.0443
Age * compulsory school	0.0165	0.0157
Age * high-school	-0.0042	0.0151
Immigrant: Nordic	-0.1596	0.0862
Immigrant: Western	-0.7193	0.1957
Immigrant: Refugee	-1.1546	0.0633
WAGE EQUATION (log wage):		
Intercept	3.7853	0.0943
Age	0.0368	0.0045
Age squared / 100	-0.0319	0.0054
Education: compulsory school	0.1512	0.0541
Education: high-school degree	0.1294	0.0446
Number of children	-0.0155	0.0030
Medium sized city	-0.0319	0.0046
Rural town	-0.0390	0.0059
Age * compulsory school	-0.0095	0.0013
Age * high-school	-0.0080	0.0011
Immigrant, Nordic	-0.0207	0.0096
Immigrant, Western	0.0162	0.0274
Immigrant, Refugee	-0.0761	0.0192
Lambda	0.0135	0.0303
$\overline{R}^2$	0.25	

Table 3. Estimation Results of the Utility Function, Model 1 and Model 2.

VARIABLE	Coefficient	MODEL 1 Parameter estimate	Std. error	MODEL 2 Parameter estimate	Std. error
Preference for leisure:	β_h				
Child: 1-year old	β_{h1}	7.573	0.485	8.742	0.901
Child: 2-5 years old	β_{h2}	1.548	0.194	3.080	0.443
Child: 6-9 years old	β_{h3}	0.746	0.176	1.777	0.428
Education: primary school	β_{h4}	1.295	0.236	0.138	0.545
Education: high-school	β_{h5}	0.525	0.202	0.326	0.473
Region: big city	β_{h6}	- 0.463	0.131	- 1.459	0.292
Age	β_{h7}	- 0.549	0.095	0.055	0.157
Age^2 / 100	β_{h8}	0.696	0.127	- 0.134	0.218
Preference for consumption	β_C	12.445	0.693	13.128	0.763
Consumption^2	β_{CC}	2.944	0.197	1.084	0.191
Leisure time ^2	β_{hh}	- 4.830	0.300	- 9.069	0.327
Leisure * Consumption	β_{hC}	- 1.404	0.246	- 2.692	0.195
Fixed costs of working:					
Intercept	γ_0	-----		4.259	0.748
Child: 1-year old	γ_1	-----		- 0.957	0.193
Child: 2-5 years old	γ_2	-----		- 0.526	0.136
Child: 6-9 years old	γ_3	-----		- 0.386	0.128
Education: primary school	γ_4	-----		0.460	0.135
Education: high-school	γ_5	-----		0.155	0.118
Region: big city	γ_6	-----		0.367	0.074
Age	γ_7	-----		- 0.109	0.039
Age^2 / 100	γ_8	-----		0.159	0.058
Classification error	ε	0.151	0.001	0.151	0.001
Unobserved heterogeneity	θ_1	58.891	2.589	12.555	2.877
	θ_2	23.555	1.833	0.055	3.796
	θ_3	-----		15.349	2.903
Associated probabilities	π_1	0.169	0.005	0.874	0.018
	π_2	0.831		0.008	0.003
	π_3			0.118	
Welfare participation:	φ				
Intercept	μ_0	2.311	0.042	24.106	6.937
Child: 1-year old	μ_1	-----		- 0.597	0.411
Child: 2-5 years old	μ_2	-----		- 0.723	0.350
Child: 6-9 years old	μ_3	-----		- 0.611	0.328
Education: primary school	μ_4	-----		- 4.023	0.532
Education: high-school	μ_5	-----		- 2.243	0.519
Region: big city	μ_6	-----		- 0.225	0.171
Age	μ_7	-----		0.456	0.093
Age^2 / 100	μ_8	-----		- 0.531	0.134
Cov(leisure, welfare)	σ_{hw}	-----		- 2.054	0.293
Log Likelihood		- 10 730.03		- 9 937.77	

Table 4. Simulations: An increase in Gross Hourly Wage Rates by 10 %.

CHANGES IN	MODEL 1	MODEL 2
	(%)	(%)
Hours of work	4.75	9.32
Share of those who changed class	0.075	0.303
Disposable income	5.48	8.14
Housing allowance	- 11.63	- 15.29
Social assistance	- 58.17	- 10.0
Cost of childcare	13.65	14.89
Taxes	15.81	21.08
Equivalent variation	4.49	11.16

Table 5. Simulations: A New Child Day-care Payment Scheme.

CHANGES IN	MODEL 1	MODEL 2
	(%)	(%)
Hours of work	5.11	8.79
Share of those who changed class	8.1	30.2
Disposable income	3.67	5.55
Housing allowance	- 2.56	- 4.63
Social assistance	- 55.92	- 9.29
Cost of childcare	- 31.08	- 28.97
Taxes	4.04	7.82
Equivalent variation	2.70	8.69

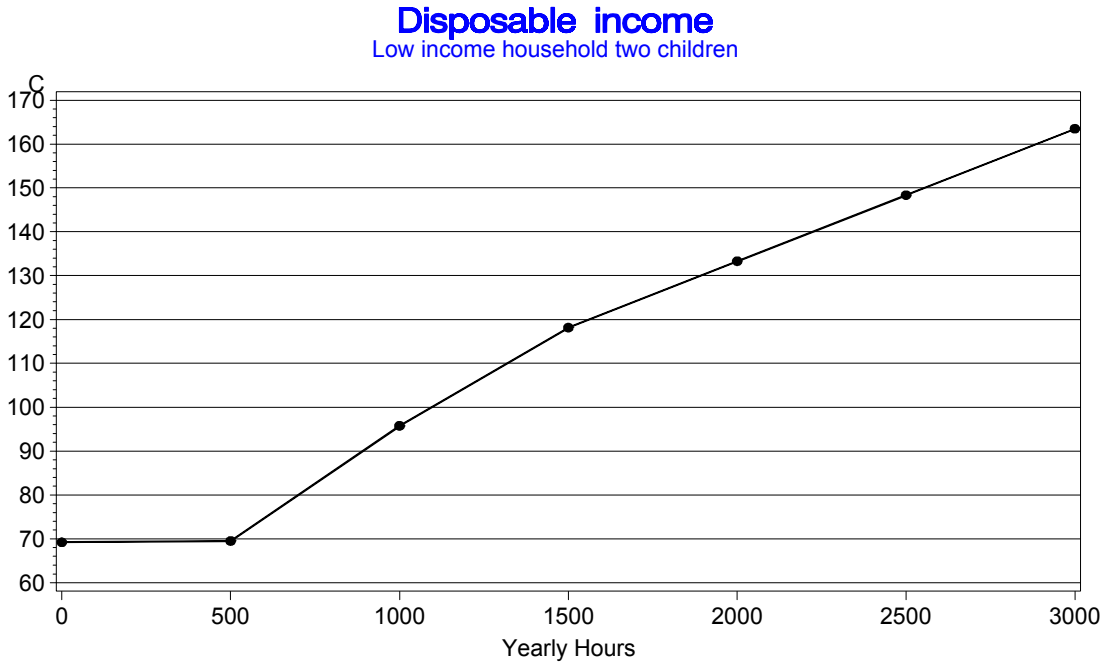
Table 6. Simulations: No Governmental Income Tax.

CHANGES IN	MODEL 1	MODEL 2
	(%)	(%)
Hours of work	5.36	7.78
Share of those who changed class	7.7	31.9
Disposable income	3.33	5.09
Housing allowance	- 2.73	- 4.51
Social assistance	- 57.42	- 9.35
Cost of childcare	5.8	4.45
Taxes	- 0.12	2.25
Equivalent variation	2.03	7.27

Table 7. Simulations: Decrease in Welfare Eligibility Limit by 25 %.

CHANGES IN	MODEL 1	MODEL 2
	(%)	(%)
Hours of work	4.54	9.73
Share of those who changed class	7.4	30.2
Disposable income	1.67	4.78
Housing allowance	- 2.23	- 3.82
Social assistance	- 29.4	- 17.86
Cost of childcare	5.13	5.7
Taxes	3.58	8.08
Equivalent variation	1.27	8.73

Figure 1.


Disposable income
Low income household two children
C
170
160
150
140
130
120
110
100
90
80
70
60
0
500
1000
1500
2000
2500
3000
Yearly Hours

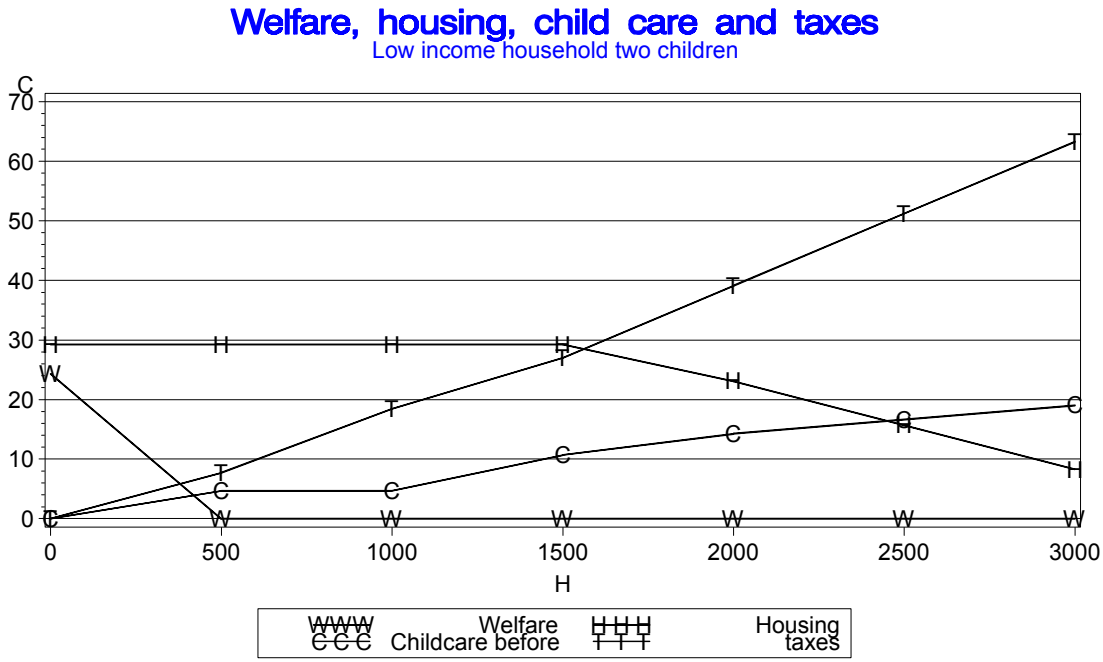

Welfare, housing, child care and taxes
Low income household two children
C
70
60
50
40
30
20
10
0
0
500
1000
1500
2000
2500
3000
H
Welfare
Childcare before
Housing
taxes

Figure 2. Income taxes in Sweden 1996

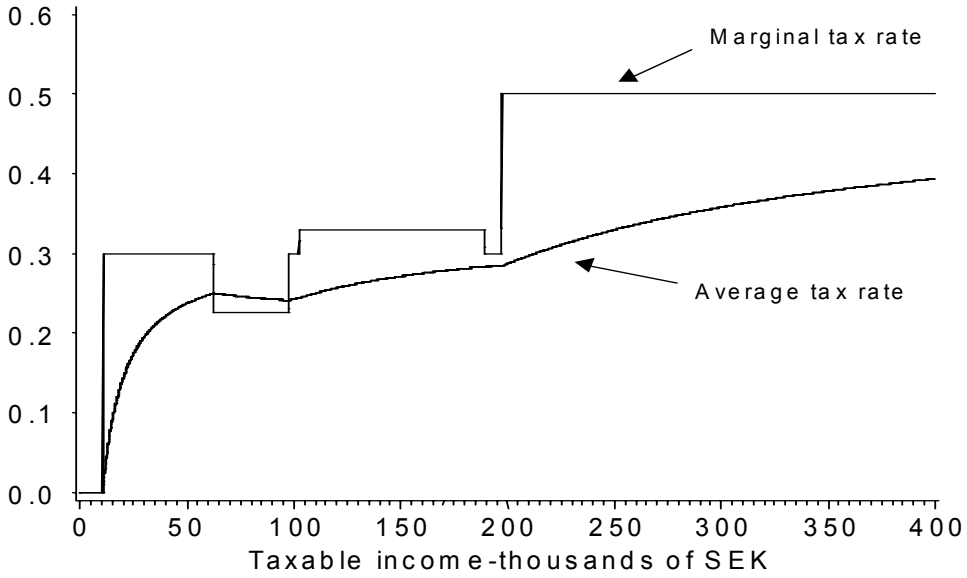
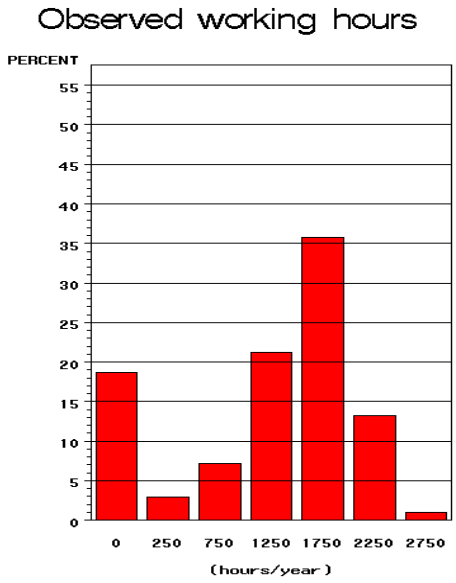
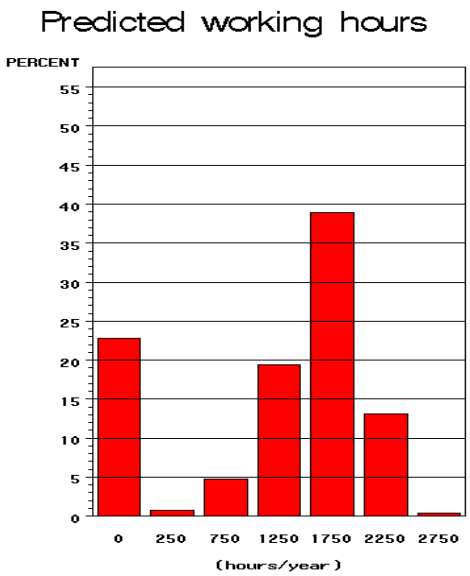


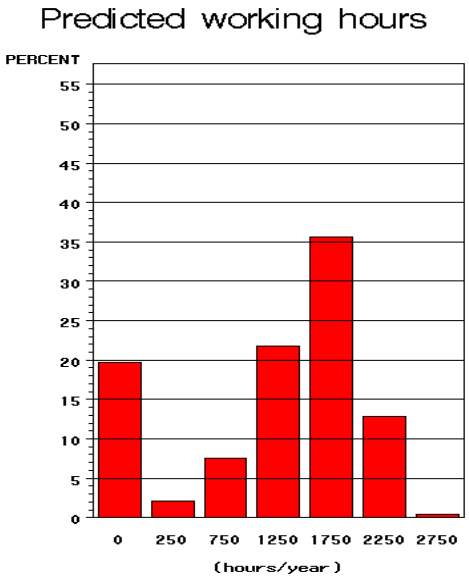
Figure 3. Observed distribution of hours of work (discrete classes), the upper panel, and predicted distributions of hours of work, the lower panels.



Model 1



Model 2



Changes in Household Production of Swedish Two-Adult Households

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August 2002

Abstract:
Recent studies show that the time allocation of men and women has become more alike over the past decades in Sweden. Women spend more time than before on market work, while men spend more time on household work. Here we analyze the Swedish time use data within the household production theory framework. The focus is on changes in household productivity and the value of household production. This study is a continuation of an earlier study of Kerkhofs & Kooreman (2002) where they examine the identification problem of household production functions and make an application to the Swedish HUS time use data from the year 1984 for Swedish households. The purpose of this paper is to use the same specification of the household production function applied to the data from nine years later (from the 1993 wave of the HUS data). The obtained results will then be compared with their respective results. The used model is a quadratic specification of the net product value function with joint production and selection correction. The overall stability of the results confirms that the previously suggested specification provides a powerful tool to identify and estimate household production. One of the main findings is that the household marginal productivity profiles have become more alike between females and males. In both applications, men's and women's household time are found q-substitutes, which also supports the validity of the chosen specification.

Keywords: Home Production, Time Use, Household Productivity.
JEL-classification: D13, J22.

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1 Introduction

Changes in the socioeconomic environment, such as changes in the wage rate, income, education, and the number of children, differ in their effects on work at home and in the market, and on the allocation of time of men and women. Technological changes in both sectors – home and market – produce new situations and environments where households act. For example, the New Economy, bases on the idea about a world in which people work with their brains instead of their hands and working does not necessarily need special locations. It is therefore of interest to analyze changes in home production and household productivity over time at the household level, rather than in the aggregate.

The objective of this study is to analyze Swedish time allocation data within the household theory framework, and to test whether and to what extent the productivity of women and men has changed in the home sector from 1984 to 1993. The emphasis is on the changes in the productivity and value of home production of Swedish two-adult households. This study provides a continuation to an earlier study of Kerkhofs & Kooreman (2002) which presents (among other things) an empirical application to Swedish HUS time allocation data from the year 1984. Here we consider the data nine years later, from 1993 wave of the HUS data.

Comparing the descriptive statistics from the respective years, we can observe that the gender differences within households have decreased. Compared to 1984, women spend more time on market work and less on household work, while men spend more time on household work and less on market work (Gråsjö & Flood, 1995). International comparisons also demonstrate that there is a growing trend towards more sharing and less specialization (Gershuny, 2000). The comparative advantage of women in home production has reduced for at least two reasons. First, the relative productivity of men in household work has increased due to new home technology, and second, the rise in the women's education level has improved their productivity in the labor market. Nevertheless, there is still a strong tendency within two-adult households towards specialization, the gender differences are smallest when comparing the time use of single men to single women.

Our results confirm that married and cohabiting females have emancipated in certain respects when comparing the results with the study for the 1984 data. The most outstanding result is that the productivity profiles of men and women have become more alike. For the 1993 data the marginal productivity at home is more even and the rate of decline of the marginal productivity is

more symmetric between men and women compared to the results for the 1984 data. In both studies, women's and men's home production times were found to be q-substitutes, rather than q-complements, which is crucial for the identification of the model. The overall stability of the results confirms that the applied method provides a powerful tool to identify and estimate the household production (over time) and the value of household production. Our estimates satisfy the regularity conditions of utility maximization and are compatible with the previous results.

Typically, time use data are incomplete, which implies that one is forced make strong assumptions or to cut down the level of detail in which the activities are defined. Not only are the inputs of market goods unobservable, but the outputs of home production are unobservable as well. The problem is whether the model of household production can be identified at all on the basis of time allocation data only. Kerkhofs & Kooreman (2002) discuss the problem and show that a class of household production models and so-called jointness functions for two-adult households can be identified.

The theoretical basis of modeling household production is a Gronau model. This model is characterized by a dichotomy property which implies that the amount of time spent on household production does not depend on the household utility function, provided that household members are gainfully employed. This property simplifies the analysis considerably. For two-earner households we only need to specify the production function but not the utility function. The applied model is a unitary household decision model that is further extended to allow for the possibility of joint production (i.e. when an activity serves a mixture of goals). Due to identification problems in earlier applications, Kerkhofs & Kooreman suggest a more flexible quadratic specification of the household production function which measures the value added in the production process.

The structure of the paper is the following. Section 2 introduces the New Home Economics theory which is the applied framework of this study, and discuss the substitutability and complementarity of household time between spouses. The model specification of the household production function is given in Section 3. In Section 4 the used time allocation data is presented with descriptive statistics. Section 5 presents the results and compares them with the previous Swedish time use study of Kerkhofs & Kooreman. Lastly, Section 6 concludes.

2 Household Production

Household production is an important part of economic activity, although generally ignored in national income accounting. The value of home production is estimated to account for 40 – 50 percent of the total production in Western countries, and in less advanced economies this fraction is presumably even higher (Bonke, 1992). A recent Swedish survey shows that in total weekly time devoted to household work (126 million hours) is nearly the same as the time devoted to market work (128 million hours). The relative share of females in the household sector is 60 percent compared to males' 40 percent, while in the market sector the shares are shifted, males do 60 percent of the market work and females 40 percent (SCB, 2001).

The productive role of households was ignored in the early neoclassical models where all non-labor time were addressed as leisure. By now the household production theory is an established part of economic theory. In the 1960s mainstream economists began to pay serious attention to household decisions, when Mincer's (1962, 1963) and Becker's (1965) pioneering work in New Home Economics imported quantitative methodologies to analyze household decision-making. This new approach was oriented toward the study of nonmarket commodities and the associated allocation of household time.

The basic idea in Becker's (1965) model is the following. Utility that household obtains is generated merely by *commodities* that are produced by combining the market goods, *auxiliary goods*, with time in a household production function. The outputs of this production process are the utility generating commodities. The striking feature of the model is that market goods and time are not desired for their own sake but only as inputs into the production of commodities. Becker calls these utility-generating processes as *activities*: market goods and services can only generate utility if they are combined with the consumer's time. Actually, in Becker's view, *all* activities in the household are productive.

Since the foundation of New Home Economics there have been several modifications for the theory of household behavior (reviews of different household models are given in Gronau, 1986, and a more recent survey in Behrman, 1997). Compared with the traditional neoclassical approach some modifications make a clear distinction between work, leisure and household labor time (Gronau, 1977). The time people do not spend on working at home or in a job is considered to be pure leisure. Nevertheless, sometimes it is very difficult to make a strict division between leisure and home production. As Pollack & Wachter (1975) argued, commodities which involve

time as an input are a particular problem, since their production often involves *joint production*. An input of time into many household activities is itself a direct source of utility or disutility to members of the household engaged in the activity. If a person enjoys direct utility from a production activity, part of the time spent on home production can be considered as leisure time.

One of the severe problems considering the empirical applications of the household production models is the lack of data. It is not usually even possible to identify the models because there is no information on specific household production inputs or outputs either. For an empirical application Gronau (1977, 1980) developed the home production theory in a testable form on the grounds of Becker's approach. He was among the first who applied the method to time allocation data and succeeded in identifying and estimating the value of household production. To reduce the complexity of identification of a household production technology he assumed perfect substitution between market goods and home produced goods. Although these first results were encouraging, many problems were still unsolved, for example how to deal with the two-adult decision-making process and possible joint production.

Some of the shortcomings in Gronau (1980) were further developed in Graham & Green (1984). They used a Cobb-Douglas specification of the household production function for two-adult households, along with a specification of the jointness functions, which allowed the household's optimization problem to be solved analytically. Their model was parametrically identified, but their estimation results were far from satisfying. Kerkhofs (1999) further developed the Graham & Green's specification, and in Kerkhofs & Kooreman (2002) the household production function and jointness function were identified in a two-adult case both non-parametrically and parametrically. Instead of using a Cobb-Douglas or CES specifications that resulted in unsatisfactory results, they proposed a more flexible quadratic specification of the net product value function. In their empirical application of the model they used Swedish time allocation data for two-adult households. For that data they received parameter estimates that satisfied regularity conditions for utility maximization which were steadily violated in earlier applications. Further, they found that the time inputs in household production of spouses were q-substitutes, not q-complements, which was an implicit assumption in the used specifications earlier. Actually, there are studies showing that female and male household production times are sooner substitutes but in leisure activities spouses times are found complements (Klevmarken, 1998).

2.1 Division or Sharing of Household Work

Time is one resource men and women have traditionally allocated very differently. Time use data provide the means to analyze the properties of the household production process, and in particular the degree of specialization between the members of a household. Actually, gender differences in the allocation of time have been a major motive for collecting and analyzing time use data (Juster & Stafford, 1991). Within New Home Economics theory framework Becker (1981) suggested that there was an efficient division of work in a household when at most one of the spouses work in both market sector and home sector. After investing more time in one sector, one's productivity in that sector increases. Consequently, there will be a sharp division of labor: the one who has a comparative advantage in home sector specializes fully in household work while the other in market work.

From Becker's reasoning it follows that spouses have to specialize in order to behave efficiently. By specializing the total production of a household would increase without any need for cooperation in the production process. However, this is not always true, normally spouses cooperate in producing at least some utilities, although, this type of complementarity is perhaps more common in pleasure or leisure activities than in household work. If spouses complement each other, they can accomplish more together than each separately, so that they would enjoy benefits from synergy (these issues are discussed, for example, in Flood & Klevmarken, 1992, and Cigno, 1990).

Household production models have been anathema to many feminist economists because they are often based on the presumption that women have a natural comparative advantage in household work because their wages are less than men's wages. Thus women choose jobs and careers which, although lower paying, are compatible with their household responsibilities (Woolley, 1999). These assumptions have been questioned and more gender-neutral approaches have been adopted lately (e.g. Apps, 1981, who treats household activity in the same way as market activity). Recently have collective approaches become more common. The basic distinction of collective models is between cooperative and non-cooperative settings. In contrast to a unitary model approach, these models give more flexibility in the household decision process by allowing for individual preferences within a household (Bourguignon & Chiappori, 1994).

Empirical studies on Swedish time use data indicate that there is a certain tendency for specialization in two-adult households. Although the latest evidence on household work show a

clear decrease for females and increase for males in time devoted to home sector, the difference in time use between the genders look quite different for single-adult households compared to two-adult households (Flood & Klevmarken, 1992, Flood & Gråsjö, 1995, Rydenstam, 2002). The gender difference in time use is larger for individuals in two-adult households compared to single-headed households. Single women work in the market much more and spend much less time on household work than married or cohabiting women. Whereas for males, marital status has no effect on their market work, but has a strong effect on their time use in household work. Contrary to single women, single men use much more time in household work (about 4 hours more in a week) than their married or cohabiting counterparts do. In fact, household characteristics seem to be more important than economic factors in determining the allocation of time within the household (Aronsson et al. 2001).

The comparative advantage of a woman in household work is less pronounced in the beginning of the relationship or when men and women start their work careers, but when a couple gets children there is a tendency to more specialization. The comparative advantages of men and women in household work and market work usually change during the course of childrearing years, and the specialization has a tendency to strengthen. Women usually take more time off work while men tend to rather increase their hours of work in the market when they have children. Consequently, women will have the comparative advantage in household production after investing more time in home sector, and conclusively there is a division of labor, which also has a tendency to persist (Henrekson, 1999).

2.2 Gronau Model Applied to Two-Adult Case

The basis of the empirical model that were used in Kerkhofs & Kooreman and in this study is a simplified framework of Becker, the Gronau model (developed in Gronau, 1977) that is applied to two-adult case. This model has a fundamental assumption: consumption goods and commodities are perfect substitutes, which implies that work at home and in the market are perfect substitutes. Hence, as far as the direct utility is concerned, a person is indifferent to the composition of the goods and services he consumes, to whether they are produced at home or purchased in the market. From this assumption it follows that, for working couples, the time spent on household production does not depend on the utility function, i.e. a so-called *dichotomy property*.

The dichotomy property of household production function implies a two-stage decision structure. It involves the production decisions at the first stage, and a separable choice over leisure and spending on consumption goods at the second stage. Provided that both partners work, we only have to specify the production function describing the household production decision. If this were not the case, the utility function would have to be specified too, because the labor force participation decisions involve the utility function.

Formally, in the Gronau model, a household maximizes a joint utility function subject to certain constraints considering the technology and resources. In the utility function three types of arguments are distinguished: consumption goods, commodities produced at home, and leisure of the members of the household:

$$U\,(X_r+Z,\, L_m,\, L_f) \tag{1}$$

where X_r denotes the total of consumption expenditures bought in the market and Z the output of home production and they enter the utility function as a Hicksian composite good. L_m and L_f are leisure enjoyed by the male and female, denoted by *m* and *f* respectively. The utility function is assumed to be strictly increasing in each argument, differentiable and quasi-concave.

The dichotomy property makes a clear distinction between work, leisure and household production time. Household production, *Z,* is separable from the other arguments in the utility function, which simplifies the empirical analysis and allows us to focus only on the production problems of households. The decision over the allocation of *Z* can be made independently of other decisions within households.

In the production process households maximize the amount of commodity *Z*. The output is produced by combining the inputs in the household production process:

$$Z = Z(H_m,\, H_f\,,\, X_z) \tag{2}$$

The inputs are market goods, X_z, and the time spent on household work by the members of the household, H_m and H_f . Z is assumed to be monotonically increasing, twice differentiable and subject to decreasing marginal productivity. The decline in the value of marginal productivity at home is not only due to fatigue and the monotonous character of housework or changes in input

proportions, but also to changes in the composition of Z. As H_i increases, there will be cheaper market substitutes for commodities (Gronau, 1977).

Household choice are found by maximizing a joint utility function subject to two interrelated constraints, for goods:

$$X_r + X_z = V + W_m N_m + W_f N_f \tag{3}$$

and for time:

$$H_i + L_i + N_i = T \qquad\qquad i = m,\ f \tag{4}$$

The full-income constraint can be simply expressed by collapsing these two, (3) and (4), into a single resource constraint. In the former constraint, W_i represents the net wage rate and N_i is the hours of work in a paid job for both members of a household ($i = m, f$), and V denotes the total of the non-labor income. The prices of market goods and commodities are set to one.

In the time constraint, T denotes the total of daily time endowment which can be allocated among its three uses: *household work*, (H), *market work*, (N), and *leisure* (L). The quantities of home produced and market goods as well as the allocated time to work and leisure are assumed to be non-negative. When considering only two-earner households we assume that by the choice of the utility and production functions none of the inequalities is binding in an optimal allocation, except the labor market time must be positive for both members of a household, i.e. the corner solutions ($N_i = 0$) are neglected. This assumption holds for every combination of wage rates, nonlabor income and other exogeneous variables of interest. Further, it will be assumed that for each of these combinations the optimum is unique.

The necessary conditions for an interior optimum call for the marginal product of household work to be equal to the marginal rate of substitution between goods and time spent at consumption (leisure), which in turn equals the shadow price of time, w^*. If the person works in the labor market, this will also equal the real wage rate, w. In the optimum, the crucial dichotomy property is satisfied if both members of the household are employed. The efficiency conditions are derived in the next section where the joint production is taken into account too.

2.3 Extended Gronau Model with Joint Production

The distinction between work at home and leisure is an integral part of the theory of the allocation of time and household production. However, when time is an input in the household production process it causes a particular problem because the production of commodities often involves *joint production* (discussed in Pollak & Wachter, 1975). People are often doing many things at the same time and it will therefore be difficult to separate different productive activities from one another. Another type of joint production occurs when there is a simultaneous usage of time for work at home and leisure, or alternatively when people mix leisure with market work. Time spent in various activities is often a direct source of satisfaction or dissatisfaction as well as input into a production activity. Time use in household work is not only an input in the production of utilities, but the process of doing an activity yields utility in itself, irrespective of the outcome. In that respect, joint production is rather the rule than an exception.

Joint production affects both data collection and empirical analysis. Time use of individuals is not easy to measure. Usually, joint activities will not be noted, if not asked for. Often hours of work in the market are overstated due to an inherent positive error of response and that a substantial amount of time on the job is spent on training and leisure (see, for example, Stafford & Duncan, 1983). On the other hand, the reported time spent on housework may underestimate the extent of work at home. The typical example is looking after children, which may not be regarded as pure housework (Kooreman & Wunderink, 1997, and Rydenstam, 2002). The related questions in the Swedish HUS survey pointed out that both men and women enjoy doing certain activities irrespective of their usefulness and outcome (Flood & Klevmarken, 1992). The survey showed that playing with children was rated highest in the preference orderings of different time use activities for both men and women. Furthermore, we could expect that these so-called process benefits (Juster, 1985) caused less specialization within households. Household decisions about the allocation of time reflect not only production considerations but also direct household preferences as to the uses of time. Hence, it is suggested to explicitly model joint production within household production models.

To allow for joint production Kerkhofs & Kooreman (2002) added a function describing which part of household production time was counted as pure leisure. The extension for joint production was suggested in Graham & Green (1984). The adopted specification exhibits flexibility and preserves the crucial dichotomy property. Individuals can attribute some part of

the household production time to leisure, which is considered as a perfect substitute for leisure. With joint production, the utility function (1) is replaced by:

$$U\,(X_r+Z,\, L_m + g_m(H_m),\, L_f + g_f(H_f)) \tag{5}$$

The individual-specific jointness functions, $g_i(H_i)$ $(i=m, f)$, are assumed to be twice differentiable, concave and initially increasing $[0\leq g'_i(H_i)\leq 1$ and $g''_i(H_i)<0]$. The negative effects of home production on utility are thus excluded. (The explicit specification of the joint production function is given in the next Section.)

The partial optimization problem for the household production decisions of working couples is now formulated as a problem of profit maximization:

$$\max_{0\leq H_i\leq T;\, X_z\geq 0} \quad Z = Z(H_m, H_f, X_z) + W_m g_m(H_m) + W_f g_f(H_f) - W_m H_m - W_f H_f - X_z \tag{6}$$

The first order conditions of household production are:

$$\partial Z(H_m, H_f, X_z) / \partial X_z = 1 \tag{7}$$

$$\partial Z(H_m, H_f, X_z) / \partial H_m = W_m(1 - g'_m(H_m)) \tag{8}$$

$$\partial Z(H_m, H_f, X_z) / \partial H_f = W_f(1 - g'_f(H_f)) \tag{9}$$

For a couple, who are both gainfully employed, the existence of a unique interior optimum implies that the production function, Z, has to be (locally) strictly concave in terms of his and her time input, H_i, and in intermediate good, X_z, at the optimal allocation.

The Gronau model predicts that an increase in the market wage rate of a spouse will reduce his or her own time spent on home production. And further, if the time inputs of the couple were complements, the partner's home production time would also be reduced, while it would increase if the time inputs were substitutes. Because of the separability property of the household model it follows that there are no income effects. An increase in non-labor income will reduce both partners' hours of work in the labor market, but has no effect on the household production decisions.

To retain the dichotomy property, we will focus on two-earner households. Consequently, the sample consists of the households chosen non-randomly, which may cause selectivity problems due to the exclusion of the other types of households. This selectivity-bias will be taken into account when specifying the econometric model (in Section 3).

3 Econometric Specification

Time allocation surveys usually contain information on H_m and H_f, but hardly ever on the amount of auxiliary goods, X_z, that are also used as inputs in home production. Neither is the output of home production, Z, usually observed. So, the question arises whether the model can be identified in the first place on the basis of the time allocation data only. We can only observe time allocations that were optimal for some input vector (W_m, W_f, V).

The problem of identification is examined profoundly in Kerkhofs & Kooreman (2002). They show that the Gronau-type of household production function extended with the Graham & Green –type of jointness functions can be identified (non-parametrically) in two-adult case, but not in single-adult case. They also suggested the following parametric specification for a household production function, and managed successfully to identify the household production function applying the model to the Swedish two-adult household data.

The specification follows the lines of Gronau (1980), who first suggested an indirect approach where the efficiency condition (equality of the marginal productivity and the wage rate) is used rather than the household production function. Instead of trying to estimate the production function (6) the idea is to estimate the marginal productivity of time in home production, and then using it in the evaluation of the value of home production.

Instead of using a Cobb-Douglas or CES specifications that resulted in unsatisfactory results, Kerkhofs & Kooreman proposed a quadratic specification of the net product value function:

$$Z = b_m H_m + b_f H_f + \tfrac{1}{2} c_{mm} H_m^2 + \tfrac{1}{2} c_{ff} H_f^2 + c_{mf} H_m H_f \qquad (10)$$

The b_i ($i = m, f$) is assumed to be strictly positive and the matrix $\boldsymbol{C}$ to be a negative definite (a symmetric 2 x 2 matrix with c_{mm} and c_{ff} as diagonal elements). The quadratic specification allows

for the possibility that the time of household members can either be q-substitutes ($c_{mf} < 0$) or q-complements ($c_{mf} > 0$).

Heterogeneity is introduced by letting b_i depend on household and individual specific characteristics:

$$\log(b_i) = \boldsymbol{x}_i'\boldsymbol{\beta}_i + u_i \qquad i = m, f \tag{11}$$

where $(u_m, u_f \mid x_m, x_f) \sim N(0, \sum_{uu})$. $\boldsymbol{\beta}$ is a vector of variables affecting the value of marginal productivity at home.

The first order conditions for individuals who are gainfully employed are:

$$b_i + c_{im} H_m + c_{if} H_f = (1 - g_i'(H_i)) W_i \qquad i = m, f \tag{12}$$

The amount of household production time that is considered as a perfect substitute for leisure is given by the jointness functions $g_i(H_i)$. These functions are assumed to be twice differentiable, concave and initially increasing. The jointness functions are specified as in Graham & Green (1984) (the properties of joint production functions were discussed in section 2.2):

$$g_i(H_i) = H_i [1 - (1 / (1+\delta_i)) (H_i/T)^{\delta_i}] \qquad i = m, f \tag{13}$$

where $\delta_i \geq 0$. If $\delta_i = 0$ there is no joint production. Increasing δ_i raises the amount of joint production, and for infinitely large values all home production time is perceived as leisure.

The first order conditions (12) hold for households in which both partners have a paid job. Because the sampling rule depends on the labor market status which is endogeneous in this model, it is important to account for the selectivity. However, it is not clear what the direction of the selection bias will be, whether our sample represents more or less productive persons in household work. Further, it is important to note that the partners' labor market participation decisions may not be independent. The problem of sample selection is therefore taken into account explicitly by extending the structural model for the home production decisions with a bivariate probit model describing the individuals' employment status:

$$I_i = \begin{cases} 1, & I_i^* \geq 0 \\ 0, & I_i^* < 0 \end{cases} \tag{14}$$

where

$$I_i^* = z_i' \gamma_i + \varepsilon_i$$

Individual *i* is employed only if the index, I_i, is equal to one. Assuming the joint distribution is a four-variate normal we have:

$$\begin{pmatrix} u_m \\ u_f \\ \varepsilon_m \\ \varepsilon_f \end{pmatrix} | x_m, x_f, z_m, z_f \sim N\left(0, \begin{pmatrix} \sum_{uu} & \sum_{u\varepsilon} \\ \sum_{\varepsilon u} & \sum_{\varepsilon\varepsilon} \end{pmatrix}\right)$$

where the diagonal elements of the $\Sigma_{\varepsilon\varepsilon}$ are normalized at 1. In order to estimate the unknown parameters of the structural household production equations, the following transformations are made:

$$\begin{cases} u_m = k_m(H_m, H_f) \\ u_f = k_f(H_m, H_f) \\ \varepsilon_m = I_m^* - z_m' \gamma_m \\ \varepsilon_f = I_f^* - z_f' \gamma_f \end{cases}$$

For a working couple the likelihood contribution for the structural equation becomes:

$$l = f(H_m, H_f) \int_0^\infty \int_0^\infty f(I_m^*, I_f^* \mid H_m, H_f)\, dI_m^*\, dI_f^* \qquad (15)$$

where

$$f(H_m, H_f) = \left| \frac{q_{mm}\, q_{ff}}{b_m\, b_f} \left((c_{mm} + g_m''(H_m) W_m)(c_{ff} + g_f''(H_f) W_f) - c_{fm}^2 \right) \right| \phi \begin{pmatrix} q_{mm} u_m \\ q_{mm} u_m + q_{ff} u_f \end{pmatrix}$$

The determinant is received by standardizing the joint distribution of the ***u***, by pre-multiplying ***u*** with a lower triangular matrix such that the distribution above is the standard normal density and

$$\hat{u}_i = \log(b_i) - \boldsymbol{x}'_i \boldsymbol{\beta}_i$$

$$\hat{b}_i = (1 - g'_i(H_i))\, W_i - c_{im} H_m - c_{if} H_f$$

and substituting b_i to the upper equation gives:

$$u_i = \log [(1 - g'_i(H_i))\, W_i - c_{im} H_m - c_{if} H_f] - \boldsymbol{x}'_i \boldsymbol{\beta}_i$$

For the other couples the likelihood contributions are given as:

Pr[$I_m^* \geq 0$ and $I_f^* < 0$] when only male is working
Pr[$I_m^* < 0$ and $I_f^* \geq 0$] when only female is working
Pr[$I_m^* < 0$ and $I_f^* < 0$] when both partners are not working

4 Data

In the analysis we use the Swedish time use data from the 1993 wave of the HUS-survey panel (Household Market and Nonmarket Activities). The data set consists of a random sample of households residing in Sweden where the household members are 18 – 74 years old. The data contain information on a very large number of demographic and labor market characteristics of the individuals and their family members in addition to their home production activities. This data are collected by personal interviews in electronic form and telephone interviews, and some part of the information originates from administrative registers. The respondents were asked to report the time they spent on a large number of activities during one randomly selected day (24-hours recall diary). That information was collected from one weekday and one day of a weekend. The HUS time use data from 1993 consist of the original panel from 1984 which are supplemented by a sample of new respondents.

In this study we only consider two-adult households. These are further divided into four groups according to the spouses' employment status. The net production function is only estimated for those households where both spouses were gainfully employed, either employed or self-employed. The sample we use contains 773 two-adult households in total. There are 497 (517 in Kerkhofs & Kooreman) households where both partners are employed, 98 (139) where only the male works, 76 (75) where only the female works, and 122 (88) households where neither of the

partners are employed. Table 4 in the Appendix summarizes the information about the 1993 sample, and, for comparison, Table 5 presents the descriptive statistics of the 1984 sample.

Key variables used in this study are home production time, age, years of education, family size, number of young children, labor market status, hourly net wage rate, non-labor income, number of cars in a household, and an indicator for a home ownership. All the variables are defined in the same way as in Kerkhofs & Kooreman in their application to the 1984 data to be able to compare the results. Home production is defined to consist of household activities that are reported in three categories: *household work* (includes: cooking, dish washing, cleaning, laundry, and shopping), *childcare*, and *repair and maintenance*. The time use activities are calculated as a weighted average of the responses for the two designated days with the weights 5/7 for week days and 2/7 for weekend days. Home production time is evaluated in hours per day on the basis of weekly time allocation on these activities. All the monetary values are expressed in SEK, including the value of home production. Education is measured as years a person has enrolled in full time education. Non-labor income contains capital income, social transfers and liabilities.

Table 1 shows the descriptive statistics of the key variables for the two-earner households sample for both of the years, 1984 and 1993, for comparison. There have been some changes in mean values of some of the variables. For example, the average age is higher in the 1993 sample (due to the panel property of the data). For the females, the total time devoted to home production has been almost unchanged, whereas for the males the time has increased considerably, by 26 minutes per day. The increase has occurred in household work and repair and maintenance while the time devoted to childcare has been unchanged. Also, the years of education has increased for about one year for both males and females.

In 1984 the unemployment rate was quite low in Sweden, only 3.1 % compared with the unemployment rate in 1993, which was 8.2 %. However, there was a large increase in the average hours of work in the market since those who had a job worked longer hours in 1993 than in 1984. This effect was notably strong for females, for whom the time spent on market work increased by 13 %, while the increase was only 6 % for males. Another remarkable change that occurred between the observation points was a big tax reform in Sweden in 1991. As a result of that, the average and marginal tax rates dropped substantially compared to 1984.

Table 1. The descriptive statistics of the samples of 1984 and 1993, two-earner households.

VARIABLE	1984 MALES (n = 517)	1993 MALES (n = 497)	1984 FEMALES (n = 517)	1993 FEMALES (n = 497)
Home Production (min./day)				
Household work	43.6	63.6	142.9	143.1
Childcare	15.1	15.1	29.7	29.5
Repair and maintenance	36.3	42.3	8.9	13.3
Total	**94.9**	**121.0**	**181.5**	**185.9**
Individual characteristics				
Age	42.3	45.0	39.7	42.7
Education (years)	11.2	12.4	11.0	12.3
Gross wage *	52.5	60.9	43.4	48.3
Non-labor income (1000) *	6.8	5.6	7.0	7.0
Average tax rate (%)	35.1	32.0	30.0	28.0
Marginal tax rate (%)	52.8	43.0	42.8	35.0
Employed /self-employed	87 / 13	86 / 14	95 / 5	94 / 6
Household characteristics		**1984**	**1993**	
Home owner (%)		79.8	74.0	
Household members		3.5	3.2	
Number of children (<7 yrs.)		0.36	0.30	
Owns a leisure house (%)		24.8	27.0	
Number of cars		1.2	0.9	
Owns a boat (%)		32.9	22.0	

* Prices in 1993 are deflated to the 1984 level.

5 Results

The results from the estimations are shown in Table 2. The first and second columns of the table contains the parameter estimates and standard errors from the model with joint production and selectivity applied to 1993 Swedish time use data. For comparison, the last column of the table shows the results from the corresponding model applied to the 1984 data, i.e. the results in Kerkhofs & Kooreman (2002).

The results show that the estimated $\boldsymbol{C}$ matrix is negative definite, which implies that the estimated model satisfies the second order conditions for optimal behavior, like it did with the 1984 data. This gives us more confirmation about the validity of the chosen specification, for the alternative Cobb-Douglas specifications used, for example, in Graham & Green (1984) failed systematically these optimization conditions. One possible explanation is that the Cobb-Douglas specification assumes the home production time of the partners to be q-complements and thus the regularity conditions of utility maximization were violated (more in Kerkhofs, 1999). In fact, the sign of c_{mf} indicates that male and female home production times are q-substitutes without

Table 2. Maximum Likelihood Estimates for Two-Adult Households. (** =significant at least on 5%-level)

	1993 Estimates	Std. Error	1984 (Kerkhofs & Kooreman, 2000) Estimates
Production function			
β_m			
Constant	4.892**	0.823	3.111**
log(age $_m$)	0.206	0.195	0.545**
log(education $_m$)	- 0.170	0.133	0.002
dummy home-owner	0.148	0.096	0.028
log(familysize)	0.165	0.140	0.048
log(1+ # young children)	0.644**	0.142	0.645**
log(1+ # cars)	- 0.118	0.211	0.175*
β_f			
Constant	4.703**	0.629	4.018**
log(age $_f$)	0.457**	0.127	0.423**
log(education $_f$)	- 0.244**	0.116	- 0.300**
dummy home-owner	0.053	0.071	0.077
log(familysize)	0.102	0.107	0.079
log(1+ # young children)	0.762**	0.110	0.566**
log(1+ # cars)	- 0.211	0.160	0.068
c_{mm}	- 112.222**	29.317	- 123.800
c_{mf}	- 6.956**	2.874	- 14.673
c_{ff}	- 91.734**	19.179	- 42.840
δ_m	0.165**	0.031	0.135
δ_f	0.076**	0.023	0.216
Participation index			
γ_m			
Constant	2.603**	1.230	5.996**
log(age $_m$)	- 1.567**	0.584	- 2.694**
log(education $_m$)	0.310	0.205	0.421
log(age $_f$)	- 0.055	0.566	0.794
log(education $_f$)	0.879	0.232	0.812**
dummy home-owner	0.538**	0.122	0.240
log(familysize)	1.603**	0.233	- 0.033
log(1+ # young children)	- 0.596**	0.221	- 0.541**
log(1+ # cars)	- 0.128	0.299	0.370
non-labor income	- 2.310**	0.250	- 1.975**
γ_f			
Constant	2.658**	1.074	2.341**
log(age $_m$)	- 0.269	0.427	0.329
log(education $_m$)	0.209	0.157	0.322**
log(age $_f$)	- 0.970**	0.432	- 1.262**
log(education $_f$)	0.597**	0.199	0.434**
dummy home-owner	0.223**	0.107	0.165
log(familysize)	0.939**	0.217	0.186
log(1+ # young children)	- 1.358**	0.174	- 0.853**
log(1+ # cars)	0.042	0.257	0.130
non-labor income	- 1.450**	0.150	- 0.659**
Covariance matrix			
var(u_m)	1.489**	0.222	0.562**
cov(u_f, u_m)	0.874	1.383	0.316**
var(u_f)	4.473**	1.214	0.411**
cov(ε_m, u_m)	- 0.584	0.518	0.018
cov(ε_m, u_f)	- 0.983**	0.401	0.164
var(ε_m)	1.000		1.000
cov(ε_f, u_m)	1.421	1.260	- 0.481**
cov(ε_f, u_f)	3.245**	1.101	- 0.608**
cov(ε_f ,ε_m)	- 0.570**	0.073	- 0.037
var(ε_f)	1.000		1.000

imposing it in the estimation, and the estimate is significant. Neither of the parameter estimates of c_{ii}'s were significant in the earlier study, but the performed likelihood ratio test supported the hypothesis that male and female home production time were q-substitutes in the 1984 study.

These c_{ii} parameters determine the slope of the marginal productivity schedules. Unlike in Kerkhofs & Kooreman, all the parameter estimates of $\boldsymbol{C}$ are significant for the 1993 data. It seems that the quadratic part of the production function is almost symmetric for men and women, which was not the case for the 1984 data. To see the effect of the parameters more concretely and to be able to compare with the previous results, the marginal productivities of males (b_m) and females (b_f) are evaluated in the sample averages of the other parameters in Table 3. In contrast to the results with 1984 data, marginal productivity at home is now initially higher for females than for males. The quadratic term states the decline of the marginal productivity, and the fall is only a bit stronger for males than for females, whereas for the 1984 data the fall in marginal productivity for males was more than double as rapid as for females. In sum, for the 1993 data, the home productivity schedules look much more alike between males and females than in 1984.

Table 3. The sample averages (and standard deviations) of marginal productivity of males and females and the value of one hour of home production in 1984 prices.

	1984		**1993**	
$\mathbf{b_m}$	250.62	(59.57)	293.23	(228.83)
$\mathbf{b_f}$	183.44	(39.77)	327.23	(190.15)
$\mathbf{Z/(H_m+H_f)}$	122.81	(63.47)	194.87	(98.17)
$\mathbf{g_m\,(H_m)/H_m}$	0.411	(0.086)	0.473	(0.111)
$\mathbf{g_f\,(H_f)/H_f}$	0.477	(0.079)	0.223	(0.061)

The estimated effects on household productivity of two-earner households are quite similar to the results in Kerkhofs & Kooreman. Young children seem to have a strong positive effect on the home productivity of both spouses. Fathers' household productivity increases too when they have young children. Besides, labor supply studies that base on time use data show that fathers actually reduce their hours or work in the market by about 3 to 6 hours per week (Flood & Klevmarken, 1992; Carlin & Flood, 1997). Our results show further that household productivity seems to increase with age for both females and males, but the effect is only significant for

females. The years of enrolled education has a strong negative effect on the productivity at home, especially for females. Women with shorter schooling have a relative advantage in household production. For males the effect is negative too, but insignificant. Other variables in production function do not show significant effects and do not differ in magnitudes either from the 1984 results.

The participation equations were estimated simultaneously to correct for a possible sample selection bias. The parameters of the participation equations show the estimates for the probability of having a paid job. Compared with the earlier results, there are again no big differences, except that most of the variables have stronger effects and the estimates are more significant. The probability of working decreases with the number of young children in the family, and the effect is stronger for women than for men. This negative effect is probably due to the Swedish parental leave system which gives both fathers and mothers the possibility to take parental leave up to 360 days altogether. However, the number of family members has an opposite effect. The bigger the family the more likely both spouses are employed. The home ownership increases the probability of having a job, and it also increases the productivity at home sector. As expected, the probability of being employed increases with years of education for both females and males, and the probability increases with the partner's years of education too. Non-labor income has a very strong negative effect to the likelihood of employment, again for both males and females.

The estimates considering the selectivity are now quite different from the previous results. The covariance between u_f and ε_f is large and positive, which indicates that unobserved heterogeneity has the same effect on the productivity at home as on the probability of having a job. This is in contrast with the earlier result where the covariance was found large and negative. Also, the correlation between u_f and ε_m shows a strong and negative sign, which was not the case with the earlier results. Participation of males has decreased somewhat from the 1984 while the productivity of females at household sector has increased. Previously the sample selection effect ran mainly through the participation equation of the female, now it seems that it affects female productivity most but the effect runs through the participation of both spouses.

If we do not take joint production into account, individuals will be induced to spend more time on home production than they actually do. As was shown in Kerkhofs & Kooreman, ignoring the effect of joint production would incorrectly be attributed to higher level of marginal productivity.

They evaluated the value of the home production both with and without joint production, and the value was halved when allowing for joint production. According to our results, joint production parameters are significant, and the estimated values of jointness parameters are 0.17 for males and 0.08 for females, which suggests that the jointness is more important for men than for women. The average values of $g_i(H_i)/H_i$ show that almost half of the men's home production time is valued as leisure, whereas the share is only 22 % for women. Men increased their household production time by almost half an hour from 1984, but a bigger share of their household time is actually generating them direct utility compared with the earlier results. For women the productivity increase combined with the decrease in jointness parameter means more efficient use of time with less process benefits. This result might also reflect the fact that usually women are engaged with more time-inflexible duties at home (e.g. childcare), whereas men do more time-flexible duties (repair and maintenance).

The value of household production is calculated taking the joint production into account. The last row in Table 3 shows the sample average of the estimated value of home production. Since market goods and home-produced goods are assumed to be perfect substitutes, home-produced goods have the same price as market goods. The value of household output depends on the choice of the functional form of the production function (and on the possibility of finding reliable parameter estimates), but since the values for 1984 and 1993 are evaluated using the same method we may compare these figures (both are evaluated at 1984 prices). Since the estimated outputs show an increase in the value of one hour of home production from 123 to 195 SEK[1], the average productivity in household sector has obviously increased.

The total time used in home production has reduced, which has been possible because the productivity in household work has increased, and perhaps because people have chosen to reduce the quality of the services obtained from household work in favor of leisure and goods and services bought in the market. The latest surveys (Rydenstam, 2002) show that the time use in work at home has further decreased, especially for women who worked 40 minutes less in home sector in 2001 than they did in 1991. Added to the 30 minutes decrease in the market work for males, these changes in time use imply that household time and market time -shares have become even more alike between males and females during the last years.

[1] 1 € is about 9,2 SEK in August 2002.

6 Conclusions

We analyzed the changes in the household productivity of the Swedish households between the years 1984 and 1993. The analysis was narrowed to consider only two-adult households since the results in the earlier study of Kerkhofs & Kooreman (2002) showed that the applied specification had limited power for the analysis of single-headed households in the presence of joint production.

The estimation of household production is difficult when most of the inputs and the output are unobservable, and therefore the specification of the household production function plays an important role in empirical applications. The lack of information on specific household production inputs and production technology cause identification problems. Many earlier studies have failed in finding a satisfactory model, and even when they were solved analytically, the estimates showed up unacceptable theoretically. However, Kerkhofs & Kooreman succeeded in their application of a specific parametric form for the production technology to Swedish time allocation data and their estimates showed satisfactory results.

The theoretical basis of modeling household production in Kerkhofs & Kooreman was Gronau model. In Gronau's (1977) model the amount of time spent on household production does not depend on the household utility function, conditional on household members having a paid job. However, no joint production and separate contributions of the partners were considered in the Gronou's first experiment. The model Kerkhofs & Kooreman suggested allows for joint production and describes household production by both spouses simultaneously. A household has one joint utility function which the partners intend to maximize. Their model emphasizes the interactions between the partners' choices.

The household production function is constructed on the efficiency conditions where the marginal productivity of work at home equals the wage rate. Therefore, the model is only identified to gainfully employed couples, which further raises the problem of sample selection. Hence the model is extended to take into account the possible selection bias. Further, since the joint production would overestimate the household production function, jointness functions for both spouses are specified along the lines of Graham & Greene (1984). The final model is a quadratic specification of the net product value function with joint production and selection correction.

The idea of the study was to estimate a parallel model to Kerkhofs & Kooreman with more recent data. The data for this study were derived from the 1993 HUS time allocation data, and the construction of variables corresponded the earlier study. The overall stability of our results confirms that the applied specification provides a powerful tool to analyze household production. Our estimates satisfy the regularity conditions of utility maximization and were comparable with the previous study. In both studies, women's and men's home production time were found to be q-substitutes, not q-complements. The most outstanding result compared to the study for the 1984 data was that the productivity profiles of men and women have become more alike. For the 1993 data, the schedules of marginal productivity at home are more symmetric between males and females compared to the results for the 1984 data. The average value of one hour of home production has increased from 123 to 195 SEK

Above we have explored only a small fraction of the implications of the model. The aim in the future is to study household production further. More recent data will soon be available and it will be interesting to analyze further the changes in household production after the establishment of the New Economy.

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Appendix

Table 4. Descriptive Statistics: Sample Means and Standard Deviations 1993. Two-adult Households

	$N_m>0$ $N_f>0$	Std. dev.	$N_m>0$ $N_f=0$	Std. Dev.	$N_m=0$ $N_f>0$	Std. dev.	$N_m=0$ $N_f=0$	Std. dev.
Number of Observations	**497**		**98**		**76**		**122**	
MALES								
Home Production (min./day)								
Household Work	**63.6**	64.6	**78.3**	78.1	**108.5**	88.1	**82.5**	84.9
Child-care	**15.11**	37.5	**39.1**	62.3	**14.2**	42.7	**18.9**	69.4
Repair and Maintenance	**42.3**	78.4	**51.1**	91.2	**48.1**	84.6	**64.1**	111.7
Total (H_m)	**121.0**	108.6	**168.5**	135.6	**170.8**	135.8	**165.5**	145.2
Leisure (min./day)	**355.1**	261.4	**318.6**	219.7	**474.5**	193.6	**481.1**	232.6
Personal Characteristics								
Age	**45.0**	10.0	**43.4**	12.3	**55.2**	15.4	**63.1**	16.8
Education (years)	**12.4**	3.5	**12.0**	4.2	**10.4**	3.4	**10.0**	4.3
Gross Wage (SEK)	**103.5**	42.9	**90.4**	35.0	**-**	-	**-**	-
Non-labor Income (1000 SEK)	**9.5**	53.9	**- 6.1**	57.9	**87.0**	90.6	**120.6**	108.9
Average Tax Rate (%)	**32.0**	4.0	**31.0**	4.0	**29.0**	4.0	**28.0**	7.0
Marginal Tax Rate (%)	**43.0**	9.0	**41.0**	9.0	**39.0**	8.0	**35.0**	10.0
Labor Market Status								
Employed (%)	**86**		**81**		**-**		**-**	
Self-employed (%)	**14**		**19**		**-**		**-**	
Unemployed (%)	**-**		**-**		**29**		**9**	
Not in the Labor Force (%)	**-**		**-**		**71**		**91**	
FEMALES								
Home Production (min./day)								
Household Work	**143.1**	94.4	**212.7**	147.1	**117.2**	86.6	**207.9**	114.5
Child-care	**29.5**	62.6	**79.3**	106.7	**16.7**	44.0	**22.3**	66.5
Repair and Maintenance	**13.3**	34.4	**20.5**	47.9	**11.1**	38.3	**17.2**	40.3
Total (H_f)	**185.9**	121.4	**312.5**	164.6	**145.0**	100.8	**247.4**	127.2
Leisure (min./day)	**331.1**	252.1	**315.4**	215.0	**372.4**	212.5	**430.7**	193.9
Personal Characteristics								
Age	**42.7**	10.1	**40.7**	13.5	**50.0**	13.3	**60.8**	16.7
Education (years)	**12.3**	3.2	**11.7**	3.2	**10.5**	3.4	**9.1**	3.1
Gross Wage (SEK)	**82.0**	40.2	**-**	-	**81.3**	23.3	**-**	-
Non-labor Income (1000 SEK)	**12.0**	33.4	**43.9**	46.0	**16.4**	51.4	**68.7**	50.5
Average Tax Rate (%)	**28.0**	4.0	**24.0**	8.0	**28.0**	3.0	**24.0**	7.0
Marginal Tax Rate (%)	**35.0**	8.0	**29.0**	11.0	**36.0**	7.0	**29.0**	10.0
Labor Market Status								
Employed (%)	**94**		**-**		**99**		**-**	
Self-employed (%)	**6**		**-**		**1**		**-**	
Unemployed (%)	**-**		**10**		**-**		**7**	
Not in the Labor Force (%)	**-**		**90**		**-**		**93**	
HOUSEHOLD CHARACTERISTICS								
Homeowner (%)	**74.0**	44.0	**67.0**	47.0	**51.0**	50.0	**57.0**	50.0
Number of household members	**3.2**	1.1	**3.4**	1.3	**2.5**	0.9	**2.2**	0.6
Number of adults	**2.3**	0.6	**2.1**	0.4	**2.1**	0.3	**2.1**	0.3
Children, less than 7 years old	**0.3**	0.6	**0.8**	1.0	**0.1**	0.3	**0.1**	0.4
Owner of Leisure-house (%)	**27.0**	43.0	**23.0**	43.0	**29.0**	46.0	**26.0**	40.0
Number of Cars	**0.9**	0.3	**0.9**	0.3	**0.9**	0.3	**0.9**	0.3
Owns a Boat (%)	**22.0**	41.0	**29.0**	45.0	**38.0**	49.0	**27.0**	45.0
Non-labor income (1000 SEK)	**9.5**	12.6	**15.5**	20.1	**8.8**	20.7	**6.4**	17.0

Table 5. Descriptive Statistics: Sample Means and Standard Deviations 1984. Two-adult Households

	$N_m>0$ $N_f>0$	Std. dev.	$N_m>0$ $N_f=0$	Std. Dev.	$N_m=0$ $N_f>0$	Std. dev.	$N_m=0$ $N_f=0$	Std. dev.
Number of Observations	**517**		**139**		**75**		**88**	
MALES								
Home Production (min./day)								
Household Work	**43.6**	47.9	**47.2**	58.5	**84.1**	75.0	**80.9**	79.3
Child-care	**15.1**	38.0	**15.4**	36.1	**15.9**	41.3	**10.3**	34.8
Repair and Maintenance	**36.3**	65.7	**39.3**	78.1	**63.2**	100.0	**62.4**	89.5
Total (H_m)	**98.9**	80.1	**101.9**	97.8	**163.2**	116.1	**153.6**	117.4
Personal Characteristics								
Age	**43.2**	10.3	**43.5**	12.5	**55.5**	13.3	**67.3**	9.2
Education (years)	**11.2**	3.6	**11.0**	4.1	**9.6**	3.4	**7.8**	3.0
Gross Wage (SEK)	**52.5**	23.8	**52.2**	39.3	**50.2**	24.1	**50.0**	31.3
Non-labor Income (1000 SEK)	**6.8**	14.4	**10.5**	14.2	**60.3**	54.7	**59.5**	37.5
Average Tax Rate (%)	**35.1**	19.0	**33.1**	10.5	**30.1**	13.8	**27.9**	11.9
Marginal Tax Rate (%)	**52.8**	11.4	**50.2**	12.9	**43.6**	20.3	**40.6**	18.3
Labor Market Status								
Employed (%)	**87**		**86**		**-**		**-**	
Self-employed (%)	**13**		**14**		**-**		**-**	
Unemployed (%)	**-**		**-**		**24**		**2**	
Not in the Labor Force (%)	**-**		**-**		**76**		**98**	
FEMALES								
Home Production (min./day)								
Household Work	**142.9**	86.3	**221.7**	118.6	**144.4**	95.8	**251.0**	117.2
Child-care	**29.7**	67.4	**57.0**	80.9	**15.4**	36.5	**7.0**	24.8
Repair and Maintenance	**8.9**	30.8	**18.7**	50.7	**11.2**	36.2	**24.2**	53.4
Total (H_f)	**181.5**	108.2	**297.4**	146.3	**171.1**	104.7	**282.1**	140.2
Personal Characteristics								
Age	**39.7**	10.1	**41.0**	12.7	**49.9**	12.1	**64.2**	8.7
Education (years)	**11.0**	3.3	**10.2**	3.0	**9.0**	3.0	**7.7**	2.4
Gross Wage (SEK)	**43.4**	24.3	**40.1**	17.6	**40.4**	11.7	**39.5**	5.3
Non-labor Income (1000 SEK)	**7.0**	12.3	**17.2**	20.3	**10.1**	15.3	**31.0**	22.0
Average Tax Rate (%)	**30.0**	16.4	**16.8**	13.3	**28.8**	7.8	**20.6**	10.6
Marginal Tax Rate (%)	**42.8**	19.9	**24.9**	18.6	**42.1**	10.8	**30.5**	14.2
Labor Market Status								
Employed (%)	**95**		**-**		**97**		**-**	
Self-employed (%)	**5**		**-**		**3**		**-**	
Unemployed (%)	**-**		**19**		**-**		**5**	
Not in the Labor Force (%)	**-**		**81**		**-**		**95**	
HOUSEHOLD CHARACTERISTICS								
Homeowner (%)	**79.8**	40.1	**68.3**	46.7	**62.7**	48.7	**61.4**	49.0
Number of household members	**3.5**	1.1	**3.4**	1.2	**2.9**	1.1	**2.4**	1.2
Number of adults	**2.3**	0.6	**2.2**	0.4	**2.2**	0.6	**2.1**	0.4
Children, less than 7 years old	**0.36**	0.6	**0.58**	0.8	**0.2**	0.5	**0.03**	0.2
Owner of Leisure-house (%)	**24.8**	43.2	**0.2**	0.4	**33.3**	47.5	**0.3**	0.4
Number of Cars	**1.2**	0.7	**1.2**	0.8	**1.1**	0.7	**0.8**	0.6
Owns a Boat (%)	**32.9**	47.0	**23.7**	42.7	**25.3**	43.8	**19.3**	39.7

Source: Kerkhofs & Kooreman (2002)

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Career Interruptions due to Parental Leave

– A Comparative Study of Denmark and Sweden

by

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Abstract:
Parental leave mandates are associated with high female employment rates, but with reductions in relative female wages if leave is of extended durations. If fathers were given longer periods of leave, would it shorten the career breaks of women? We analyze the impact of family policies of Denmark and Sweden on women's career breaks due to childbirth. These countries are culturally similar and share the same type of welfare state ideology, but differ remarkably in pursued family policies. This setting provides us with a fruitful point of departure to analyze explicitly the effects of different family policy regimes on job retention of Danish and Swedish mothers. Our analysis takes advantage of the availability of comparable longitudinal data and allows us to estimate parallel models across the two countries. The impact of family policies and economic incentives on the probability of returning to the labor market is estimated with a flexible model of parental leave duration. Our results show that economic incentives affect the behavior of mothers in both countries. However, the parental leave mandates as such are very important determinants for the observed behavior. The role of the fathers differs considerably between the two countries. In Sweden fathers have much longer parental leave periods than fathers in Denmark. A striking result from the policy simulations is that if fathers were given more parental leave, it would promote the labor supply of women. For Denmark we do not observe this substitution effect.

JEL classification: J1, J22.
Keywords: Maternal Leave, Parental Leave, Childcare, Family Policy, Mothers' Labor Supply.

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1 Introduction

Employment rates of mothers with young children have increased in almost all countries over the past thirty years. However, the increasing employment rates of mothers have been accompanied by a large decrease in fertility (OECD, 2001). In contrast, in the Nordic countries there has not been such a strong trade-off between mothers' employment and fertility. Both female employment and fertility rates have been relatively high. Studies on female labor supply show that, contrary to most other countries where young children have a large negative impact on mothers' labor supply, this effect is much smaller or non-existing in the Nordic countries (see, Callan et al., 1999). The fertility rate in Scandinavia has been amongst the highest in Europe in the beginning of 1990s (about 2 in Sweden and slightly lower in Denmark and Norway), and yet the labor force participation rate has been amongst the highest internationally (about 80 %). To which extent are the high female labor force participation and fertility rates explained by the generous parental leave and childcare systems that characterizes the Nordic family policies?

The family policies in the Nordic countries have a long tradition in offering facilities and subsidies to encourage mothers to combine family and work. Many international comparative studies show that women appear to increase their attachment to the labor force when given the opportunity to take paid leave (see, for example, Ruhm & Teague, 1995; Joesh, 1995; and Waldfogel et al., 1999). Thus, the positive effects to the labor market tend to outweigh the costs of conducting such parental leave and benefit policies and therefore legitimizes these family friendly polices (Joesh, 1995; Gustafsson et al., 1996; Rönsen & Sundström, 1996). Ruhm's (1998) comprehensive comparative study on European countries, for example, finds that parental leave legislation raises the female employment-to-population rate by 3 – 4 %, and even more for women of childbearing age.

The aim of this study is to examine the duration of career interruptions contingent to childbirth of Danish and Swedish women. Which factors affect a mother's decision to return to work after childbirth? How important are the benefit compensation rate and the parental leave schemes? Do the prices and availability of publicly provided childcare affect the retention decision? How do the availability and eligibility rules concerning fathers' leave affect the length of the career break of the mothers?

Our analysis takes advantage of the availability of comparable longitudinal data. These data allow us to estimate parallel models across the countries in order to determine to which extent the

family leave policies affect women's retention. The study examines Danish and Swedish mothers who participate in the labor market and interrupt their careers due to childbirth during 1990s. Here we also make use of fathers' characteristics and their uptake of parental leave. It is interesting to compare these two culturally similar countries which share the same pattern of employment of women overall and of women with young children in particular, but differ remarkably in their family policies. During the last decades, Sweden has implemented fairly long maternal and parental leave schemes compared to Denmark. On the other hand, the coverage of publicly provided and subsidized childcare for children aged less than 3 has been considerably higher in Denmark compared to Sweden (Ellingsäter, 1998). Focusing on differences between these countries we test by simulations the impact of family policy regimes on the length of mothers' career breaks.

The raw data and the empirical estimations show clearly that women have a very high probability of returning to employment when the parental leave has expired (well over 90 % do return). The rules of parental leave schemes as well as the other parts of the family policy regimes affect the mothers' decision on job retention. And, the same seem to apply to men, too. When given explicitly the possibility for taking parental leave, the majority of the fathers (about 70 % of fathers in Sweden, and almost 50 % of fathers in Denmark) make use of it. Our results show clearly that there is room for policy changes, which might promote both female labor supply and equal role sharing by both parents.

The structure of the paper is the following. The next section describes shortly the family policies in Denmark and Sweden. Section 3 summarizes some of the recent international studies about the impact of family policies on mother's employment. In Section 4 the econometric model is presented. The description of data and the descriptive statistics are presented in Section 5. Section 6 analyzes the results from the estimations and policy simulations and Section 7 concludes.

2 Description of the Danish and Swedish Family Policies

Although the Danish and Swedish family policies are much more developed compared to most other countries, there are large differences in the rules concerning parental leave programs as well as the coverage and price structure of childcare. On the whole, the Swedish parental leave schemes are highly flexible and fairly generous compared to the Danish schemes. The principal idea in the Swedish system is that parenthood is considered to be a shared responsibility between

the mother and the father. Fathers are therefore particularly encouraged to take leave, which has resulted in a very recent policy reform providing as a minimum of two months of ring-fenced leave for either parent (typically for the father) that is not transferable to the other parent.

In Denmark, the leave schemes have, until the recent years, been rather inflexible in the sense that the maternal leave period cannot be split in several periods like in Sweden. There is much less focus on a shared responsibility of both parents, and thus the period of parental leave which can be taken by either parent is much shorter in Denmark than in Sweden, and a ring-fenced leave for the father has not existed until recently, except for two weeks in connection with childbirth. In both countries, the length of the leave period has been extended over the years. In Sweden, the compensation rate has been slightly reduced during the 1990s, whereas in Denmark the tendency is mixed: for some schemes the compensation has increased, for others reduced.

A major aspect of the effect of children on the earning capacity of parents is the access to as well as the quality and prices of day-care facilities. If it were easy and relatively cheap to get childcare, the earnings capacity of the parents (mothers) might well be less "damaged" than in countries where childcare facilities are scarce or expensive. Furthermore, if the quality or stability of the childcare arrangements were low, it may induce higher absenteeism from work and lower the productivity of the parents (mothers), compared to countries with high coverage along with high quality and stable childcare. In Sweden and Denmark the coverage of publicly provided childcare for children aged below 3 years has increased considerably during the last decades. The quality is fairly high in an international setting when measured by the staffing and economic resources spent on public childcare (see Rostgaard & Fridberg, 1998; Waldfogel, 1998, for international surveys of child care systems).

2.1 Parental Leave Schemes

Duration of the Leave Schemes

Sweden has a universal parental leave and benefit coverage. All parents are entitled to the leave, regardless of whether they are participating in the labor force or not. Since 1994 parents have been entitled altogether to 450 days compensated leave per child. The leave can be taken flexibly from 60 days before the expected date of birth until the child is eight years old. Benefits can be used either full-time or part-time or saved and used any time within the entitlement period. The system allows both parents to share the leave and to interrupt the leave in order to save days for later use. Parents are entitled to have 360 days (each have 180 days) parental leave with a

compensation level that is related to the income prior to the leave period, and in addition to that, a father is permitted to take 10 extra days of leave in connection with childbirth. A parent is allowed to transfer his or her days of leave to the other parent, but 30 days are reserved for him or her only. If the other parent does not use these days, they are lost. In addition to that, parents are allowed to take an extra period of leave of 90 days with only a guarantee level of compensation, a flat rate which is 6.7 € per day.[1] So, the parental leave for each child amounts to 450 days in total, which can be divided among the parents in a very flexible way. Single parents are entitled to 450 days as well. In the case of multiple births, parents are entitled to an additional 180 days leave.

Denmark has a slightly less universal system compared to Sweden (see, for instance, Rostgaard et al., 1999, for a more detailed description of the Danish leave schemes). Since 1985, mothers who had a regular income during the latest 13 weeks before the birth are entitled to a maternal leave of 4 weeks before the birth (8 weeks in some unions in the public sector) and 14 weeks after, plus a parental leave period of 10 weeks. This parental leave can be taken either by the mother or the father, but the parents cannot be on leave at the same time. During these 10 weeks, a parent is only allowed to work a few hours weekly, and whether one chooses to work part time, the benefit is reduced accordingly, and the "non-used" period cannot be saved and used later as in Sweden. Further, a father is entitled to 2 weeks' leave in connection to childbirth. During 1999 - 2002, a father has been entitled to two extra weeks after the 10-week parental leave. These weeks were reserved for a father only and lost if he did not use them. In 2002, the rules were changed, and the extra 2 weeks of leave was abolished, and the parental leave period was extended from 10 weeks to 32 weeks. In some cases, the parental leave period may be further extended.

There was a childcare leave scheme in 1992 - 2002 in Denmark which was changed several times, and was abolished completely in 2002 when the extended parental leave scheme was introduced. In 1994, the coverage and compensation of the parental leave scheme were extended substantially and consequently the take-up rate increased dramatically. In recent years, compensation has been reduced and the leave made more flexible along the lines of the Swedish system, but still faraway as flexible as the Swedish parental leave system. This new scheme allows both parents, whether employed or unemployed, to take leave for a period of up to 52 weeks for each child aged less

[1] The guarantee level of compensation is 60 SEK (since 1987). The exchange rate used here is 1 € = 8.6 SEK.

than 9 years.[2] Most parents are entitled to the leave, irrespective of membership of unemployment insurance funds (UI-funds), employment etc.

Compensation During the Leave Period

Sweden: The level of compensation depends on prior earnings. If parents have not been employed a period before childbirth, they are eligible only for a guarantee level of benefits which amounts to 6.7 € per day (since 1987). If the parents were employed, they are entitled to 80 percent replacement of their previous income up to an income ceiling. In some sectors (specified in collective agreements between unions and employers' confederation) the public compensation may be supplemented by the employer to a full-wage compensation. Further, there is a so-called "speed-premium" for mothers who intend to have another child soon after the previous child. A mother is guaranteed to have the same level of compensation without returning to employment if there is not more than 30 months in between the childbirths.

Denmark: The compensation during maternal leave depends on the sector of employment. In the public sector, there is a full-wage compensation. For the privately employed, the compensation depends on collective agreements between the employers and the unions, and some of them have specified a full pay during maternal and parental leave.[12] For those groups, which are not covered by these agreements, the compensation is calculated according to the rules of the unemployment insurance benefit system (UI-benefits). The compensation is 90 % of previous earnings up to a maximum, which is rather low compared to other Nordic countries. On average, the compensation rate is 60 – 70 % of former earnings. Since men on average tend to have higher earnings than women, and since more than half of the mothers are entitled to a full pay during parental leave, most households have a strong economic incentive to let the mother use the 10 weeks of parental leave, which could have been shared between the parents.

The compensation during childcare leave was considerably lower than for the maternal and parental leave periods. Initially, the compensation rate was 100 % of the UI-benefits but it has been reduced several times since 1994, and since 1999 the compensation has been 60 % of the

[2] Thus, more individuals are entitled to childcare leave than to parental leave schemes. Housewives without any regular income are the only group which is not entitled to childcare leave. However, this group constitutes less than 5 % of the population in the age groups concerned. The duration of the childcare leave period depends on the age of a child. If the child is less than 1 year, the entitled period is 26 weeks, and it might be extended to 52 weeks if the employer accepted this extension. If the child was older, the duration was shorter.

[12] An increasing number of workers in the private sector are entitled to a full compensation of former earnings. Collective agreements between unions and employers specify that the employers are due to supplement the public benefits. In 2002, all women have a full pay during maternal leave.

UI-benefits. In 2002, when the childcare leave and parental leave schemes were combined into a one scheme, the compensation rate for this extended parental leave period was left to the same level as the former childcare leave, i.e. 60 % of the UI-benefits.

2.2 Childcare

In both Denmark and Sweden, families have an access to highly subsidized, publicly provided childcare services. Municipalities are responsible for arranging childcare. There are various forms of public day-care programs: day-care centers, family day-care, and after school homes. Beside the public services, there also exist private childcare services (some of them are also publicly supported), but the amount of private services is considerably less than in other non-Nordic countries. The public childcare system is universal and is based primarily on children's needs, and therefore it is very common for children to attend publicly provided childcare even though the parents were not working. The public childcare system started to expand in both countries during the 1960s and the coverage has been steadily increasing (OECD, 2001). Despite the large expansion, there is a constant shortage of child day care places in both Sweden and Denmark. One major reason is that public daycare is highly subsidized, i.e. the price is much lower than the actual price of producing these services.

Sweden: In autumn 2000, 76 % of children aged 1 – 5, 67 % children aged 6 – 9 and about 7 % of children aged 10 – 12 attended public childcare (Socialdepartementet, 2001). According to a survey, only about three percent of 1 – 5 years old children were in private childcare (Skolverket, 2002). Day care fees have been increased especially during the 1990s because of the dampening economic situation in municipalities and in order to suppress the demand. The fees contributed to 18 % of the total costs in 1999 while the share was barely 10 % in 1990. The payment scheme varies across municipality although most often the payment is related to the number of children, time used and parents' income. While the time-based fees provide parents with greater opportunities to influence the costs of childcare, they can also cause large marginal effects when a parent increases hours of work, especially for single parents. On average, the cost for two-earner household with two children is 230 € (ranging from 0 to 467 €). A completely new payment scheme was introduced in 2002, which is called 'maxtaxa' referring to a payment ceiling (for a respective family the cost will be at maximum 210 €).

Denmark: About 92 % of all children aged 3 – 5, and more than half of the children aged 0 – 2 years attended publicly provided childcare in 1999. As in Sweden, the demand for public

childcare is strongly stimulated by large price subsidies to childcare. According to the governmental regulations parents are not allowed to pay more than 30 percent of the variable costs of the day-care place, i.e. the local governments stand for at least 70 % of the variable cost and additionally all fixed costs. In many municipalities, the subsidies are even larger. Further, there is an additional means-tested subsidy for low-income households which usually provides the childcare for free. The monthly costs of a childcare place vary between municipalities. The typical monthly cost for a 0 – 2 year-old child ranges 250 - 300 €, while for older children the prices are lower. Expenditures on publicly (or privately) provided childcare are not deducible from taxable income.

Despite the high coverage of publicly provided childcare in both countries, there is an excess demand for childcare places in many municipalities. The availability and price of a daycare place varies a lot across municipalities. There are more or less formal queuing systems in many municipalities implying that parents either have to extend their leave of absence or use private childcare. In either of the countries, there is no systematic information on queues to public childcare (there are some surveys made). Furthermore, there also exists a small market for untaxed private childcare,[4] but there is fairly little information on the amount and prices of privately provided childcare. One reason that private childcare is seldom used and the lack of exact information is that private childcare is almost always untaxed and part of the underground ("black") sector because of the high levels of VAT and income taxes in Denmark and Sweden. If private childcare were produced in the formal (taxed) sector and without subsidies, the prices would be extremely high compared to publicly provided care. However, parents also seem to prefer public day care for quality reasons.[5]

2.3 Other Family Policy Regulations

The law guarantees a job security which entails the same or a comparable position upon the parent's return from leave. In both countries, it is illegal to fire a parent on parental leave. In Sweden, there is a job protection period of 18 months for parents of a newborn, and furthermore, parents are legally entitled to work shorter hours until the eighth birthday of the

[4] A Danish study on the underground economy by Pedersen and Smith (1998) shows that about 14 percent of the adult Danish women worked in the untaxed sector in 1996, and about 1/4 out of them were occupied in childcare activities. This means that about 3 – 4 percent of the adult women worked in privately provided day care. However, these jobs were seldom full-time jobs, but typically only part-time jobs with about 10 or less hours weekly.

[5] In a study by Bertelsen (1991) the parents who had their children in public childcare, were asked whether they would prefer privately provided childcare if available. Less than 5 percent answered yes to this question. The main reason probably is that there exist some mechanisms for a quality control for publicly provided childcare.

child, with a corresponding reduction in wages, in both the public and private sectors.[6] In Denmark, this is only the case for publicly employed parents.

In both countries, there exist a scheme for care days. In Denmark, the publicly employed have a right to 10 care days annually with a full pay, which can be used if the child is ill, for visits at the doctor etc. Since 1998, some groups in the private sector have also got the right to care days (14 days with full pay). In Sweden, there is a parallel care day scheme. A parent has a right to 60 days of care annually if the child is ill up to the 12th birthday of the child.

Since the 1970s, the tax systems in both countries have been based on the separate taxation principle, which tends to be neutral with respect to work incentives for each of the spouses (see Gustafsson, 1992; Callan et al., 1999). Due to income related compensation schemes parents are encouraged to work full-time and maximize the earnings before the childbirth. This also holds for Sweden, despite the fact that everybody is entitled to parental leave compensation irrespective of the labor market history.

3 Earlier Studies

According to many comparative studies, the impact of family policies on the mothers' (or fathers') return to work can be quite substantial. A large literature provides insights on how different policies result in different labor force attachments of women. Waldfogel et al. (1999) compare mothers in the US, Britain and Japan and find that young children have a very strong negative effect on women's employment. However, they find strong evidence that family leave coverage increases the likelihood that a woman will return to employment after childbirth in all three countries they investigate. They conclude that the recent expansions in family leave coverage in these countries are likely to lead to increased employment of women after childbirth and in some cases even boost job retention. Ruhm (1998) investigates the economic consequences of paid parental leave in nine European countries and finds that a right to paid leave raises the employment rate of women. Even short durations of guaranteed work absence have a substantial effect on female employment. These results are confirmed for Germany in a study by Ondrich et al. (1999).

[6] In Sweden, but not in Denmark, part-time work is very common among the parents of young children. Typically, the mother works part-time. In 1998, 46 % of the Swedish mothers and about six percent of the Swedish fathers of young children worked part-time (SCB, 2001). In Denmark, the part time frequency has been declining since the early 1980s. In 1983, 43 % of all employed women were part-time employed while in 2000 the frequency was only 17 %. Women with young children tend work longer hours than women without children (see, Smith, 1998).

A longer entitlement period, such as the Swedish one, tends to lengthen the time out of employment shortly after childbirth, but in the long run, a longer leave period enables more parents (mothers) to join and stay in the labor force and therefore results in higher overall re-entry rates. Rönsen & Sundström (1996) study the impact of family policies on the return to work by comparing the post birth employment activity of Norwegian and Swedish women. They analyze rates of re-entry into paid work after the first birth for mothers in 1968 – 1988. The most important findings are that the right to paid maternity leave with job-protection greatly speeds up the return to employment and that women who have this right are much more likely to resume employment. However, part of this effect may be due to the fact that those women, who are eligible for leave schemes, are also the women with a more permanent attachment to the labor market and the strongest preferences for market work. Extensions in leave schemes and the so-called Swedish "speed-premium" on the next birth have, though, delayed the return to work.

Gustafsson et al. (1996) analyze labor force transitions around childbirth and the extent to which lower labor force participation rates of mothers are explained by different family policies. They compare German, Swedish and British women and find that different welfare policy regimes produce different outcomes in labor force participation among mothers. These countries represent the three main types of different welfare states. The difference in total labor force participation of women is a result of fewer mothers entering the labor force and entering later after births in Germany and Great Britain than in Sweden. Although there is no such difference before the birth of the first child, the difference is more pronounced for second and third births. Women's own human capital is important both in Germany and Great Britain, whereas in Sweden also less educated women have entered the labor force by the time the child is two years old.

There is a good deal of literature that has found that at least part of the wage gap between the sexes is the result of women having more frequent career interruptions (some of the early references are Mincer & Polachek, 1974; Gronau & Weiss, 1981). Forgone growth of human capital and the depreciation of human capital during lengthy leave periods cause wage setbacks for women. The wage gap can be a consequence of a direct or indirect discrimination too. Entitlements that allow substantial time off work may cause employers to limit women to jobs where absences are least costly, thereby increasing occupational segregation, which has obviously occurred in Nordic countries (see, Stoiber, 1990).

Since the parental leave mandates and job-protection during the leave of absence tend to promote job retention, they may also promote more rapid wage growth. If protected leave allowed women to return to a previous employer, as opposed to getting a new job or leaving the labor market entirely for a period, the leave policies would prevent women from loosing tenure and firm specific human capital, and consequently promote wage growth through gains from good job matches and reduced depreciation of human capital during non-employment periods. Recent studies in the US and Britain provide evidence of positive wage effects of returning to the same employer after childbirth (see, for example, Waldfogel, 1997; Joshi et al., 1996). There is also some recent evidence on the positive wage effects of maternity leave coverage in the US and Britain (Waldfogel, 1998). However, this effect may to a large extent be a consequence of that those women who are covered by generous leave schemes, are a selected group, who are able to get a job at firms with attractive working conditions and "fringe benefits", like maternal leave schemes. For countries like Sweden and Denmark, these selection effects are expected to be very small since the leave schemes are almost universal in both countries, and to a great extent publicly financed. A government mandate eliminates this type of sorting of workers.

Empirical studies from Sweden and Denmark have found very small long run effects on subsequent earnings for mothers who entered formal maternity leave (see Albrecht et al., 1999; Datta Gupta & Smith, 2000). However, Datta Gupta & Smith compare the wage growth of women to that of men, and they find that when controlling for background characteristics, the wage increases of men are considerably larger during the child bearing period compared with women, irrespective whether they are mothers or not. The explanation could be that since almost every mother make use of the compensated parental leave she is entitled to, employers expect every woman, by default, to experience career interruptions, and thus, even those women who actually do not get children face lower wage growth, a type of statistical discrimination. Hence, the leave schemes may have negative long run wage effects in Denmark, but they are not observed when comparing the wage development of mothers with non-mothers. This conclusion is consistent with Ruhm's (1998) who finds that, based on time series from OECD countries, the gender wage gap tends to increase significantly when new leave schemes are introduced or the leave schemes are extended.

There are far less recent empirical research on the effects of child day care programs on parents' (mothers') work choices and families' decisions about how to provide care for their children. Even though, it is known that a lack of formal and affordable good quality care may constrain

mothers to take paid employment (OECD, 2001). The limited empirical evidence within this area is probably due to lack of data on the availability, prices and type of childcare. A recent comprehensive study based on British data is found in Paull et al. (2002).

4 Model

Our intention is to estimate parallel models of the effects of different family policies on job retention of Danish and Swedish mothers, controlling for other individual and family characteristics that are likely to affect retention. In deriving a model that describes the decision to re-enter the labor market after childbirth, we assume that the fertility decision has already been made and the decision whether to resume employment depends on the expected utility over the lifecycle at each point of time. A formal theoretical model based on this approach is found in Ondrich et al. (1998, 1999).

Based on an inter-temporal plan, the timing of job retention may be described by a model where the mother in each period evaluates her expected utility of returning to work ($V_W(t)$) with her expected utility of staying at home ($V_M(t)$) for one more period. The expected utility from returning to work includes the wage effects from human capital depreciation, forgone training and the potential wage effects of loosing the current job, and thus, probably loosing a firm specific human capital. The expected utility from staying at home one more period depends on individual preferences, family situation (e.g. the existence of other children) and the rate of compensation while on leave. The model by Ondrich et al. does not explicitly include prices and availability of alternatives to a mother's time with respect to care for the child, i.e. public or private childcare, and the price and availability of the father's time but these variables may be added to the model. The presence of a newborn is likely to increase V_M strongly within the first months or years, but as children grow they become less time intensive (but more goods intensive) and thus the utility of staying at home one more period is likely to fall. The mother will return to work at the first t for which $V_W(t) > V_M(t)$. Ondrich et al. show that the probability of returning to work in a given period is a positive function of the time until the leave period expires and a negative function of the compensation rate.

In analyzing the return to work after the childbirth, we use a continuous time duration model. A set of parameters is used to generate probabilities of events occurring in intervals of different lengths. The intention is to consider the impact of family policies on job retention, controlling for

other aspects that might affect their preferences, such as education, age, marital status and having other young children. Mothers' return from leave depends on parental leave programs, job-protected leave at childbirth (retain ties with the labor market), whether the father takes leave, attachment to the labor market (compensated leave), and the price and availability of childcare.

The career break due to childbirth is measured as a period on compensated parental leave, calculated as full-day equivalents and measured in weeks on parental leave. The probability of ending a career break and resuming employment is estimated using a Cox proportional hazard model of the duration of parental leave. The advantage of this method is that it does not require any a priori assumption about the probability distribution to represent survival times.

The model is written as

$$h_i(t;X) = \lambda_0(t) \exp [X(t) \beta] \quad (1)$$

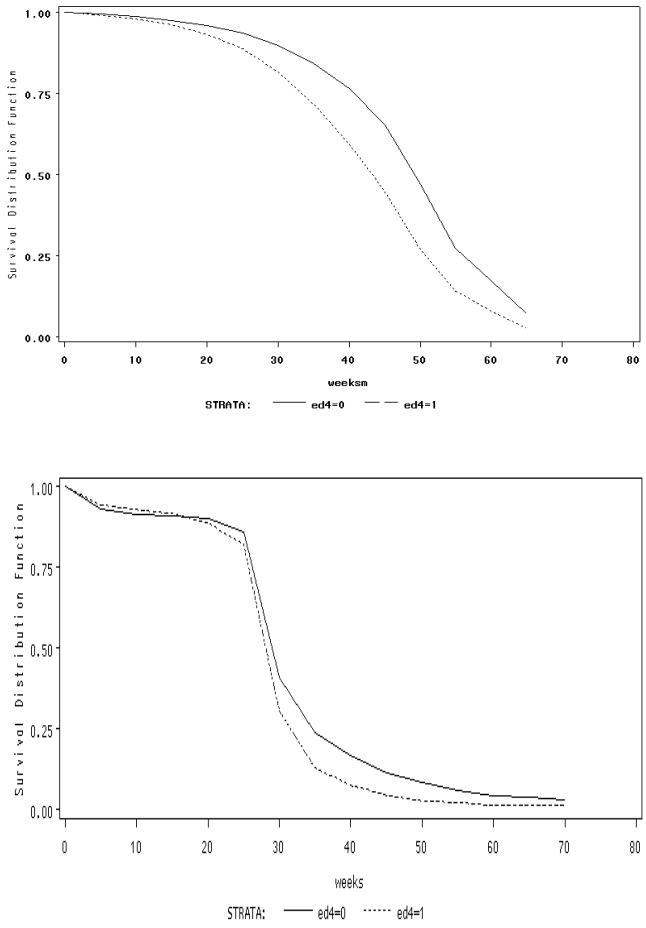
where $h_i(t;X)$ represents the hazard for individual i at time t, $\lambda_0(t)$ is the baseline hazard function that is left unspecified, i.e. we use a semi-parametric approach, and $X(t)$ represents a vector of time invariant and time-varying covariates and β is a vector of parameters.

In Sweden, mothers of young children are more likely to work part-time than women having older children or no children at all. It would have been interesting to see whether mothers end up to a part-time or full-time employment after the parental leave spell by estimating a competing risks model, which allows us to estimate destination specific hazard functions. Unfortunately, the information in our data sources on part- and full-time states after childbirth is incomplete, and therefore, we are not able to apply a competing risks approach.

A principal drawback when applying the basic Cox proportional hazard model is that it assumes that for any two individuals the ratio of the hazards is constant over time. However, there are various ways to test whether this proportionality assumption holds, for example, with the Schoenfeld residuals method, that is used here. Another drawback with the model is that it does not account for unobserved heterogeneity. Individuals usually differ in ways that are not fully captured by the model. As pointed out in numerous studies, estimation of hazard models that do not control for unobserved heterogeneity may result in biased estimates of the parameters (Heckman & Singer, 1985). For example, individuals with unobserved characteristics in the form

of preferences for market work and career ambitions, will probably return to work before individuals who are less committed to work. Thus, the observed probability of returning to work, conditional of not having returned yet, i.e. the hazard, will tend to decline with the length of the spell simply because of a sorting effect where more and more individuals with unobserved characteristics for non-work will dominate the group of individuals still on leave. On the other hand, along the lines of the human capital theory, the heterogeneity with respect to the preference for work is at least partly observable. Differences in human capital endowments are reflected in differences in the level of education and in labor market experience. Therefore, we could expect to capture the group of women with a higher preference for work by controlling for these observable characteristics if schooling attainment could be thought to be a function of ability and motivation and other unobserved characteristics. Figure 1 provides evidence on differences in the rates of return between the highly educated and the less educated (drawn from the raw). The survival curves of these groups show almost parallel shapes, where the group of highly educated women returns to employment sooner after childbirth than the less educated.

Figure 1. Survival curve of the career break of mothers. Comparison between the highly educated mothers and mothers having lower education. The upper panel show the Swedish sample, the lower the Danish.



Due to the differences in the constructions of the data, the Danish and Swedish observations (events) are collected in different ways. In both samples, we avoid left censoring by conditioning on parents who get a baby within the observation period. In the Swedish case, mothers are followed about fifteen months after the childbirth or until they re-enter the labor market if it happens before. Right censoring occurs after the observation period if the mother has not returned to the labor market, which is the case if she has a new period of parental leave, starts studying, or stays at home caring the child. In the Danish case, the sample is selected from a random sample of mothers who had a child during the period 1993 – 1996. These women are observed weekly during the period. A spell is right censored if the woman is still on maternal, parental or childcare leave at the end of the observation period, i.e. ultimo 1997.

5 Data and Descriptive Statistics

The Swedish Data

To study career interruptions due to parental leave we use register data containing information on parental leave periods of all parents and compensation levels, conducted by the National Insurance Board, Sweden. These data are the supplement to the large longitudinal LINDA database[7] which have register-based information on income and taxes with a rich array of individual and family characteristics. The LINDA data are representative data on the Swedish population and contain information on about 300 000 households annually. Due to the panel property of the data we are able to follow individuals from the year 1992 up to 2000.

The parental leave data contain information on all children and their parents who have taken parental leave during the child's first eight years. The data have records on the periods when taking the leave, the level of compensation, number of days with compensation and the rate of compensation. These data cover years 1993 – 2001 (June). The key variables of the study are collected from both the basic LINDA database and the supplementary data basis.

Since the idea is to study the length of the career break, we focus only on those mothers who were employed, self-employed or unemployed prior to childbirth. In order to be able to follow mothers at least 15 months after childbirth, the birth cohorts that are considered are 1993 – 1998.

[7] Longitudinal Individual Data (LINDA) is a joint endeavour between the Department of Economics at Uppsala University, The National Insurance Board (RFV), Statistics Sweden, and the Ministries of Finance and Labor. The data have been collected systematically since 1960.

The records for mothers' and fathers' characteristics are collected from a year before and the information about the re-entry to the labor market from a year after the parental leave spell.

In Sweden, mothers can take parental leave with a 25, 50, 75 or 100 percent compensation rate. Parental leave periods are then converted as full-day equivalents. Nevertheless, the biggest majority (92 %) of all mothers take the leave with 100 percent cover. Most often, they take the leave periodically rather than taking the leave with a smaller than 100 percent cover. Mothers are followed until they resume work or stop their parental leave schemes. A career break, the dependent variable, is counted as the time in weeks between the first day of the parental leave period and the last one during the first fifteen months after the childbirth. Even though the majority of the mothers take their period of leave very concentrated right after the birth, there are some women who choose to return to employment before their maternity leave has expired.

The Danish Data

The Danish sample is selected from the Danish Longitudinal Panel Database which is a random register based sample selected by Statistics Denmark.[8] The sample is an unbalanced representative panel sample, which covers each of the years 1976 – 1997 and includes comprehensive information on each individual's education, labor market history, incomes, taxes and income transfers, and family characteristics for about 300 000 individuals (5 % of the Danish adult population). The sample unit is an individual, not a household.

For this study, we have selected all the women in the master sample who gave birth to at least one child during the period 1993 – 1996 and who were labor market participants prior to childbirth. For these women, additional register information from "The integrated Social Statistics" owned by Statistics Denmark is merged to the master sample. The register includes weekly or monthly information on all types of public income transfers and weekly information on participation in different leave schemes. The first year included in this register was 1993, and at the time of selecting the sample, the last available year was 1997. Therefore we restrict the selected sample to children born during the period 1993 – 1996 in order to reduce the number of right-censored observations. Based on the information from the "The integrated Social Statistics", we construct spells of career breaks related to each childbirth. A spell is defined as an unbroken period out of the labor market, either in maternal leave, parental leave or childcare leave, or out of job without being in any scheme. The spell ends when the woman starts to work.

[8] Documentation of the 5 % sample is found on www.cls.dk.

The later periods are not taken into account, for instance, in cases where the father took up a part of the parental leave and the mother continued on leave after the father's period.

From the registers in Statistics Denmark, we get additional information on the fathers of the children who are born in the master sample during 1993 – 1996. Thus, we are able to construct the necessary household information by combining the additional information on fathers with the sample of mothers. The background information are collected from the years 1992 – 1996 since a number of the explanatory variables are defined by their value during the year prior to birth.

Selections

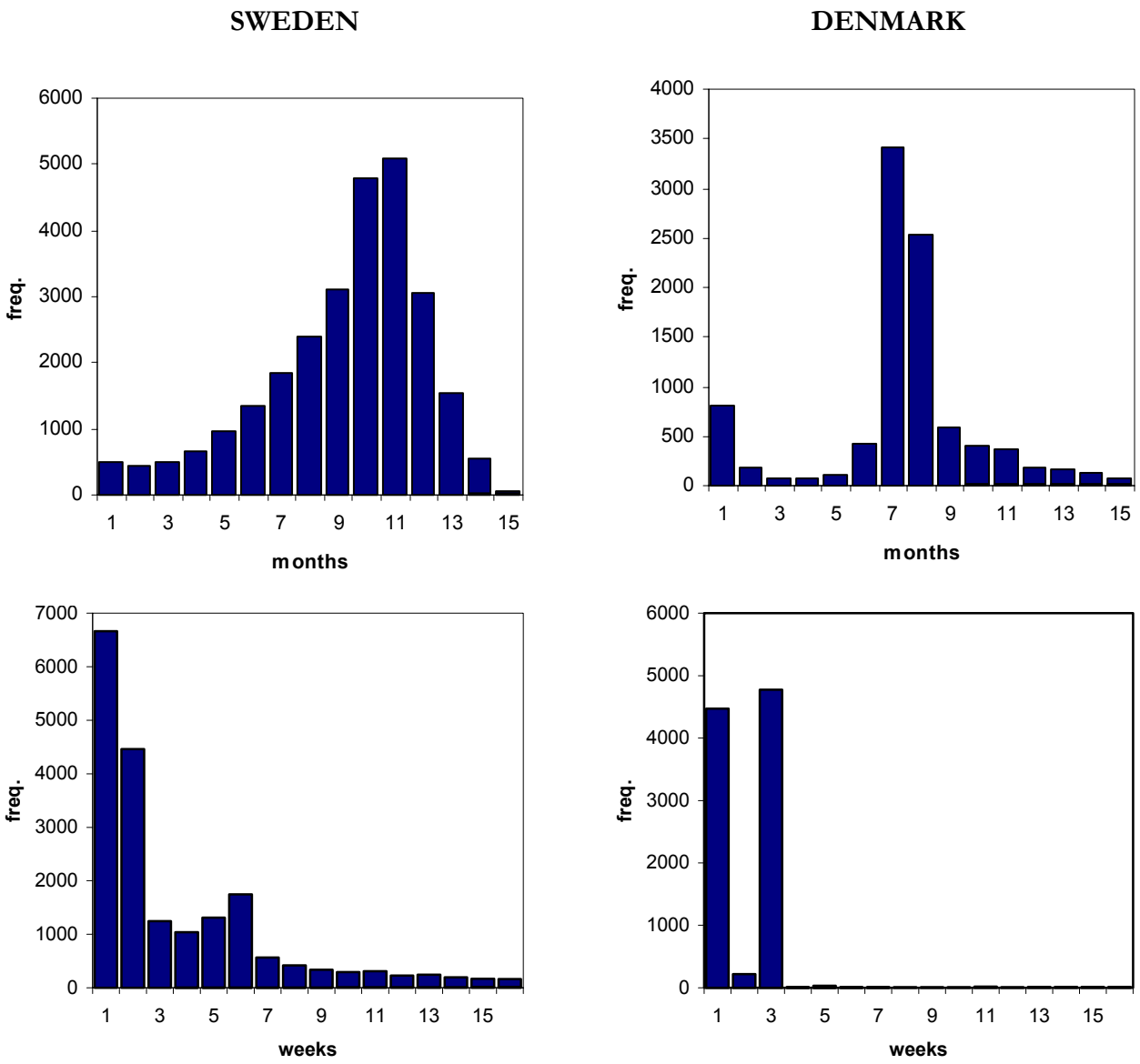
The Danish and Swedish mothers are classified into three different samples according to the order of the child. The first sample consists of mothers who give birth to their first child, the second sample contains the mothers who are having their second child and the third sample contains the higher order births. The adopted children and multiple births are excluded. Further, we only choose mothers who have a partner, either married or cohabiting with her. Table 1 shows the sample means of parental leave durations for mothers and fathers in Denmark and Sweden (the period of observation is 1993 – 1996 for the Danish sample, and 1993 – 1998 for the Swedish sample). Figure 1 shows the sample frequencies of weeks on parental leave for all mothers and fathers.

Table 1. The mean duration of parental leave periods of mothers and fathers in weeks and the share of fathers taking parental leave.

SWEDEN [1)]	First Child	Second Child	Higher order
Parental leave taken by a mother (duration in weeks)	40.2	42.5	43.1
Parental leave taken by a father (duration in weeks)	4.4	3.8	4.0
Percentage of fathers who takes a leave period	77 %	69 %	72 %
DENMARK	First Child	Second Child	Higher order
Parental leave taken by a mother (duration in weeks)	27.9	28.1	29.4
Parental leave taken by a father (duration in weeks)	1.0	1.1	1.0
Percentage of fathers who takes a leave period	49 %	46 %	47 %

[1)] For Sweden, the observation period is restricted to the first 15 months after childbirth.

Figure 2. Duration of parental leave of mothers (the upper panels) and fathers (the lower panels). The parental leave period is measured in months in 1993–1998 Sweden (n=27 000), and in 1993-1996 Denmark (n=9 500) and in weeks for fathers. The figures left show the Swedish samples and in right the Danish.



Variables

The dependent variable is the duration of parental leave. It is a sum of all types of leave contingent to childbirth. A distinction is sometimes made between "maternity leave" as well as "paternal leave", which is granted to mothers and fathers for a limited period around the time of childbirth, and "parental leave" or "childcare leave", which permit additional time off work to care for infants. All these types of continuous leave periods related to childbirth are included in the definition of parental leave used in this study.

To assess the impact of family policies on women's return to work, we use information on relevant family policy legislation. The first set of explanatory variables represents *the family policy regimes* in Sweden and Denmark: the compensation rate, father's use of parental leave, and the prices and availability of public childcare.

The rate of compensation is not constant during the mandated leave in either of the countries but decreases stepwise. Based on the register information on hourly wages, duration and timing of leave periods and supplementary information on the compensation rules, we are able to construct for each individual a time varying variable representing the compensation rate that she receives during the leave of absence for the Danish sample. The compensation rate is defined as the hourly compensation divided by the hourly market wage that the woman had prior to the leave period. For the Swedish sample the rate of compensation is given according to the rules under the respective period taking the sector of employment and the income ceiling into account (about 5 % of women had income over the ceiling). The rate of compensation has changed several times during the 1990s.[9]

The length of the parental leave period that is targeted to fathers is used as a family policy variable. In Sweden a father has been entitled to a two-week leave in connection with childbirth since 1980, and a 30-days quota for each parent was introduced in 1995 in addition to that.[10] For the Swedish sample, the father quota that varies along the period of observation is used as a covariate. For the Danish sample, we use the length of a parental leave the father took. The actual take-up of parental leave may be endogenous in the model because the duration of both parents' spells may be determined in a simultaneous process. As an alternative to actual take-up we might have used the potential duration of paternal leave (like the father quota in Sweden), but since the duration of the paternal leave has been unchanged over the period in question in Denmark, we are not able to use that. The actual duration of fathers' leave period might be instrumented or the duration of both parents' spells might be modeled in a simultaneous structure. But since we prefer to estimate almost identical models for the two countries, we have not estimated a simultaneous model for Denmark.

[9] During the period of observation the replacement rates were 90 % in 1993-94, 80 % in 1995, 75 % in 1996-97, and 80 % in 1998-99 up to an income ceiling. For a 30 day-period there were extra 10 percentage points' increase in the replacement rate both in 1995 and 1996.

[10] In Sweden the duration of leave was decreased from 360 to 270 in 1994 (July), but was raised again to 360 in the beginning of 1995 with the 30-day ring-fenced leave for each of the parents. Thereafter the duration of leave has remained unchanged for the whole period of observation.

For both samples we include additional information on the local prices of publicly provided childcare. The prices vary quite a lot between the municipalities, and we include information on prices in 1993 in each of the 273 Danish municipalities and about 150 Swedish regional areas.[11] In order to control for the rationing of the public childcare we also add an indicator variable for those municipalities where the availability of public childcare is limited.[13] Especially in some big cities parents may meet difficulties in getting a place in daycare center for their children in their most preferred district.

Other control variables (time-constant) are collected from the LINDA data (Sweden) and the 5 % sample (Denmark) a year prior to childbirth. These are age, the level of education, years of labor market experience, sector of employment, employment status, marital status, the total income of a household, and the number and ages of other children. We have the respective information about fathers too.

The labor market status before childbirth will possibly affect the timing of the labor market re-entry. For women without permanent job, the employment status during pregnancy might be highly relevant. Thus, we include an indicator variable for whether a woman was unemployed before the childbirth. We also control for a sector of occupation prior birth. The sector of occupation is a classification corresponding the employer: the state, a municipality or a private employer (includes also unemployed). The hypothesis is that those employed in the public sector might return to work earlier due to wider opportunities of combining work and parenthood (more flexible work schemes, e.g. part-time work). In both countries about half of the women are in fact employed in the public sector. The majority of publicly employed work for a municipality at service sector and only a few are working for the state.

The timing of paid work is hypothesized to depend on a woman's opportunity cost of working for pay relative to her opportunity cost of staying home. The opportunity cost of staying home depends on a set of *human capital variables*. Those who have a higher opportunity cost will be expected to return to work sooner. In view of that, the age at childbirth has a negative effect on

[11] There are about 238 municipalities in Sweden, but the information of prices is aggregated to regional prices.

[13] Our indicator of excess demand for childcare is far from perfect since we do not have precise information on childcare queues. For Denmark, we include an indicator assuming the value of 1 if the mother lives in Copenhagen or Frederiksberg (two biggest municipalities in the Copenhagen area) and Aarhus (the second biggest city in Denmark). For Sweden this variable indicates the biggest cities where the availability is known to be worse than in minor cities and towns.

job-retention since younger women have longer future work horizons and therefore would lose more from a career interruption. Also, women who have invested more in human capital, having higher education and more work experience, may have more to lose when staying out of the employment. On the other hand, more education has shown to raise the reservation wage of a mother too (Even, 1987). To capture these effects we use age, the attained level of education and the years of work experience as covariates. The level of education is defined with four categories: primary school, high-school or vocational school, short university degree, and long university degree. The lowest level of education is used as a reference group in the estimations. A striking feature of the raw data is a strong effect of education on the job retention of mothers. Figure 1 (in Section 4) compares the survival curves of the career breaks between the mothers having the highest level of education and the others.

The family situation plays an important role in women's employment decisions. The age of other children seems relevant to the timing of women's work decisions in addition to the number of children. To address these effects, we use categorical variables for other 0 – 2 and 3 – 6 years old children. Also an indicator variable for marital status is used. Further, the economic situation of a family may play an important role in the timing of women's employment after childbirth. To capture this effect we use family income as a covariate.

To control for *the macro economic trends* during the period of interest, yearly national unemployment rate is used as a covariate. Higher unemployment rates are expected to lengthen the time out of work.

All the monetary values are expressed in Euros at year 2000 prices. Tables 6 – 8 in Appendix summarize the descriptive statistics of all of the samples of mothers during the period of observation (Denmark 1993 – 1996; Sweden 1993 – 1998).

6 Results and Policy Simulations

Earlier studies report that women return to work sooner after childbirth if they are more likely to gain financially from employment, which is when women earn higher wages and have more work experience, and, of course, if she worked during the pregnancy (see, for example, Klerman & Leibowitz, 1990; Joesh, 1994). Family income has been reported to have either a negative or no relationship with the timing of post-birth employment (Wenk & Garrett, 1992). Results are more

mixed for most other factors, such as education level, age at birth, marital status, and race (Desai & Waite, 1991; Wenk & Garret, 1992). For Sweden, Rönsen & Sundström (1996) found that more educated women have shorter career breaks contingent to childbirth compared to less educated women. Another study by Gustafsson et al. (1996) finds that longer labor market experience increases the tempo of re-entry.

6.1 Results from the Hazard Model

The intention is to study explicitly to what extent the conducted family policies affect the re-entry rates of women after childbirth. The results from the proportional hazard model of the duration of parental leave are presented in Tables 2 - 3 for the Swedish and Danish samples, respectively. There are no big differences in the characteristics of the Swedish and Danish mothers, except that the mean duration of the career break is about 13 weeks longer in the Swedish samples due to the mandated parental leave which is much longer.

Since previous fertility may be an important, but endogenous variable, we condition our estimations on the number of children in the household, i.e. we estimate separate models for the first, second and higher order births.

The first set of explanatory variables represents *the family policy regimes* in Sweden and Denmark: the compensation rate, father's use of paternal leave and the prices and availability of public childcare.

For the Swedish samples, the higher compensation rate seems to lengthen the career break, which is in accordance with a priori expectations. The economic situation of the family depends, of course, on the compensation while on leave and a mother can afford better to stay longer home the higher the compensation for that time is. The second variable measures the length of the parental leave devoted only to a father. When the amount of days that are quoted to a father increases women tend to return to the labor market sooner (also when controlling for the entitled days for the mother). Even though the effect is small (for each one week increase in the fathers' quota the hazard of job retention goes up about 4 %), it is significant in all three estimations, i.e. irrespective of the number of children in the household.

Day-care prices show also an expected sign for the second and higher order births, but the effect is only significant for the second birth sample. The effect is not significantly different from zero

Table 2. The results from the estimations of the proportional hazard model of re-entering the labor market after childbirth according to birth order, the Swedish samples.

VARIABLE	1ST CHILD		2ND CHILD		3RD CHILD	
	PARAMETER ESTIMATE (STANDARD ERROR)	HAZARD RATE	PARAMETER ESTIMATE (STANDARD ERROR)	HAZARD RATE	PARAMETER ESTIMATE (STANDARD ERROR)	HAZARD RATE
Family Policy regimes:						
Compensation rate	- 0.638 *** (0.197)	0.528	- 0.235 * (0.103)	0.790	- 0.343 ** (0.113)	0.710
Father's leave	0.036 ** (0.013)	1.037	0.040 *** (0.007)	1.041	0.045 *** (0.008)	1.046
Daycare price	0.024 (0.087)	1.024	- 0.113 ** (0.043)	0.893	- 0.076 (0.049)	0.927
Big city	- 0.512 (0.873)	0.599	- 2.578 *** (0.490)	0.076	- 1.650 ** (0.565)	0.192
Daycare price * city	0.150 (0.367)	1.162	1.053 *** (0.206)	2.865	0.688 ** (0.237)	1.989
Labor Market status						
Sector of occ.: state	0.198 ** (0.072)	1.219	0.192 *** (0.039)	1.212	0.352 *** (0.052)	1.422
Sector of occ.: municip.	0.102 * (0.050)	1.108	0.045 (0.025)	1.046	0.116 *** (0.029)	1.123
Unemp. prior to birth	- 0.371 *** (0.113)	0.690	- 0.182 *** (0.042)	0.833	- 0.208 *** (0.049)	0.813
Human Capital variables:						
Age	- 0.010 (0.010)	0.990	- 0.010 (0.005)	0.990	- 0.029 *** (0.005)	0.984
Educ: High-school	0.169 (0.114)	1.184	0.133 ** (0.047)	1.143	0.168 *** (0.042)	1.112
Educ: Short university	0.410 *** (0.121)	1.507	0.334 *** (0.053)	1.397	0.442 *** (0.051)	1.411
Educ: Long university	0.701 *** (0.126)	2.016	0.570 *** (0.059)	1.768	0.651 *** (0.055)	1.752
Years of work exp.	0.072 (0.017)	1.074	0.056 *** (0.009)	1.057	0.063 *** (0.010)	1.053
Yrs. of work exp^2/100	- 0.240 (0.095)	0.787	- 0.159 ** (0.051)	0.853	- 0.139 ** (0.057)	0.881
Family situation:						
Marital status: married	- 0.170 (0.102)	0.844	- 0.013 (0.024)	0.987	- 0.028 (0.031)	0.972
Family inc (10 000 €)	0.004 (0.011)	1.004	0.001 (0.007)	1.001	- 0.005 (0.004)	0.995
Other child: 0-2 yrs. old	- - - -	- - - -	0.333 *** (0.043)	1.395	0.081 * (0.038)	1.085
Other child: 3-6 yrs. old	- - - -	- - - -	0.207 *** (0.038)	1.230	0.013 (0.029)	1.013
Macro economic variables:						
Unemployment rate	- 0.073 ** (0.027)	0.930	- 0.042 ** (0.014)	0.959	- 0.067 *** (0.017)	0.936

Significance levels: * < 0.05, ** < 0.01, *** < 0.001

Table 3. The results from the estimations of the proportional hazard model of re-entering the labor market after childbirth according to birth order, the Danish samples.

	1ST CHILD		2ND CHILD		3RD CHILD	
VARIABLE	**PARAMETER ESTIMATE (STANDARD ERROR)**	**HAZARD RATE**	**PARAMETER ESTIMATE (STANDARD ERROR)**	**HAZARD RATE**	**PARAMETER ESTIMATE (STANDARD ERROR)**	**HAZARD RATE**
Family Policy regimes:						
Compensation rate	- 0.447 *** (0.138)	0.640	- 0.590 *** (0.121)	0.554	0.081 (0.195)	1.085
Father's leave	0.010 (0.019)	1.010	0.016 (0.017)	1.016	0.034 (0.030)	1.035
Daycare price	- 0.019 (0.118)	0.981	0.030 (0.092)	1.031	0.019 (0.165)	1.020
Big city	- 1.575 (2.848)	0.207	1.524 (2.837)	4.595	- 2.903 (5.836)	0.055
Daycare price * city	0.110 (0.191)	1.116	- 0.103 (0.191)	0.903	0.201 (0.394)	1.223
Labor Market status						
Sector of occ.: state	0.186 * (0.095)	1.205	0.109 (0.089)	1.115	- 0.041 (0.149)	0.960
Sector of occ.: municip.	0.071 (0.056)	1.074	- 0.012 (0.049)	0.988	- 0.076 (0.076)	0.927
Unemp. prior to birth	0.183 ** (0.059)	1.200	0.072 (0.054)	1.075	0.172 * (0.086)	1.188
Human Capital variables:						
Age	- 0.007 (0.009)	0.993	0.002 (0.007)	1.002	- 0.010 (0.010)	0.990
Educ: High-school	0.206 *** (0.060)	1.229	0.035 (0.051)	1.036	0.070 (0.077)	1.073
Educ: Short university	0.310 *** (0.073)	1.363	0.100 (0.060)	1.105	0.289 *** (0.086)	1.335
Educ: Long university	0.547 *** (0.123)	1.729	0.323 ** (0.107)	1.382	0.266 (0.170)	1.305
Years of work exp.	0.053 ** (0.021)	1.055	0.017 (0.018)	1.017	- 0.046 (0.025)	0.955
Yrs. of work exp^2/100	- 0.211 (0.118)	0.810	- 0.047 (0.095)	0.954	0.388 ** (0.125)	1.474
Family situation:						
Marital status: married	0.083 (0.046)	1.087	0.007 (0.038)	1.007	0.050 (0.064)	1.052
Family inc (10 000 €)	- 0.214 (1.004)	0.807	0.934 (0.857)	2.545	- 0.168 (1.276)	0.845
Other child: 0-2 yrs. old	- - - -	- - - -	- 0.118 ** (0.046)	0.889	- 0.011 (0.063)	0.989
Other child: 3-6 yrs. old	- - - -	- - - -	- 0.116 * (0.051)	0.891	- 0.124 * (0.064)	0.883
Macro economic variables:						
Unemployment rate	0.171 *** (0.015)	1.186	0.153 *** (0.014)	1.166	0.157 *** (0.022)	1.171

Significance levels: * < 0.05, ** < 0.01, *** < 0.001

for the other two samples, which is not surprising since the prices of childcare are relatively low and queuing systems may dominate price effects. The effect of prices is negative only if the availability is good (the interaction term shows a positive sing). This can be seen in the estimate of the availability of public childcare which has more importance to the job retention decision for the third sample than the price has. It may well be the case that many mothers have to postpone the job retention due to queuing. The availability of all types of childcare is meager in big cities not only the publicly provided childcare but also the availability of informal care. Informal sources of care, such as that provided by grandparents, friends and neighbors in a non-market setting, may be more difficult to get if a family does not live near these informal networks.

For Denmark, the estimates of the family policy variables are different. The coefficient of the compensation rate is significant with the expected sign for mother having their first and second child, but insignificant for the third sample.[14] Father's uptake of parental leave has the expected sign, but the effect is insignificant, which might be due to the fact that there is only a little variation in the observed behavior of the Danish fathers (see Figure 2) and hence the substitution effect between spouses' times cannot be captured. If a father takes leave, he usually takes 2 weeks of leave, only extremely few fathers take more than 2 weeks. This may reflect the desired behavior of the Danish parents who are not willing to substitute a mother's time with the father's time at home. But, it may also reflect the Danish rules, during the period of observation the rules were inflexible or unattractive for fathers (families) because of poor economic incentives.[15] For child day care prices no significant effects are found for any of the samples either. Neither does the proxy variable for poor availability of childcare show any significant effects.

The second set of the variables controls for the characteristics considering *the labor market status.* The sector of employment seems to affect the retention decision in the Swedish samples. Women employed in the public sector tend to return at a higher rates compared with the private sector employed (the reference group). This effect is significant for all of the samples when the employer is the state or a municipality, except for the mothers having their second child and being employed by a municipality. This may reflect a more tolerant and supportive attitude from

[14] Since the Danish compensation rate of childcare leave decreased during the observation period, exactly as the macro unemployment rate, we have tested whether multi-collinearity between these two variables affected the estimated coefficients. However, this did not seem to be the case.

[15] The majority of the fathers were employed in the private sector, where the compensation rate was only about 60 % of their wage, while the compensation rate for mothers were much higher. For the publicly employed the rate was 100 % (more than half of the mothers) and for privately employed the rate was also higher than for men because women have lower wages in general.

the employer's side towards parenthood, mothers return sooner but are allowed more flexibly to take time off work when needed. In the private sector there is not necessarily such a family-adjusted flexibility. Further, the employment status prior to childbirth affects the decision to return to the labor market. If a mother was unemployed prior to childbirth the longer is her period of leave, which is quite intuitive. The effect is significant for every Swedish sample: the hazard of return for unemployed is only about 37 percent of the hazard for those being employed prior childbirth in the sample of the first time mothers.

In the Danish samples the effect of the sector of employment is only significant for the 1st child mothers. Mothers employed by the state seem to return sooner to the labor market compared with privately employed. For the other samples the effect is mixed and insignificant. The unemployment status prior to birth seems to have a reversed effect for the Danish mothers compared with the Swedish mothers. The effect is significant for the 1st and the 3rd samples.

The human capital variables capture the effect of education, age and the years of labor market experience on the risk to return to work. The raw data shown earlier in Figure 1 (Section 4) and the results from the hazard models confirm that the level of education has a very strong and pronounced effect on women's decision to return to work. The higher the attained degree of schooling the shorter the career break. The effect is clear almost in all three samples. The reference level in the estimations is a compulsory school, and compared to that, for all three higher categories the effect is positive, indicating a higher risk to return. For example, for the Swedish samples the hazard for employment is estimated to be almost 2 times higher for women having a long university degree than for those with the lowest level of education. For the Danish samples the effect is also strong, especially for the 1st child sample. The education variable is likely to pick up some of the differences in forgone earnings since wages are not included in the model.

The affect of the age on a mother's return from leave has a significant effect only for the Swedish sample of 3rd or higher order births. For them the effect is negative on job retention, though the effect is minimal for them too, for each one-year increase in age at childbirth the hazard of return goes down by 1.6 percent.

The number of years of labor market experience reflects the attachment to the labor market prior to childbirth. This variable and its square are significant for almost all of the samples. The more

mothers have work experience the shorter the career break but with a decreasing rate. This effect is clearly seen in the Danish samples too, except for the 3rd or higher order births for which the effect is reversed and significant at the 5 % level.

The model has control variables for *the family situation* of a mother. The marital status, an indicator for being married, stands for a proxy for traditional values or a more stable family concept. Being married affects in this respect as expected, the interruption in career lasts longer if the mother is married. Though the effect is hardly significant for any of the Swedish samples. On the other hand, the effect is the opposite but again not significant for the Danish samples. The family income has no significant effect either on the length of the mothers' career break.

One interesting variable reflecting the differences between the family policies in Denmark and Sweden is the existence of other young children in the family. For the Swedish samples the existence of other children shortens the career break, whereas the effect is reversed for the Danish samples. Apparently, the availability of childcare is part of the cause. In Sweden it is easier to get a daycare place if there are other siblings who already have a place in daycare. In Denmark it is more likely that a mother stays longer home if she has other young children too.

To include the effect of *macro economic situation*, the national unemployment rate is added as a covariate to the model. For the Swedish samples the effect is clearly negative, indicating longer career interruptions for mothers, while the effect is the opposite for the Danish sample. The conflict in results may reflect mothers' situation in the labor market and the job-protection law. When the unemployment rate is high, mothers who have a job might want to return sooner if they fear for loosing the job. However, if there is a job-protection, this may not be a problem (in principle).

6.2 Policy Simulations

In order to test how changes in family policy regimes would affect the length of career breaks of mothers, we pursue some policy reforms and apply the new rules to the Danish and Swedish samples. To predict the length of the career break, we replace a set of family policy covariates with the new ones and evaluate the survivor estimates for a "typical" case. In order to be able to obtain predictions, the time-dependent covariate, the rate of compensation, is changed to a time-constant replacement rate that will only depend on the previous income, the sector of employment (Denmark) and the year in question (Sweden). For the Swedish case, the mandated

parental leave period for mothers is added to the equation as an explanatory variable to be able to control for that in simulations.[16]

The survival probability, $S(t)$, at time t for an individual with covariate values **x** can be written as

$$S(t) = [\, S_0(t) \,]^{\exp(\boldsymbol{\beta}\mathbf{x})} \qquad (2)$$

where $S_0(t)$ is the baseline survivor function. After estimating $\boldsymbol{\beta}$, we get an estimate of $S_0(t)$ by a non-parametric maximum likelihood method. With that estimate we generate the estimated survivor function for the chosen "typical" case by substituting her characteristics and the suggested policy reforms in the equation (2).

First we apply the Danish system to the Swedish 2nd child mothers' case, but keeping the entitled days for mothers constant. In the second policy suggestion we apply a more equal parental leave schemes that share the responsibility more even between the parents and predict the effect on the length of the mothers' career breaks. The parental leave quota for fathers is set to four months with everything else unchanged, i.e. maintaining the idea of flexibility. The third policy reform tests the effect of a free and perfectly available child daycare. Lastly, we test the effects of different compensation rates, with a full pay and with a lower rate of compensation.

Table 4. Results from policy simulations for a typical household. The predicted length of the career break under different family policy rules applied to the Swedish sample of mothers having the 2nd child.[1)]

FAMILY POLICY RULES	2ND CHILD (the Swedish rules)	2ND CHILD (the Danish rules)	2ND CHILD (4 months of leave for fathers)	2ND CHILD (no daycare fees, availability)	2ND CHILD (compensation rates: 1.0 / 0.5)
Compensation rate	0.8	0.7 / 1.0	0.8	0.8	1.0 / 0.5
Father's leave	4.0	2.0	16.0	4.0	4.0
Entitled period /100	3.3	3.3	3.3	3.3	3.3
Daycare fee	2.5	2.0	2.5	0	2.5
Childcare availability	0	1	0	1	0
Duration of leave	**41**	**40 / 43**	**37**	**39**	**42 / 38**

1) A typical household is defined as a household with a mother having average characteristic for continuous variables and modal values for indicator variables. Thus, the mother is 32 years old who is married and she has another child aged 0-2 years. She has 7 years of labor market experience, a long university degree, and she is employed in the public sector (state). Her husband takes 4 weeks parental leave. The family income is 33' €.

The last row of Table 4 shows the predicted lengths of the career breaks after the suggested changes in family policy schemes. According to the results, mothers would react to changes.

[16] The results from these estimations are in line with the results in Table 3 - 4.

When the Danish system with the average level of compensation is applied to the Swedish sample it results in a one-week shorter career break, which is not much out of the total of 330 days of leave, but the effect could be more substantial in the macro level. When the rate of compensation was set to 1.0 it resulted in 2 weeks longer leave. The second policy reform gives fathers a 16-week long parental leave all other things unchanged (the entitlement period of mothers is left unchanged). This reform would decrease the career break for the mother of the type family by 4 weeks. The result could imply that, if we tried to promote equality between males and females in the labor market, more leave should be directed explicitly to fathers (even without decreasing the entitlement period of mothers). If the idea were to encourage women to shorten the career breaks contingent to childbirth, i.e. work more hours, this might also result in smaller loss in wages and future earnings.

The third reform involves changes in child daycare availability and its price. As we saw earlier, we cannot test the price effect separately, because the restrictions in the supply side of the childcare may dominate the price effect. Free and perfectly available childcare would result in two weeks shorter parental leave periods for mothers, when the quality aspects of child daycare are not considered. Finally, we assessed the effects of different rates of compensation. When mothers were given a full compensation, they would increase their leave by one week, and when the compensation were decreased to 0.5 they would return three weeks sooner to the labor market.

The possibilities to pursue policy simulations with the Danish samples are more restricted because there has been no changes in the rules during the period of observation and because the simulation with insignificant estimates is questionable. Hence, we only assessed policy reforms considering the child daycare system and the compensation rates.

Table 5. Results from the policy simulations for a typical household. The predicted length of a career break under different family policy rules applied to the Danish sample of mothers having the 2nd child.[1)]

FAMILY POLICY RULES	2ND CHILD (the Danish rules)	2ND CHILD (no daycare fees, full availability)	2ND CHILD (compensation rates: 1.0 / 0.5)
Compensation rate	0.75	0.75	1.0 / 0.5
Father's leave	1.0	1.0	1.0
Entitled period (weeks)	28	28	28
Daycare fee	2.5	0	2.5
Childcare availability	1	1	1
Duration of leave	**27**	**27**	**27 / 26**

1) A typical household for the Danish sample: the mother is 30 years old, she is married and has another child aged 0-2 years. She has 3 years of labor market experience, a high-school degree, and she is employed in the public sector (municipality). Her husband takes one week of parental leave. The family income (excluded the mother's income) is 20' €.

The results from these policy reforms applied to the Danish sample are seen in Table 5. There seem to be no effect on time off work if the childcare were free and better available. Only if the rate of compensation were decreased to 0.5 it would bring about one week shorter career break.

The Swedish examples of policy simulations suggest that there is room for changes within the framework of family policies. Some of these policy simulations resulted in small changes in the level of a single family, but they might result in more far reaching effects in the labor market from the macro perspective, and regarding the shortage of the labor force in the future there can be substantial effects on the total supply of labor. Also, more flexible parental leave schemes and child daycare systems would allow a more effective use of the labor force.

On the other hand, family policy rules may determine the take up of parental leave even when the rules allowed flexibility and parents tend to adopt the rules as norms which conduct their behavior – and this applies to fathers in particular. As the results from the hazard estimations and policy simulations show, when increasing the fathers' quota women react by decreasing their parental leave periods, and most likely this happens via changes in the behavior of the fathers.

7 Conclusions

This study investigated the effects of different family policy regimes on the job retention of Danish and Swedish mothers, controlling for other individual and family characteristics that are likely to affect retention. Here we focused only on mothers who had a partner and participated in the labor market and interrupted their careers due to childbirth during the 1990s.

Our analysis took advantage of the availability of comparable longitudinal data and allowed us to estimate parallel models across the countries. The timing of re-entry to the labor market was hypothesized to depend on a woman's full wage relative to her reservation wage. The probability of ending a career break and resuming employment was estimated using a Cox proportional hazard model.

Compared to previous research, this study applies the latest and more representative data. So far, only a few studies have addressed the impact of family policies on the return to work, positive exceptions are the studies of Rönsen & Sundström (1996) and Gustafsson et al. (1996), where they compare the determinants of the length of a career break in connection with childbirth

between Sweden and some other European countries. The novelty and the contribution of this study is to compare the two Scandinavian countries with similar welfare state ideologies with high labor force participation of mothers but with different parental leave regimes. Moreover, here we also take the family policy regimes explicitly into account including the child daycare availability and prices.

The labor market activity of mothers in Nordic countries is among the highest in the world, and yet they have the most generous parental leave schemes. The parental leave regimes base on the labor market attachment before the childbirth and contain a job-protection. The Danish and Swedish family policies provide families with different kinds of incentives, which are reflected in labor market outcomes. The idea was to compare these two countries which are much alike. They have similar cultural background, and in both countries female labor force participation rates are high, and particularly, mothers with young children are very active in the labor market compared with other countries. But, the rules of family policies differ. Whereas Sweden represents a country that has a universal, flexible and generous parental leave schemes, Denmark represents a more conservative type of family policies when it comes to parental leave schemes. On the other hand, in Denmark the child daycare is better on average in quantity and quality. In Sweden many families have to queue for a place in a day care center, which makes things more difficult for families and perhaps cause mothers a need to go down on their hours of work.

The paid parental leave mandates determine to a great extent the rate of return to employment. Since parental leave is longer in Sweden the return rates are lower than in Denmark during the first months after childbirth. To be able to compare the re-entry rates of mothers between the two countries we should keep in mind the country-specific features (e.g. other benefit systems and the labor market legislation) which counteract with the family policy rules. Economic factors have a striking effect on the decision to return from leave, especially for Sweden. Basing on our results, the lower compensation rate boosts the return and in areas with a good availability of childcare the higher prices of daycare postpone it. We also found that fathers' parental leave take-up play an important role in the timing of women's employment after childbirth in Sweden, the longer leaves for fathers produces shorter time off work periods for mothers. Our findings underline also the importance of the labor market attachment of mothers. Over 90 percent of the mothers in both countries return to the labor market after the childbirth, and at the higher rates the more they have invested in human capital.

We also carried out some policy simulations regarding the effects on the length of parental leave. The idea was test to how much these changes would affect the mothers' parental leave take up. The policy changes included applying the Danish rules to the Swedish mothers, giving fathers more ring-fenced leave, providing an access to a free childcare, and varying the rate of compensation. Each of these changes resulted in some reactions in mothers' parental leave take-up for the Swedish sample, but the most interesting result was that when fathers were given a parental leave of 16 weeks, all other things unchanged (the entitlement period of mothers), it would decrease the leave for the mother of the type family by 4 weeks. This result would imply that, if we tried to promote equal career prospects between men and women, more leave should be directed explicitly to fathers. If the idea were to encourage women to shorten the career breaks contingent to childbirth, i.e. work more hours, this might also result in smaller loss in wages and future earnings.

We believe that this paper provides some evidence that by courageous and more flexible family policies we could promote the labor supply of women and more equal role sharing between mothers and fathers. More ambitious endeavors, such as the analysis of the fathers' parental leave take up and simultaneous decision-making over parental leave within a household are in the agenda for the future research.

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Appendix

Table 6. Descriptive statistics of the sample of parents, the Swedish (1993 – 1998) and the Danish (1993 – 1996) sample, where the mother gives birth to her first child. All variables related to the market work are records from a year prior to the birth. Monetary values are given at the year 2000 prices in Euros. In the Swedish sample n=3 297, in the Danish sample n=3 248.

VARIABLE	SWEDEN		DENMARK	
	MOTHERS	FATHERS	MOTHERS	FATHERS
AGE	29.2	33.4	28.0	28.0
AGE WHEN HAVING THE FIRST CHILD	29.2	30.9	28.0	28.0
HAVING CHILDREN 0-2 YEARS OF AGE	0	0.00	0	0
HAVING CHILDREN 3-6 YEARS OF AGE	0	0.01	0	0
NUMBER OF CHILDREN	1.0	1.09	1.0	1.0
MARRIED	0.94		0.29	0.29
EDUCATION (the highest attained level)				
ELEMENTARY SCHOOL	0.05	0.11	0.37	0.19
HIGH-SCHOOL DEGREE	0.47	0.44	0.40	0.51
BACHELOR'S DEGREE	0.24	0.22	0.20	0.14
MASTER'S DEGREE (or higher)	0.24	0.23	0.04	0.07
HOURS OF WORK *)	1 788.4	2007.1	1 517.3	1 743.0
SHARE OF FULL-DUTY *)	0.90	0.93	0.92	n.a.
HOURLY WAGE RATE (€) *)	10.9	12.9	15.4	18.3
LABOR INCOME (1000 €) *)	18,5	22,3	21,5	27.2
YEARS OF WORK EXPERIENCE	7.4	11.5	6.1	8.5
FAMILY INCOME	3.40		3.57	
SECTOR OF EMPLOYMENT				
STATE	0.11	0.14	0.37	0.06
MUNICIPALITY	0.38	0.13	0.31	0.07
PRIVATE	0.48	0.67	0.56	0.86
OTHER	0.03	0.06	0.07	0.01
LIVING IN A BIG CITY **)	0.48	0.48	0.20	0.20
PARENTAL LEAVE				
TAKEUP OF LEAVE (weeks)	40.2	4.4	27.9	1.03
SHARE OF THE FATHERS HAVING LEAVE		77.3		49.0
DAYCARE FEE (€)	232.0		205.7	
COMPENSATION RATE 1 ***)	0.83	0.78	0.78	0.55
COMPENSATION RATE2	0.79	0.75	0.48	0.36
COMPENSATION RATE3	0.14	0.17		
LENGTH OF THE PAID LEAVE (weeks) ****)	25.7	27.7	28.0	12.0

*) For Sweden, the information on hours of work and hourly wage rate are not available for every individual but on about 1/3 of our sample, therefore the mean value are calculated only for those having these information.
For Denmark, the mean values are calculated excluding the self-employed.
**) For Sweden, Stockholm, Göteborg and Malmö areas. For Denmark, Copenhagen, Frederiksberg and Aarhus.
***) For Sweden, the rate of compensation changes during the parental leave (time-varying variable) and varies across sector of occupation (with an income ceiling), and there have also been changes in the parental leave compensation rules over the years. For Denmark, the rate of compensation varies across sector of occupation, and further there is an income ceiling for compensation.
****) For Sweden, each parent has 180 days of parental leave, which could be transferred to the other parent only, except for 30 days (a father also have 2 weeks of leave contingent to childbirth). For Denmark, 10 weeks of leave can be taken either by a mother or a father (a father also have 2 weeks of leave contingent to childbirth).

Table 7. Descriptive statistics of the sample of parents, the Swedish (1993 – 1998) and the Danish (1993 – 1996) sample, where the mother gives birth to her second child. All variables related to the market work are records from a year prior to the birth. Monetary values are given at the year 2000 prices in Euros. In the Swedish sample n=9 756, in the Danish sample n=4 404.

VARIABLE	SWEDEN		DENMARK	
	MOTHERS	FATHERS	MOTHERS	FATHERS
AGE	30.4	33.1	29.7	30.9
AGE WHEN HAVING THE FIRST CHILD	27.8	28.8	26.6	n.a.
HAVING CHILDREN 0-2 YEARS OF AGE	0.25	0.24	0.28	0.28
HAVING CHILDREN 3-6 YEARS OF AGE	0.64	0.64	0.47	0.47
NUMBER OF CHILDREN	2.00	1.89	2.00	2.00
MARRIED	0.56		0.54	
EDUCATION (the highest attained level)				
ELEMENTARY SCHOOL	0.07	0.13	0.32	0.19
HIGH-SCHOOL DEGREE	0.57	0.55	0.42	0.54
BACHELOR'S DEGREE	0.20	0.16	0.22	0.14
MASTER'S DEGREE (or higher)	0.16	0.16	0.04	0.08
HOURS OF WORK*)	1 378.1	1 921.9	1 481.0	1 754.8
SHARE OF FULL-DUTY*)	0.81	0.92	0.91	n.a.
HOURLY WAGE RATE (€) *)	10.8	13.1	14.6	19.8
LABOR INCOME (1000 €) *)	13,5	21,6	20.0	29.9
YEARS OF WORK EXPERIENCE	8.2	13.1	7.4	10.6
FAMILY INCOME	3.46		4.11	
SECTOR OF EMPLOYMENT				
STATE	0.09	0.12	0.05	0.07
MUNICIPALITY	0.43	0.12	0.35	0.07
PRIVATE	0.42	0.68	0.49	0.85
OTHER	0.06	0.08	0.11	0.01
LIVING IN A BIG CITY **)	0.39	0.39	0.13	0.13
PARENTAL LEAVE				
TAKEUP OF LEAVE (weeks)	42.5	3.8	28.1	1.07
SHARE OF THE FATHERS HAVING LEAVE		69.0		46.0
DAYCARE FEE (€)	230.0		207.3	
COMPENSATION RATE 1 ***)	0.84	0.79	0.80	0.54
COMPENSATION RATE2	0.81	0.76	0.49	0.36
COMPENSATION RATE3	0.17	0.17		
LENGTH OF THE PAID LEAVE ****)	25.7	27.7	28.0	12.0

*) For Sweden, the information on hours of work and hourly wage rate are not available for every individual but on about 1/3 of our sample, therefore the mean value are calculated only for those having these information. For Denmark, the mean values are calculated excluding the self-employed.
**) For Sweden, Stockholm, Göteborg and Malmö areas. For Denmark, Copenhagen, Frederiksberg and Aarhus.
***) For Sweden, the rate of compensation changes during the parental leave (time-varying variable) and varies across sector of occupation (with an income ceiling), and there have also been changes in the parental leave compensation rules over the years. For Denmark, the rate of compensation varies across sector of occupation, and further there is an income ceiling for compensation.
****) For Sweden, each parent has 180 days of parental leave, which could be transferred to the other parent only, except for 30 days (a father also have 2 weeks of leave contingent to childbirth). For Denmark, 10 weeks of leave can be taken either by a mother or a father (a father also have 2 weeks of leave contingent to childbirth).

Table 8. Descriptive statistics of the sample of parents, the Swedish (1993 – 1998) and the Danish (1993 – 1996) sample, where the mother gives birth to her third or higher order child. All variables related to the market work are records from a year prior to the birth. Monetary values are given at the year 2000 prices in Euros. In the Swedish sample n=7 519, in the Danish sample n=1 855)

VARIABLE	SWEDEN		DENMARK	
	MOTHERS	FATHERS	MOTHERS	FATHERS
AGE	33.2	35.9	32.5	32.6
AGE WHEN HAVING THE FIRST CHILD	25.4	27.6	24.4	n.a.
HAVING CHILDREN 0-2 YEARS OF AGE	0.14	0.13	0.65	0.65
HAVING CHILDREN 3-6 YEARS OF AGE	0.66	0.80	0.43	0.43
NUMBER OF CHILDREN	3.37	3.17	3.25	3.25
MARRIED	0.75		0.67	
EDUCATION (the highest attained level)				
ELEMENTARY SCHOOL	0.14	0.20	0.29	0.24
HIGH-SCHOOL DEGREE	0.55	0.52	0.39	0.47
BACHELOR'S DEGREE	0.18	0.13	0.28	0.15
MASTER'S DEGREE (or higher)	0.14	0.15	0.03	0.07
HOURS OF WORK*)	1 386.2	1 958.0	1 397.8	1 663.8
SHARE OF FULL-DUTY*)	0.77	0.92	0.86	n.a.
HOURLY WAGE RATE (€) *)	10.8	13.3	13.8	18.6
LABOR INCOME (1000 €) *)	12,9	21,2	17.9	28.2
YEARS OF WORK EXPERIENCE	9.2	15.7	8.0	11.5
FAMILY INCOME	3.83		4.30	
SECTOR OF EMPLOYMENT				
STATE	0.07	0.12	0.04	0.06
MUNICIPALITY	0.53	0.15	0.44	0.09
PRIVATE	0.32	0.63	0.36	0.84
OTHER	0.08	0.10	0.16	0.01
LIVING IN A BIG CITY **)	0.34	0.34	0.09	0.09
PARENTAL LEAVE				
TAKEUP OF LEAVE (weeks)	43.1	4.0	29.4	1.03
SHARE OF THE FATHERS HAVING LEAVE		72.5		47.0
DAYCARE FEE (€)	229.0		205.9	
COMPENSATION RATE 1 ***)	0.84	0.79	0.85	0.54
COMPENSATION RATE2	0.81	0.76	0.50	0.35
COMPENSATION RATE3	0.17	0.17		
LENGTH OF THE PAID LEAVE ****)	25.7	27.7	28.0	12.0

*) For Sweden, the information on hours of work and hourly wage rate are not available for every individual but on about 1/3 of our sample, therefore the mean value are calculated only for those having these information. For Denmark, the mean values are calculated excluding the self-employed.
**) For Sweden, Stockholm, Göteborg and Malmö areas. For Denmark, Copenhagen, Frederiksberg and Aarhus.
***) For Sweden, the rate of compensation changes during the parental leave (time-varying variable) and varies across sector of occupation (with an income ceiling), and there have also been changes in the parental leave compensation rules over the years. For Denmark, the rate of compensation varies across sector of occupation, and further there is an income ceiling for compensation.
****) For Sweden, each parent has 180 days of parental leave, which could be transferred to the other parent only, except for 30 days (a father also have 2 weeks of leave contingent to childbirth). For Denmark, 10 weeks of leave can be taken either by a mother or a father (a father also have 2 weeks of leave contingent to childbirth).