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Working Paper

Effects of Family Policy Reforms in Norway. Results from a Joint Labor Supply and Child Care Choice Microsimulation Analysis

Discussion Papers, No. 450

Provided in Cooperation with:

Research Department, Statistics Norway, Oslo

Suggested Citation: Kornstad, Tom; Thoresen, Thor Olav (2006) : Effects of Family Policy Reforms in Norway. Results from a Joint Labor Supply and Child Care Choice Microsimulation Analysis, Discussion Papers, No. 450, Statistics Norway, Research Department, Oslo

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Tom Kornstad and Thor Olav Thoresen

**Effects of Family Policy Reforms
in Norway**
Results from a Joint Labor Supply
and Child Care Choice
Microsimulation Analysis

Abstract:

Mothers of preschool children represent one part of the population that might be able to increase its labor supply. We discuss effects of family policy changes that encourage the labor supply of these mothers, as child care fee reductions and increased availability of center-based care. Effects of policy changes are described by employing a joint labor supply and child care choice decision model. Detailed empirical results are provided with respect to mothers' labor supply, families' child care choices, public expenditures, and distributions of income and money metric utility.

Keywords: female labor supply, child care, family policy, discrete choice, microsimulation, compensating variation

JEL classification: D12, D31, J22, H23

Acknowledgement: This work has been supported by The Norwegian Research Council. We would like to thank Bård Lian for valuable assistance in preparation of this study and John Dagsvik and Rolf Aaberge for helpful discussions and comments. Comments from seminar participants at the 2003 IIPF conference in Prague are also gratefully acknowledged.

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1. Introduction

The ageing of populations and the economic consequences of this are generating widespread concern in many countries. A growing ratio of the population will be unavailable for work, while at the same time there might be a positive shift in the demand for labor, due to the fact that elderly need more health assistance and care than younger persons. The increased demand for labor in a situation with fewer individuals available for work may have severe implications. Scenarios include increased pressure on wages, inducing worsened international competitiveness, as well as financial problems because of expansion in care sectors and increased public pension system expenditures, imposing higher tax burdens on a shrinking working population. Even if the last decades have brought about a drastic change in women's position in the labor market, and even if Norwegian females supply more market work than females in many other countries, there is still scope for an increase in their labor supply. Many mothers of preschool children are part-time workers and some do not participate in market work at all. If we interpret the difference between male and female labor supply as a measure of the unexploited female manpower potential for this group, a pool of about 50 000 man-years is available for market work. By engaging in various work stimulating policy changes, one can encourage the flow of preschool mothers into market work.

The main purpose of this paper is to provide policy relevant empirical information, such as labor supply effects, distributional effects, and effects on public expenditures, with respect to two proposed reforms and two hypothetical family policy reforms, which we expect to be work stimulating: abolition of queues in the market for care in child care centers; child care fee reductions; withdrawing the home care allowance reform; and the introduction of a Norwegian variant of the Working Families Tax Credit in the U.K. The former two reforms are of strong current interest, as the Norwegian Parliament has passed a resolution to end queues in child care centers and to reduce fees. This is the so-called "child care compromise", which adds to the concept of Norwegian politicians to be remarkably willing to introduce family policy reforms. The previous major family policy reform was the introduction of the home care allowance scheme in 1998, which entails parents of preschool children aged 1–2 years to receive a transfer in cash dependent on their utilization of subsidized center-based care. Non-users of care at centers are eligible to an yearly cash support of NOK43,884 (in 2004), or about \$6,200 (according to the average exchange rate for 2003), while provisions are scaled down to nil for users of full-time center-based care. The reform was introduced in order to equalize transfers across modes of care. However, as we want to focus on work stimulating changes in the present paper, we assess effects of abolishing the reform. Finally, we also consider effects of another hypothetical reform: the introduction of "in-work" benefits in the Norwegian tax system, copying

Anglo-American tax system arrangements that have been established in order to promote employment, such as the Working Families' Tax Credit in the U.K. and the Earned Income Tax Credit in the U.S.

In order to describe effects of these reforms we derive information from various simulations, based on a particular joint labor supply and child care choice decision model for married or cohabiting mothers of preschool children, presented in Kornstad and Thoresen (2006).¹ The decision model is a discrete choice random utility model, where mothers are assumed to choose from a finite set of jobs and child care alternatives when there might be availability restrictions in markets for care. Child care availability issues are important when assessing labor supply effects of family policy changes in Norway. The discrete choice microsimulation approach shares similarities with analyses of labor supply effects seen in e.g., Zabalza, Pissarides and Barton (1980); Aaberge, Dagsvik and Strøm (1995); Bingley et al. (1995); van Soest (1995); Aaberge, Colombino and Strøm (1999); Blundell et al. (2000); Bingley and Walker (2001); Kornstad and Thoresen (2004), and analyses with respect to joint labor supply and child care choices seen in e.g., Michalopoulos and Robins (2000); Duncan, Paull and Taylor (2001); Powell (2002).

Each policy alternative is evaluated by its effect on the labor supply of married or cohabiting mothers, the families' choice of child care, public costs and distributional effects. The distributional effects are assessed by two measures of gains and losses: change in post-tax income and money metric utility. Estimates of money metric utility in nonlinear random utility models, of the type we are applying here, are rarely seen in the literature (Herriges and Kling, 1999), since analytic formulae for the distribution of equivalent variation and compensating variation (CV) when preferences are nonlinear in income have not been available until recently. We apply a novel framework developed by Dagsvik and Karlström (2004) that allows us to calculate the probability distribution of the CV from explicit formulae for the Hicksian choice probabilities.

The paper is organized as follows: in Section 2 we discuss the size of the pool of female manpower that could be available for market work. The decision model for mothers of preschoolers is presented in Section 3, while the framework for assessing the distributional impact of the reforms is discussed in Section 4. The simulation results are discussed in Section 5, and Section 6 concludes the paper.

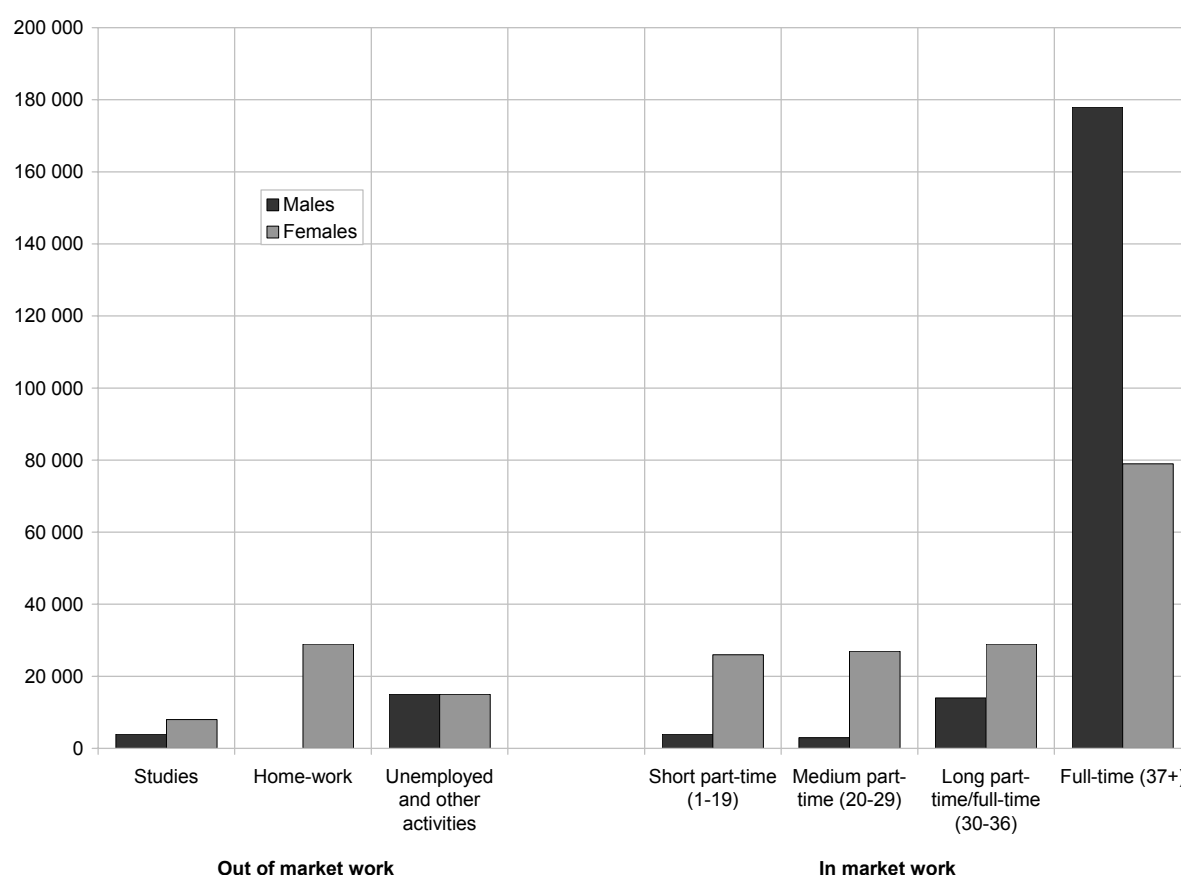
2. The scope for increased female labor supply

An important motivation for the analysis in this paper is that there exist unexploited female manpower resources that can be activated through policy changes. Even if participation rates are high (OECD

¹ Confer Creedy and Duncan (2002) and Creedy et al. (2002) for surveys of recent developments in behavioral microsimulation. They discuss microsimulations based on both discrete and continuous choice.

2004), there is more part-time work in Norway than in most other OECD countries. This result is primarily due to Norwegian females' connection to market work. In Figure 1 we show the labor market connection of fathers and mothers of preschool children, based on data from the Labor Force Sample Survey 2003.² While nearly 90 percent of the males work full-time, only about 50 percent of the females are full-time workers (including the long-part time/full-time category of Figure 1). If the labor supply of fathers of preschool children represents the level of labor supply that can be achieved by mothers, an increase of about 50,000 man-years is a tentative measure on labor supply growth potential for this group, which would denote a substantial input to the Norwegian labor market. However, as mothers work at home, the real increase in production would be less than this.

Figure 1. Married or cohabiting mothers and fathers of preschool children categorized w.r.t. main activities, 2003



Source: The Labor Force Sample Survey 2001

² Note that parents of children under 1 are included; parents that presumably are on maternity or preternity leave. However, they are registered by their usual working hours, so they are not influencing the main message of Figure 1.

3. A framework for simulations of family policy changes

A discrete choice joint labor supply and child care choice model

Let us probe deeper into our framework for simulations of effects of reforms. According to traditional models of labor supply hours of work is the primary choice variable, and this variable can be adjusted continuously (given the pre-tax wage rate). Thus, one ignores other aspects of labor supply that might be at least equally important, such as job location, type of work and other factors related to job satisfaction.

Moreover, when modeling the labor supply decisions of parents of preschoolers one needs to take into consideration that market work participation by both parents typically implies a demand for non-parental child care, which entails (pecuniary) costs and affects the well-being of children. Recent suggestions of decision-making frameworks of joint labor supply and child care choices include, e.g., Blau and Hagy (1998); Michalopoulos and Robins (2000); Connelly and Kimmel (2003). One should also consider the possibility that the family might be constrained in the market for non-parental care, as well as in the labor market. The child care availability issue is emphasized by Gustafsson and Stafford (1992) and del Boca (2002) with respect to labor supply responses of Swedish and Italian mothers, respectively.

Our modeling approach, laid out in Kornstad and Thoresen (2006), is based on a discrete choice approach, and starts out from the assumption that jobs and various care alternatives are characterized by a number of pecuniary and non-pecuniary attributes. Parents' choice of job is influenced not only by working hours and wage rates, but also by the set of non-pecuniary attributes characterizing job satisfaction. Similarly, child care options vary with regards to facilities, quality of staff, etc., as well as opening hours and fees. Many of these attributes are fixed for a given job or child care option. For instance, opening hours are fixed at child care centers, as frequently are hours of work and job satisfaction factors. A desire to alter features such as these would most likely imply a job change or a change of care provider. Hence, we assume that labor supply and choice of child care are outcomes of discrete choices from finite sets of jobs and child care arrangements, where each job is assumed to have fixed working hours, a wage rate and a number of non-pecuniary characteristics, and each care alternative has fixed opening hours, a care fee and specific quality attributes.

We do not observe all variables and choice opportunities that are relevant to the decision-makers. For instance, the quality of non-parental child care is latent. Nor do we observe the variables determining job satisfaction apart from hours of work and wage rates for mothers that participate in market work. To capture the effects of these non-pecuniary attributes on preferences, alternative specific stochastic error terms are introduced.

A particular feature of the Norwegian market for non-parental child care that is considered in the model specification, is that it can be divided into two submarkets: a market for care at day care centers and a market for other types of paid care, dominated by childminders. The two markets differ in many respects, such as eligibility for public support, parental fees, opening hours and rationing, and should therefore be treated as separate markets. Availability is an important issue of the market for care at centers, which our modeling approach is well-suited to handle. Although there has been substantial growth in the number of places at day care centers over the past few decades, there are still queues, at least in some municipalities. At the national level the child care attendance ratio for children aged 1-5 reached about 69 percent in 2003 (Statistics Norway, 2004), see Figure 2 below. However, coverage varies across municipalities. Based on these characteristics of the market for child care, we divide all child care arrangements into three different modes of care: care at centers ($m = 1$); care by other paid providers ($m = 2$); and own/parental care ($m = 3$). Similarly, jobs are divided into groups according to working hours. We distinguish between non-participation ($j = 1$); three types of part-time work; corresponding to 1–16 hours per week ($j = 2$); 17–24 hours per week ($j = 3$); 25–32 hours per week ($j = 4$); and full-time work, 32+ hours per week ($j = 5$).

Table 1 summarizes our categorization of working hours and care alternatives. Note that since we want to elaborate the point that market work for mothers must imply some sort of non-parental care, we assume that there is a fixed link (Ilmakunnas, 1997) between hours of market work and hours of non-parental care for $j > 1$. This means that the male is not providing care during the working day.³ However, note that we do not exclude the possibility of home-working mothers employing non-parental care alternatives, see the second column in Table 1. Thus, $j = 1$ does not imply $m = 3$, i.e., home work does not imply parental care. The combinations $j = 1$ and $m = 1$ or $j = 1$ and $m = 2$ suggest that non-parental care might be seen as a sole contributor to child care quality, not only as a means of custody.⁴ Leisure is otherwise assumed to contribute to the well-being of preschoolers, since mothers typically spend time with children when not working in the market.

³ As seen in Figure 2 and evident from other data sources, males are predominantly full-time working.

⁴ Supported by observations in data of parents that report availing themselves of non-parental care even if the mother does not participate in the labor market.

Table 1. Classification of jobs and child care arrangements

<i>Mode of care (m)</i>	<i>Weekly working hours / weekly child care hours (j)</i>				
	0	1-16	17-24	25-32	32+
Day care center	$j=1, m=1$	$j=2, m=1$	$j=3, m=1$	$j=4, m=1$	$j=5, m=1$
Other paid care	$j=1, m=2$	$j=2, m=2$	$j=3, m=2$	$j=4, m=2$	$j=5, m=2$
Parental care	$j=1, m=3$	-	-	-	-

As pointed out above, there is a finite number of jobs and child care arrangements within each cell in Table 1, and the female is assumed to choose the job and child care arrangement that maximizes preferences subject to the budget constraint. It follows from our model specification that the probability of choosing a job and child care arrangement of category (jm) depends on the number of jobs and care arrangements offered within this group, relative to the numbers in other groups. In the simulations it is assumed that the relative numbers of feasible opportunities in the various groups in Table 1 remain fixed.

To consider the effects of rationing in the market for care in centers, we employ information from respondents on their access to such care. Mothers that report unsuccessful applications for center-based care have a more limited choice set since they cannot choose care at centers, i.e., the choice opportunities in first line of Table 1 are not available. The effect of ending these queues is discussed below.

Let us briefly present the main features of the model more formally. A more detailed model description can be found in Appendix 1. The discrete choice framework is based on the following: Let $U(C_{kr}, H_k, k, r) = v(H_k, C_{kr}) + \varepsilon_{kr}^*$ denote the utility of choosing job k from a finite choice set B and child care arrangement r from a finite choice set S , where C_{kr} is annual consumption/disposable income corresponding to job k and child care arrangement r and H_k is hours of work in job k for the mother. The stochastic error term takes account of preferences being influenced by non-pecuniary variables, such as quality of care and variables related to job satisfaction. The budget constraint is defined by wage income (w_k times H_k), family income other than the mother's own earnings (I), the price of non-maternal child care (Q_r) and taxes (T):

$C_{kr} = w_k H_k + I - Q_r - T(w_k H_k, I, Q_r)$. The conversion into the categories described by Table 1 utilizes that the utility of the preferred job/care alternative in B_j and S_{jm} (see Table 1) is distributed as follows (Dagsvik, 2001):

$$(1) \quad U_{jm}^* \equiv \max_{k \in B_j, r \in S_{jm}} U(C_{kr}, H_k, k, r) \stackrel{d}{=} \log \left(\sum_{k \in B_j} \sum_{r \in S_{jm}} \exp(v(C_{kr}, H_k)) \right) + \varepsilon_{jm},$$

where ε_{jm} is i.i.d. according to the standard type 1 extreme value distribution, similar to the distribution of $\varepsilon_{kr} \equiv \varepsilon^*(C_{kr}, H_k, k, r)$, and d denotes equality with respect to distribution. We let the working hours within each hours of work group j be represented by median hours of work, and assume that the following approximation is close:

$$(2) \quad \frac{1}{n_{jm}} \sum_{k \in B_j} \sum_{r \in S_{jm}} \exp(v(C_{kr}, H_k)) \approx \exp(v(\tilde{C}_{jm}, \tilde{H}_j))$$

where n_{jm} is the number of opportunities in $B_j \times S_{jm}$, \tilde{H}_j is the median working time in hours of work group j , and \tilde{C}_{jm} is consumption, corresponding to working time, \tilde{H}_j . Thus, this modeling approach captures that the utility of the preferred job/child care arrangement depends on the number of opportunities in each category, as discussed above.). The choice probabilities corresponding to Table 1 are then given by

$$(3) \quad P_{hjm} = \frac{\exp(v(\tilde{C}_{hjm}, \tilde{H}_j, X_h) + \log(n_{jm}/n))}{\exp(v(\tilde{C}_{h13}, \tilde{H}_1, X_h) + \log n_{13}) + \sum_{i=1}^5 \sum_{l \in \Omega_h} \exp(v(\tilde{C}_{hil}, \tilde{H}_i, X_h) + \log n_{il})},$$

where

$$\Omega_h = \begin{cases} (1,2) & \text{if household } h \text{ is constrained in the market for care at centers} \\ (1) & \text{otherwise} \end{cases},$$

and X_h is a taste modifying variable⁵ and n is the base-line value of number of jobs. In other words, P_{hjm} is the probability that household h chooses a job with hours of work in group j and a child care arrangement in mode m . In the following, effects of the family policy changes are reported in

⁵ We employ number of children as taste modifier. Some other candidates were tested but not included in the final specification, as for instance number of preschool children and education level of mothers. They are correlated with other explanatory variables: number of preschool children influences child care expenses and thereby disposable income, while education is a key variable in the wage equation.

terms of changes in these choice probabilities. Kornstad and Thoresen (2006) and Appendix 1 describe in further detail the estimation procedure and the parameter estimates.

Data

Data from the Home Care Allowance Survey 1998 is employed in the estimation and in the simulation of the model, but in the simulations the data are projected to 2003 as described in Section 5. They were collected through postal interviews before the reform, with a response rate at 70 per cent, and include detailed information on families' connection to work, use of child care and composition of income. A number of checks have been carried out in order to assess the representativity of the sample. We find that there is close correspondence between the distribution of variables as mothers' education and age, and the number of children in this sample and a much larger sample of families with preschool children, collected from the 1998-wave of the Income Distribution Survey.

Consumption and hours of work are measured annually, and consumption is defined as disposable family income. Post-tax family income in each state is derived by employing a tax benefit model, e.g., taking into consideration that child care expenditures are deductible, up to a threshold.

In the calculation of disposable income in the various states in the choice set, observations on child care fees and wage rates are needed. Measures of the fees that the parents face in child care centers are derived from the Parental Pay Survey 1998 (Bendiksen and Hovland, 1998). The survey includes measures of the average parental pay in Norwegian counties, in publicly and privately owned centers. As there might be some price differences between centers run by local governments and private owners, the price measures are weighed averages (weighed by market shares). The price measures include rebates for care of the second and third child of the family and price reductions in part-time care. Fees in other paid care alternatives are derived from a survey of childminders' child care production in 2002 (Løyland and Thoresen, 2004), and adjusted to the 1998 level by the consumer price index. There is close correspondence between measures of average prices in other paid care according to this survey and the Home Care Allowance Survey 1998. Thus, the care prices that families in the present analysis face will vary with respect to modes of care (centers and other paid care), and the center-based care price measures reflect families' geographical location and discount schemes with respect to siblings.

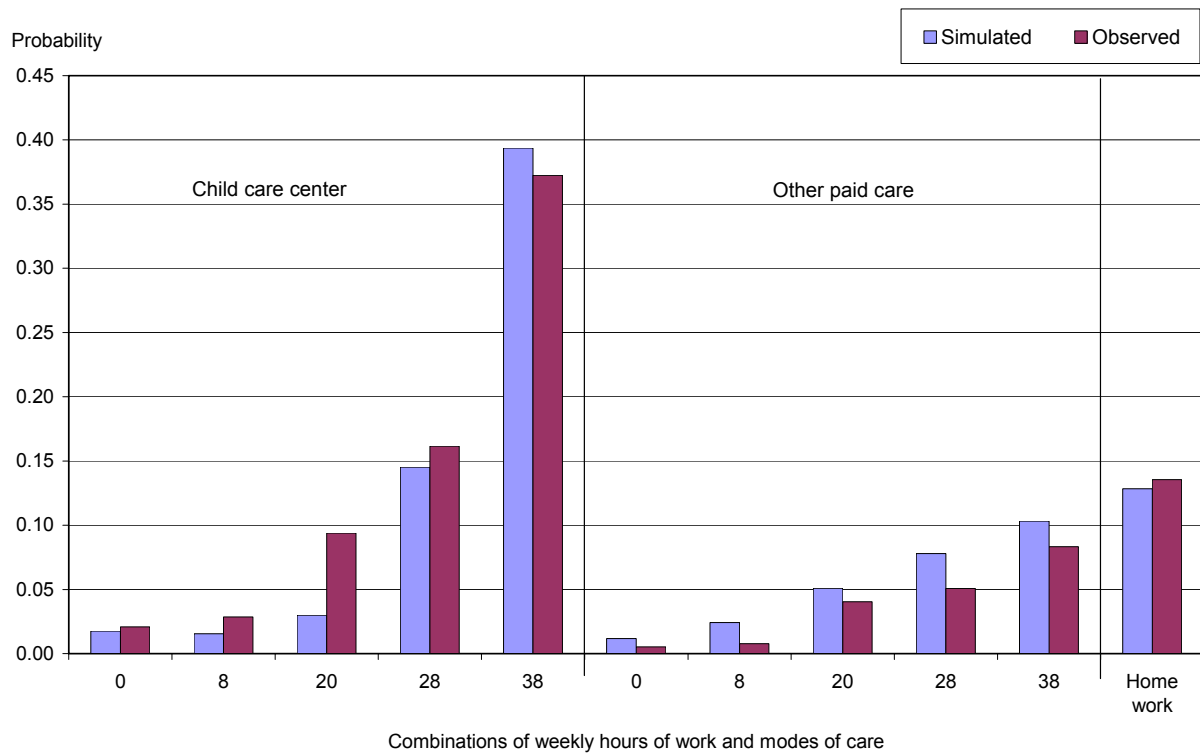
Table 2. Summary statistics for the sample used in the simulations

<i>Variable</i>	<i>Mean</i>	<i>Standard deviation</i>
Household disposable income (NOK)	326,200	89,628
Number of children	2.0	0.98
Mother's weekly hours of work	26.2	13.9
Mother's gross wage rate (NOK)	102.4	17.7
Dummy variable for rationing in the market for care at centers	0.163	0.37
Participation dummy (participation rate)	0.838	0.37
Dummy for part-time work 25-32 hours per week and use of day care center	0.162	0.37
Dummy for full-time work and use of day care center	0.373	0.48
Dummy for work at home and parental care	0.136	0.34

Measures of mothers' wages are derived by estimating a wage equation (with log wage as the dependent variable) using Heckman's (1979) selection model. This equation is applied both for females that do not work as well as for those working. To consider that wages vary across jobs, we make 30 random draws of the error term from the log-normal distribution for each female. Wages are measured by dividing annual labor income by annual hours of work. Table 2 yields summary statistics for the non-projected data. Household disposable income is derived from the families' actual income in 1998.

Figure 2 shows how well the estimated model fits the data by displaying the actual frequencies of the different combinations of working time and child care modes and the corresponding probability distribution based on model simulations. The simulated probabilities are derived by calculating the average probability for each state, based on the individual probabilities from equation (3). Despite the tendency to underestimate the probability of employing care at center for low values of weekly hours of work, the model scores well on this kind of visual evaluation.

Figure 2. The distribution of observed and simulated choices, 11 states. Families with children 1-5 years old



Simulations of effects of policy changes

As discussed by Creedy and Duncan (2002) there exist alternative procedures in order to derive measures of effects of policy changes from simulation models that employ discretized hours. An important issue is how to determine the individuals' hours level positions under the base-line tax-benefit scheme and under an alternative scheme, when information is derived from a probability distribution, as is the case here. One alternative is to let maximum probability determine the individual allocation. Another alternative is to follow a maximum utility rule, as in Aaberge, Dagsvik and Strøm (1995). They employ various drawings based on the stochastic elements of the discrete choice model to establish a choice set. In the present analysis the simulation results are derived by employing the state probability distributions. For each family the probability of choosing a particular combination of labor supply and child care arrangement is predicted under various tax-benefit schemes. Then the mathematical expectation with respect to various variables such as disposable income, hours of work, hours in non-parental care and income taxes can be calculated. Differences in mean expectation values for these measures across households are reported. This procedure is in accordance with the approach seen in Bingley et al. (1995).

4. Measures of distributional effects

Money metric utility

Two measures of individual welfare are applied in the present analysis of the distributional effects: post-tax income and money metric utility. Descriptions of distributional effects in terms of money metric utility are valuable as such measures also reflect households' valuation of leisure, and not only the value of income. King (1983), Aronsson and Palme (1998) and Preston and Walker (1999) are examples of empirical analyses providing information on effects on money metric utility in non-random utility models that are linear in income. Measures of money metric utility in empirical studies based on random utility models that are nonlinear in income have, however, been scarce, as discussed by Herriges and Kling (1999). The reason is that, until recently, an explicit expression for the distribution of equivalent variation (EV) and compensating variation (CV) in this type of models has not been known. However, applications of simulation procedures to calculate CV can be seen in McFadden (1999). The present analysis also provides measures of CV , but we base our calculation on results from a recent paper by Dagsvik and Karlström (2004). According to that paper, one can find explicit formulae for the distribution of CV and EV for rather general random utility models.

In order to specify the concept of CV more precisely, assume that the utility of the preferred job and child care arrangement in cell (jm) in Table 1, corresponding to the (direct) utility function in equation (1) can be given by the following indirect utility function

$$(4) \quad V_{jm} = v_{jm}(W_{jm}, I) + \mu_{jm},$$

where μ_{jm} is an error term that has the same distribution as $\varepsilon^*(C_{kr}, H_k, k, r)$ and $W_{jm} = [w, Q_{jm}]$ is a price vector consisting of the wage rate and the fee in child care group jm . Recall that I is family income other than the mother's income. Then CV is defined implicitly according to

$$(5) \quad \max_{jm} \left(v_{jm}(W_{jm}^0, I^0) + \mu_{jm} \right) = \max_{jm} \left(v_{jm}(W_{jm}^1, I^0 - CV) + \mu_{jm} \right),$$

where superscript 0 denotes initial attributes and superscript 1 denotes attributes after policy interventions. According to this, CV is that value of a tax-free transfer that makes the household as well off under the new regime with prices W_{jm}^1 , as in the initial situation, when it is assumed that the random terms $\{\mu_{jm}\}$ are not affected by the policy change. It follows from the definition in equation

(5) that CV will be negative when prices rise. Appendix 2 provides a more detailed description of the framework.⁶

Income inequality effects

One often sees that public policy actions are evaluated by other principles than those prescribed by the "welfarist" approach, and among economists there are prominent opponents of relying upon "welfarist" measures alone when describing the social good, as for instance Sen (1985) and Musgrave (1990). To extend the informational content of the present analysis we thus assess the effects on post-tax income also. As a matter of fact, distribution of income plays a major part in public policy discussions of policy changes.

The effects of policy changes on income can be decomposed into two sources: Firstly, the reforms affect household incomes in a direct way, which refers to the effect on disposable income before behavioral adjustments. Secondly, alterations in the tax-benefit system make the mothers adjust behavior both with respect to labor supply and the choice of child care alternatives. In the following these two effects are added into a total effect on income and income inequality, calculated by choice model simulation results.

Social ranking

Empirical measurement of distributional effects of reforms involves a number of methodological issues. One key issue is how households are ranked initially, or what defines the initial household welfare levels. In accordance with descriptions of reforms we base the social ranking of households on equivalent post-tax income. This measure is obtained by aggregating expected disposable income over all household members in each state, dividing it by an equivalence scale, and letting each person in the household be represented by household equivalent post-tax income. The equivalence scale we adopt is defined by the square root of number of household members (Buhmann et al., 1988).

However, any description of individual rankings with respect to well-being is questionable. Future analyses should explore interpretations and results when employing more comprehensive measures of welfare for the ranking of individuals, i.e., measures that include the contribution from leisure to welfare, which the approach here renders possible. Such analyses could also preferably go into further detail on comparability and aggregation issues of applied welfare analysis, as seen in e.g., King (1983); Preston and Walker (1999); Creedy and Duncan (2002).

⁶ Confer also Dagsvik and Karlström (2004) where explicit formulae for the distribution of CV are presented.

5. Effects of family policy reforms

Base-line system

Let us see how the decision model presented in Section 3 can be employed to describe the effects of various work stimulating reforms. The simulations are carried out for the same sample of households as included in the estimation of the model: married or cohabiting females with at least one child 1–5 years old.

Let us first emphasize that there are "general equilibrium" effects not taken into account. The policy changes we are studying are by no means neutral with respect to net effect on state budgets, as will be evident soon. To the extent that increased costs are financed by increased tax burdens on other families not affected directly by the reform, there will be additional labor supply effects and distributional effects not considered in this analysis.

The year 2003 tax and transfer system serves as a reference or base-line when studying the effects of the proposed policy changes. Thus, we project the data from the year of data collection, 1998, to 2003. The projection means that all income components and the female wage rates adjusted to 2003 levels by the wage growth in the period, that the prices of non-parental care are adjusted according to information on price changes in the period, and that the families are taxed according to the 2003 tax-law. The home care allowance was increased from NOK3,000 (\$424)⁷ to NOK3,657 (\$516) per month from 1st of August 2003, and a weighted average is employed when calculating yearly transfers of this benefit. With respect to rationing in the market for care at centers, it is assumed that those families that report being constrained in 1998 still are constrained in 2003.

Increasing the number of spaces at child care centers, the abolition of queues

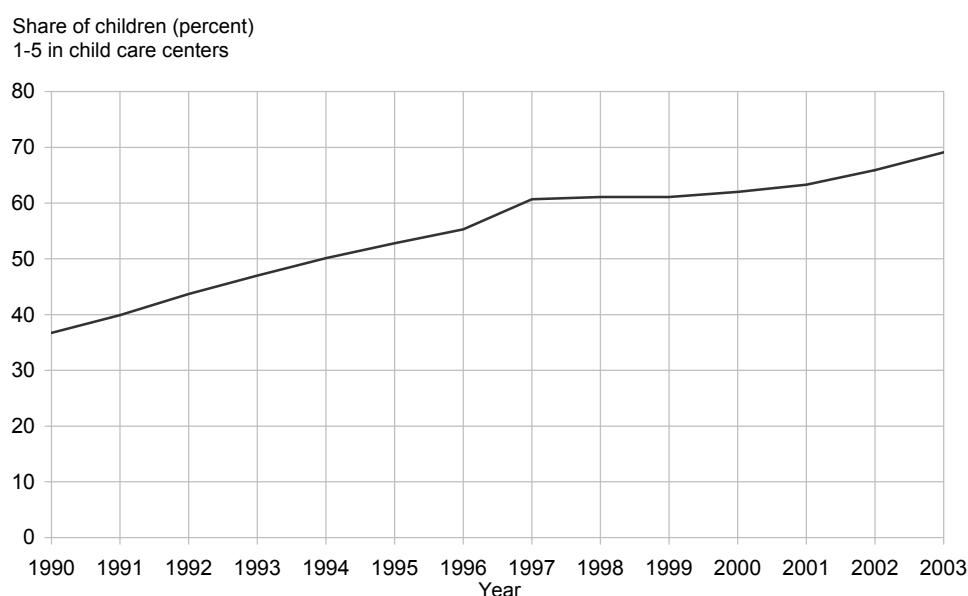
Norwegian politicians have shown a remarkable willingness to introduce new family policy reforms the last decade. The latest effort is the so-called "child care compromise", approved by the Parliament in spring 2003 (Innst. S. nr. 250, 2002-2003). The agreement implies a substantial reduction in child care fees, introducing maximum monthly parental pay at NOK1,500 (\$212), combined with a termination of queues at child care centers. In the following we first discuss the effects of increasing the number of spaces at child care centers, and then next, assess the effects of the suggested fee reductions.

The number of places at child care centers has increased substantially during the 1990s, as shown in Figure 2. Whereas less than 40 percent of 1–5-year-old children attended child care

⁷ The conversion into U.S. dollars is based on average exchange rates for 2003, which implies that \$1≈NOK7.08.

centers in the beginning of the 1990's, more than 69 percent of them did so in 2003.⁸ Nevertheless, demand still exceeds supply in the sense that there are waiting lists in many municipalities, at current price levels, which induced the "child care compromise". In our data from 1998 about 16 percent of the parents reported that they had applied for care at centers without success⁹, and, as noted above, this share also represents the degree of rationing in the child care market in 2003, even if the number of places has been somewhat increased from 1998 to 2003, cf. Figure 2.

Figure 2. The child care center attendance ratio in percent, 1990–2003, preschool children aged 1–5



Widening of choice sets for constrained mothers would most likely have significant effects on female labor supply, as discussed by Del Boca (2002). This is confirmed by the results presented in Figure 3. As expected, this change moves people from non-work and other paid care alternatives to center-based care. For instance, it is predicted that the probability for the full-time/child care center combination increases from about 31 percent to about 37 percent, whereas the parental care probability is reduced, from about 15 to about 13 percent. However, some parents choose other paid care alternatives both before and after this reform. There might be several reasons for this, for instance that the home care allowance is still in work, see more detailed descriptions of the home care

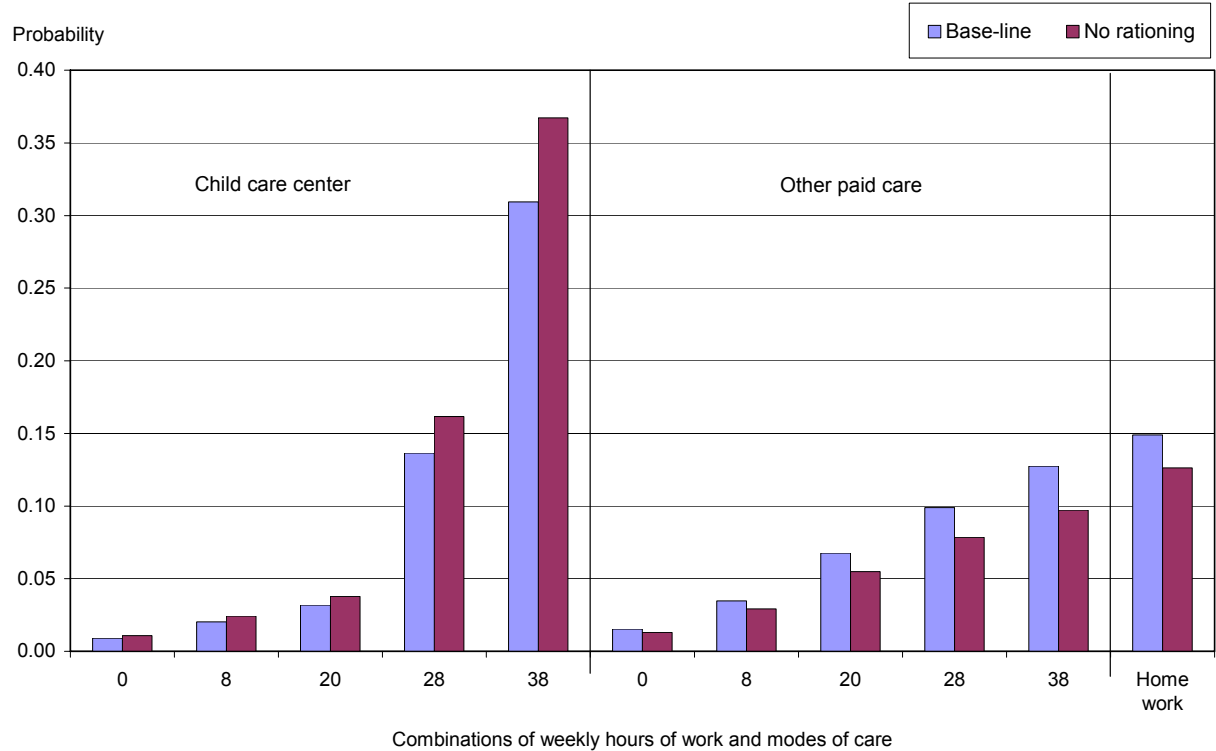
⁸ Includes all state subsidized care, including care for smaller groups of children in the home of a child or in the home of a care provider.

⁹ The precise meaning of this might be somewhat dubious: Our data do not provide information on to what extent parents report being constrained in the market for care in centers because they do not get access to their preferred center while having access to another center.

allowance below. In total, expected hours of work for this group of females increases by approximately 4 percent, or about one hour per week on average. Since married or cohabiting mothers of preschoolers delivered about 90,000 man-years under the pre-reform conditions, 4 percent increase in labor supply for this group corresponds to a growth of about 3,500 man-years.

Information on distributional effects with respect to all four family policy reforms are summarized in Figure 4, by presenting average measures of effects across quintiles with respect to various characteristics. The figure shows distributional effects with respect to two measures of well-being, change in post-tax income and *CV*, both weighed by the equivalence scale to control for family size. The distribution of changes in mothers' labor supply and changes in families' use of child care centers are also shown.

Figure 3. Probabilities in base-line system compared to probabilities in a non-rationing situation



We see that the effect of child care availability improvements are rather dissimilarly described by the two measures of well-being: change in equivalent post-tax income and *CV*. With respect to the change in post-tax income, Figure 4 shows that ending queues has had small effect. The reason is that the reform has moderate effects on working hours, while a larger share of families employ center-based care, which is a little more expensive than other paid care alternatives. Quintile 1

benefits most according to change in equivalent post-tax income,¹⁰ and the somewhat stronger labor supply effects at the low end of the income distribution contributes to this,¹¹ cf. the distribution of changes in mothers' working hours in Figure 4.

Estimates of CV reflect the gain in utility from the improved access to center-based care, which enables families to switch from other paid care alternatives and care at home to care at centers. We see that the distribution of gains in terms of CV follows relatively closely the change in hours of care at centers.

As pointed out in the introduction, an advantage of the simulation approach used here is that it allows us to calculate the net costs of reform proposals. For instance, the simulations provide us with estimates of expected income taxes and expected transfers for the families used in the simulations, and combined with additional information on the share of the population used in the simulations, we can predict figures at the national level. Abolition of queues in the market for care in day care centers requires new investments in order to establish new centers. In the estimation of the costs of this reform we focus on the operational costs only, which means that set up costs are neglected. We also focus on the central government part of these expenses, i.e., the state subsidies. According to official planning documents (The Ministry of Children and Family Affairs, 2003), the subsidy costs will reach NOK7.6 billion (\$1.1 billion) in 2003.¹² Tentative measures of the expenditure growth from abolishing queues indicate that costs will increase by about NOK1.1 billion (\$155 million). In the calculation of this figure it is assumed that the costs are proportional to total expected hours in day care centers. Note also that whereas 16 percent reported that they were rationed in the initial situation, post-reform choice probabilities are in correspondence with approximately all these mothers entering this mode of care.

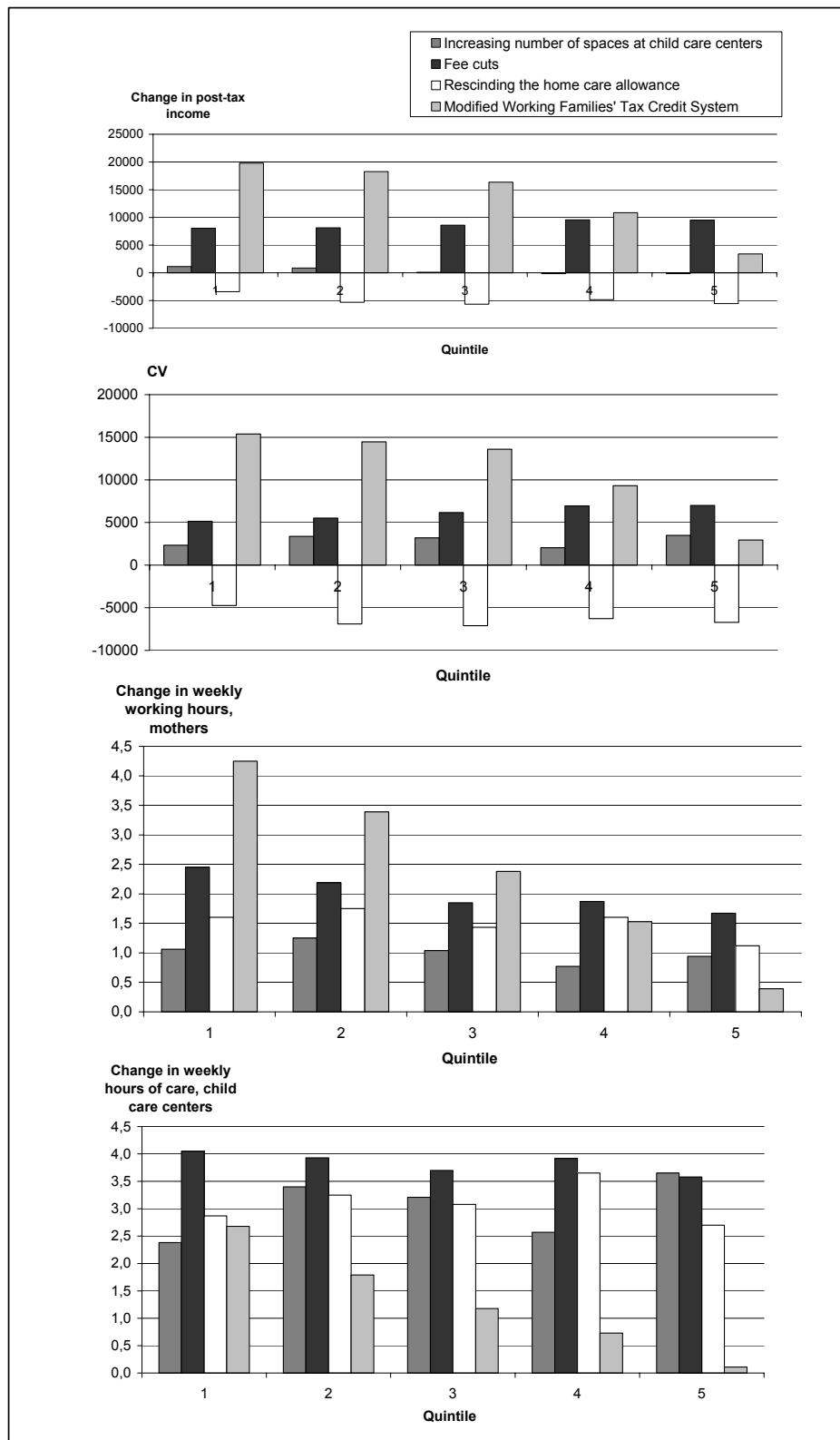
The tax base widening that follows from the increase in labor supply impacts on tax revenues. Tax revenues increase by about 1.5 percent, and recalculated to national figures this means that about NOK340 million (\$50 million) of the initial 1.1 billion (\$155 million) is returned to the Treasury. The net costs of abolishing queues in the market for care at centers are then about NOK760 million (\$100 million). Hence, approximately one-third of the increase in the operational costs in centers is returned in terms of increased income taxes.

¹⁰ Since many aggregate measures of inequality, as the Gini coefficient, is invariant with respect to proportional changes in incomes, the distribution of gains of abolishing queues in terms of equivalent income in Figure 4 implies a reduction in overall inequality.

¹¹ Recall that the ranking of households is based on expected values of equivalent income.

¹² However, note that this measure includes costs of initial steps, already taken, to reduce prices at child care centers.

Figure 4. Summary of distributional effects



Rate cuts

As noted above, the "child care compromise" also implies that parental fees at child care centers will be substantially reduced. A system of maximum prices, similar to the Swedish system, was introduced in 2004 and will be further developed in the years to come. When the reform is fully established, the fee for full-time care in day care centers will not exceed NOK1,500 (\$212) per month per child.¹³ In contrast, parents paid NOK2,800 (\$395) per month on average for full-time care in centers run by local authorities in August 2003 (Eibak, 2003).¹⁴ The compromise is less precise with respect to what extent the scheme will include discounts for siblings and part-time care. In the following we assume that fees are NOK1,200 (\$169) for the second child, whereas the maximum fee is set at NOK900 (\$127) for the third child. In order to let expenses vary with respect to working hours/opening hours at centers (cf. Table 1) the cost of 25–32 hours of weekly care is set equal to 75 percent of the full-time rate, while the fees for 17–24 hours and for 1–16 hours of care per week are scaled down to 50 percent and 25 percent of the full-time rate, respectively.

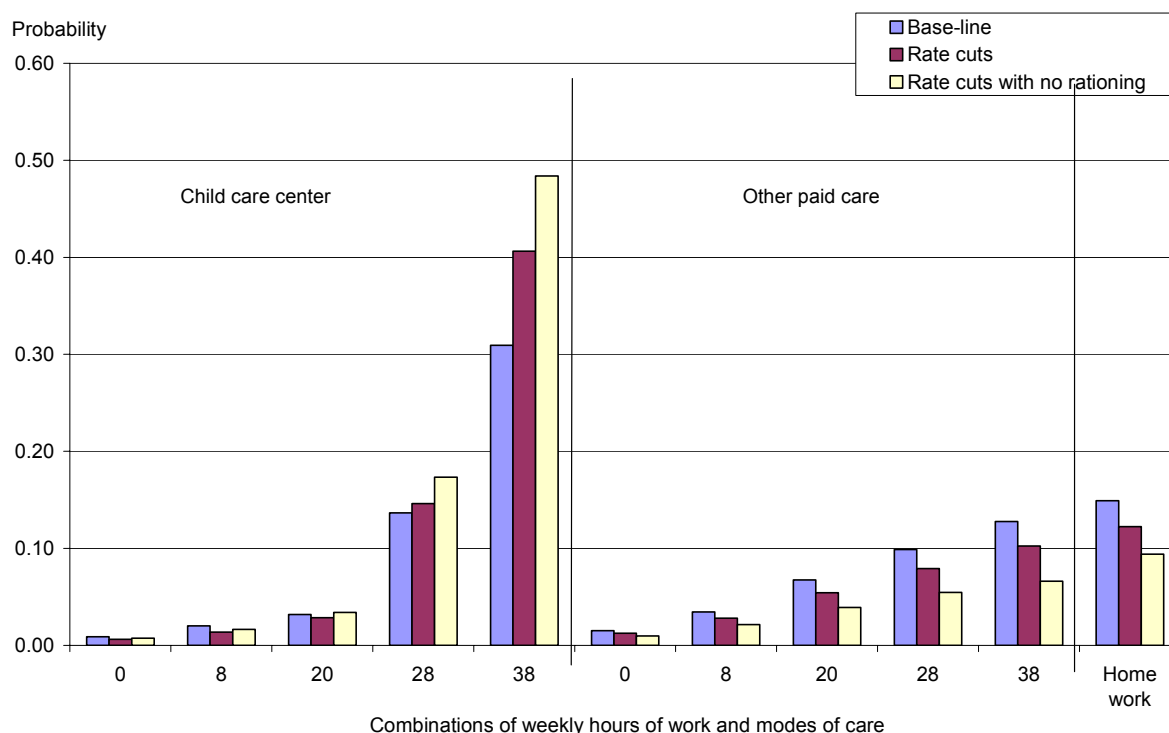
The reduction in prices will increase demand for center-based care, and it might be unrealistic allowing mothers to choose freely under the prevailing conditions in the market for care at centers, cf. the discussion of capacity problems above. Under the assumption that the degree of rationing is at the same level as in the reference system, we expect that the depicted rate cuts will induce changes as described in Figure 5. The probability for parental care/home work is reduced, and the use of full-time work/child care center increases substantially. In total, labor supply increases by about two hours per week on average, or about 8 percent. This corresponds to an increase of about 7,000 man-years.

Figure 5 also shows the probabilities for an alternative where the rate cut is combined with a no-rationing assumption, thus, simulating the total effect of the "child care compromise". We see that the behavioral effects are substantially stronger when removing the rationing constraint. Now the overall effect on hours of work is that the labor supply increases by about 13 percent, or approximately 12,000 man-years.

¹³ The future inflation regulated maximum fee is set to NOK1,750. Here (in 2003) we employ the NOK1,500 rate.

¹⁴ Fees at privately owned centers are usually somewhat above that.

Figure 5. Probabilities in base-line system compared to probabilities when maximum fees at child care centers are set at NOK1,500 (\$212)



The distributional effects of fee reductions in the case of unchanged rationing are shown in Figure 4. The changes in equivalent income and equivalent CV both reflect the direct effects of the fee reductions (before behavioral adjustments) and the changes in behavior (indirect effects). The distributional gains reflect that the indirect effects through working hours responses and changes in the use of child care centers are larger at the low end of the income distribution, while the direct effects are more significant among high-income families, as there is a positive relationship between income and use of center-based child care in the pre-reform situation. The distributional gains in terms of money metric utility and in post-tax income are rather similar, as both measures indicate that the gains are larger for high-income families than for families with lower incomes. The increase in post-tax income is somewhat larger than the measure of CV , as the latter welfare measure includes the disutility of losing leisure/time with children, when working hours increase.

With respect to the effect of fee cuts, the overall impression is that the distribution of CV in Figure A4-1 is rather similar to the description of CV in Figure 4. However, the difference between Quintile 1 and Quintile 5 is less in Figure A4-1.

According to official planning documents (Innst. S. nr. 250), total costs of the child care compromise are approximately NOK3.15 billion (\$440 million). As described above, estimated costs of ending queues when fees are unchanged are NOK1.1 billion (\$155 million), which implies that rate

reductions costs amount to approximately NOK2 billion (\$280 million). This figure reflects both the 8 percent rise in the demand for care in centers and the direct effect of reduced fees (for unaltered demand). Moreover, we find that tax revenues will increase by about NOK740 million (\$100 million), due to the widening of the tax base that follows from increased female labor supply. The net effect on state budgets of rate cuts is then about NOK1.250 billion (\$180 million).

Rescinding the home care allowance

It is fair to say that one of the most debated political issues in Norway in the last decade was the introduction of the home care allowance in 1998. This scheme gives parents of preschool children aged 1–2 a tax free transfer in cash, depending on utilization of public or private day care centers: non-users are eligible to a benefit of NOK36,000 (NOK43,884 from 1st of August 2003) or about 5,000 US dollars a year per child, while provisions are scaled down to nil for users of full-time center-based care.¹⁵ Families using child care centers are supported by the subsidized services, while the home care allowance implies that families whose children do not attend child care centers, receive a transfer in cash, which they in turn can use to pay a childminder, an au pair or to finance own care. The reform thus strengthens the incentives to provide care at home for young preschoolers or to let the children be taken care of by childminders.

The decision to introduce a transfer system that amplifies incentives for parents to care for children at home questions the simplified representation of the targets for public policy inherent in the present analysis, and indicates that policy makers might trade labor supply effects against other objectives. Regarding the home care allowance reform, it was apparent that the "equality of support" – the horizontal equity argument – was an important motivation. There might also be externalities in the parents' time use that the policy makers want to correct for,¹⁶ for instance that the allocation of time between market activities and time spent on children impacts on child development and consequently the productivity of future generations of workers (Kennedy and Welling 1997). The child development literature often refers to cognitive and emotional competence of the child, cf. e.g. Andersson (1992), and one cannot disregard that these aspects might be differently affected by parents' and others' care (Baum 2003).

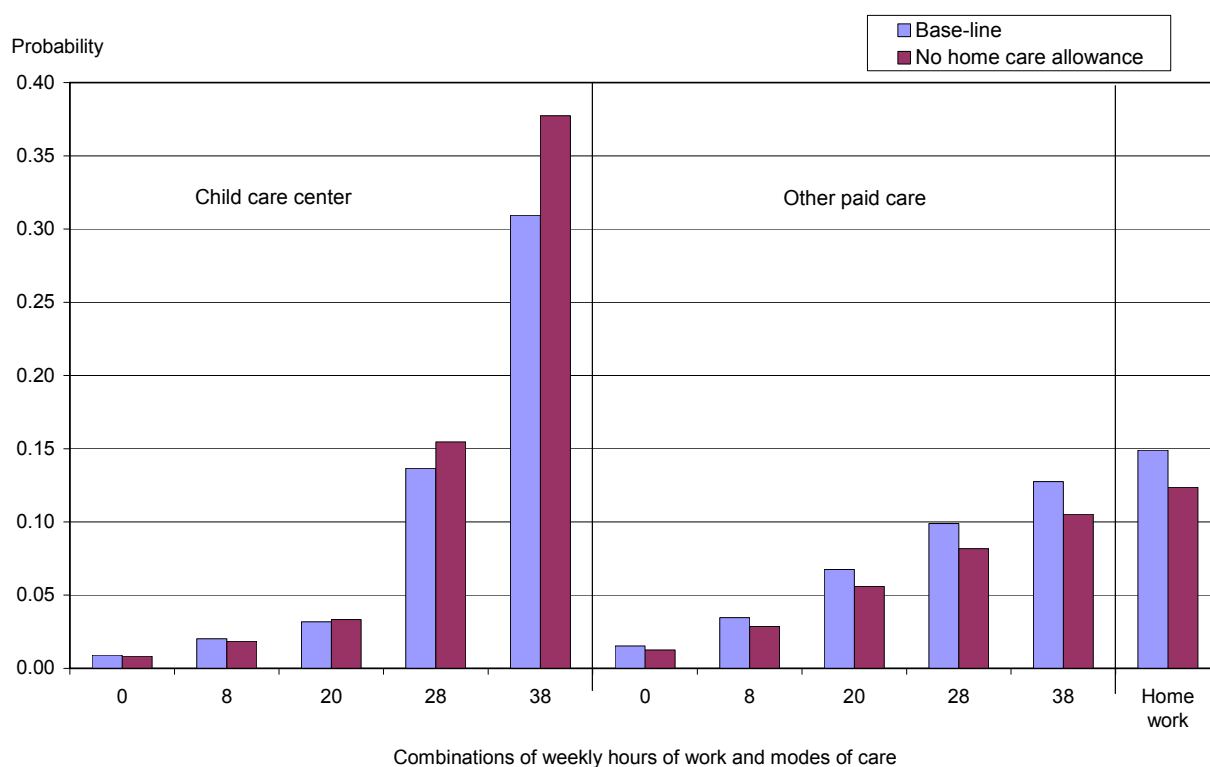
Reversing reforms is rarely appreciated, and reversing this one would doubtlessly meet with substantial resistance. One advantage of this policy change is, however, that it bears the promise

¹⁵ The term "home care allowance" is in accordance with the terminology used in Ilmakunnas (1997). However, the transfer could also be characterized as an "out-of-child-care-center allowance". Some, as Naz (2004) and Schöne (2004), refer to the reform as the "cash-for-care subsidy".

¹⁶ Some would argue that this is already taken care of by the tax system, i.e. the asymmetry in that income is taxed and leisure not.

of simultaneously stimulating the labor supply and reducing costs. According to our simulations, the allowance would cost about NOK2.8 billion (\$400 million) in 2003.¹⁷ In addition; we predict tax base expansions through labor supply responses, cf. Figure 6. The figure shows, for instance, that the probability of combining full-time work and center-based care will increase from about 31 percent to 38 percent. In total, the mothers will increase their labor supply by 1.5 hours per week, or about 6 percent. The increased labor supply means that tax revenues increase by 2.4 percent, or about NOK530 mill. (\$75 million). Demand for care at centers is also increased (19 percent), and this will cost about NOK1.4 billion. (\$200 million) in terms of increased state subsidies. Rescinding the home care allowance reform will therefore have positive effect on the budget balance, a net effect of about NOK1.9 billion (\$270 million), according to our estimates.

Figure 6. Probabilities in base-line system compared to probabilities when the home care allowance reform is rescinded



There is a mixture of factors that contribute to the distributional effects of putting an end to the home care allowance. Note that since this reform involves a transfer from individuals to the Treasury, the measures of effects on well-being (change in post-tax income and *CV*) are negative,

¹⁷ According to the Ministry of Children and Family Affairs (2004), the allowance cost about NOK3.0 billion (\$0.42 billion) in 2003. However, note that transfers to single parents are included in this measure, while our figures do not.

which reflects that families need to be compensated in order to be equally well-off in the situation with no home care allowance. As households with children aged 1–2 are eligible only, results are affected by the composition of incomes among these families and the others. Moreover, the changes in the measures of well-being both reflect the actual loss of the transfer (direct effect) and the behavioral adjustments. As described by Håkonsen et al. (2001), the female labor supply adjustments will counteract the first, direct effect. Figure 4 shows that the losses are rather equally distributed, but average losses are lowest in the lowest quintile.

The distribution of the utility losses follows relatively closely the effects with respect to post-tax income, but estimates of CV show higher values. Rescinding the home care allowance reduces households' standard of living, but to reduce the fall in consumption of goods, households increase their labor supply, which means a loss of leisure/time with children. The latter effects are reflected by the measure of CV , while the disutility of leisure losses are not reflected by the post-tax income measure.

A modified Working Families' Tax Credit system

The work stimulation problem we address here is related to the motivation behind various tax system arrangements in other countries, such as the Working Families' Tax Credit (WFTC) in the U.K. and the Earned Income Tax Credit in the U.S.¹⁸ These systems aim at promoting employment among low-income families without creating adverse work incentives (Blundell 2000).

In what follows, we specify and assess the effects of a Norwegian variant of the WFTC, as the WFTC was structured before it was subsumed within the child tax credit and the working tax credit from April 2003 (Brewer, 2003). To qualify for WFTC a number of criteria have to be fulfilled. Among them, we note that at least one of the parents must be working 16 hours per week or more and the family must include at least one child under 16.¹⁹ Since the focus here is on stimulating female labor supply, we let the tax credit eligibility depend on mothers' labor supply only (and not on family labor supply as in the U.K. system). Thus, we assume that the family is eligible for the credit if the mother works more than 16 hours per week.

The WFTC consists of four components: A basic credit (£53.15 per week in 2000–01) that commences at 16 hours of work per week; an additional credit (£11.25 per week) if at least one of the spouses works 30 hours or more a week; a child credit for each child within the family and, finally;

¹⁸ See e.g., Blundell et al. (2000) and Eissa and Hoynes (2004) for recent empirical analyses of effects of these arrangements in the U.K. and the U.S., respectively.

¹⁹ If the child is in full-time education up to A-level or equivalent standard, the age limit is under 19.

a child care tax credit if both parents work for at least 16 hours per week. The credit is tested against net family income adjusted for capital, with an income taper rate of 55 percent.²⁰

The Norwegian tax system already includes a child benefit and a child care income deduction scheme, and this part of the tax system is assumed unchanged in the following. Regarding the basic credit and the 30-hours credit in the WFTC, we adopt a similar specification. It is assumed that the family is entitled to NOK30,000 (\$4,237) per year if the female works at least 17 hours per week (the basic credit). If she works more than 24 hours per week ($m=3$ or $m=4$ in Table 1), the family also qualifies for an additional credit of NOK20,000 (\$2,824) per year. Similar to the WFTC the credit is tested against net family income. The taper is set at 25 percent for income above NOK400,000 (\$56,500).

Figure 7. Probabilities in a base-line system compared to probabilities under a modified Working Families' Tax Credit system (U.K.)

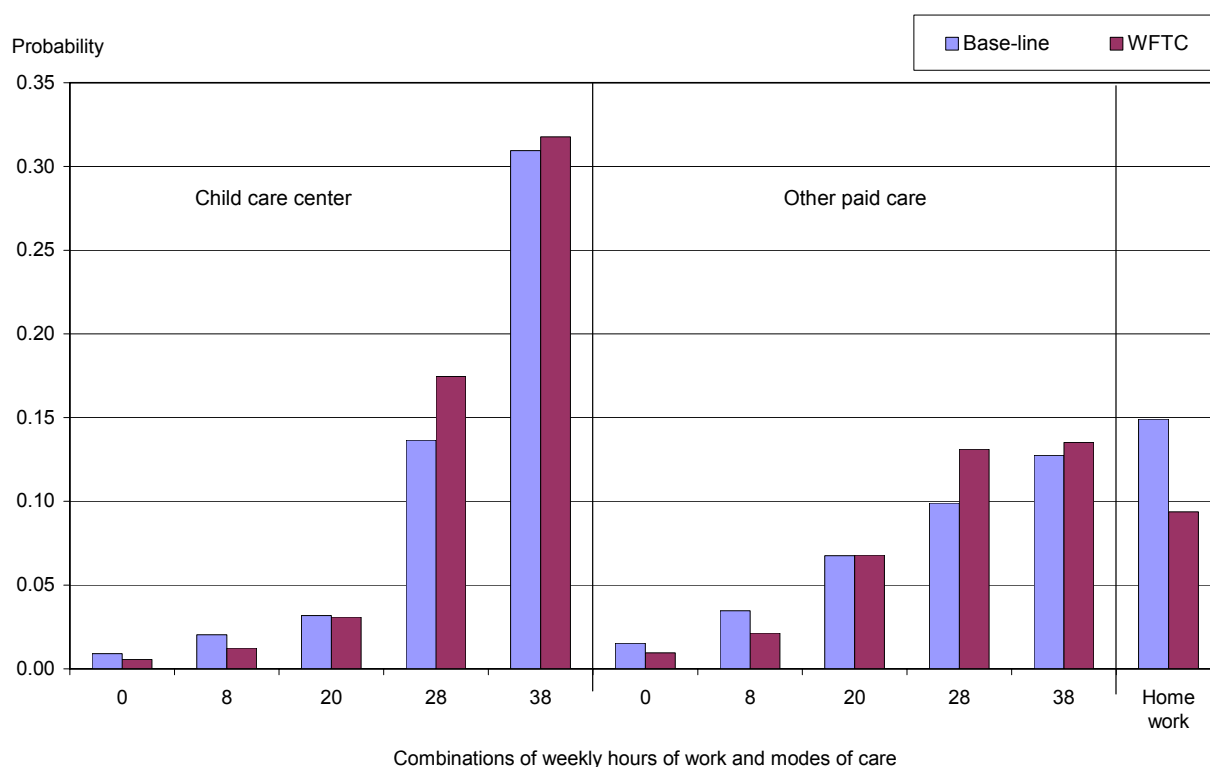


Figure 7 displays the effects on labor supply and choice of child care arrangement of this policy change. We note that the tax credit scheme has strong effects on participation, as the probability

²⁰ An alternative to the standard deductions in the Norwegian tax system, the so-called wage deduction, introduced in 2000, shares some similarities with the ideas behind the Working Families' Tax Credit and the Earned Income Tax Credit as it phases out with respect to income. However, the wage deduction is of minor importance in the Norwegian tax system.

for the parental care/home work alternative is substantially reduced. Encouraging labor supply participation by introducing a benefit that is conditioned on working time, then seems to work according to our simulation results.

The probabilities of working large part-time fractions have increased according to the figure, whereas the probability of working full-time is less influenced, which is due to the income testing feature of the reform. In total, we expect that mothers' hours of work will increase by about 9 percent. Revenue from income taxes is expected to rise by about 2.9 percent, or by about NOK650 million (\$90 million). This reform also increases expected hours of care in centers by about 8 percent. Assuming that the state subsidies are increased correspondingly, the reform increases subsidies by about NOK600 million (\$85 million). We estimate that the direct costs of the working family tax credit are about NOK4.5 billion. Thus, total net costs of this reform are NOK4.55 billion (\$0.64 billion).

The distributional effects of introducing a Norwegian WFTC are very advantageous, both described by post-tax income and CV , as seen in Figure 4. High-income families are less affected by this reform, as the transfer is tested against family income, while the benefits for lower income deciles are substantial. The effects on incomes for low-income families both come from direct effects of the subsidy and from females working longer hours. We see that in particular the lowest income groups have large labor supply responses, and this effect contributes to our finding that the change in post-tax income is larger than CV for these income groups. The distribution of CV across income quintiles is rather similar to the distribution of the change in post-tax income.

6. Summary

The trend towards population ageing is seen as an important policy challenge in many developed countries. In this paper we focus on means to increase the labor supply of married mothers with preschool children in order to meet the likely increased demand for labor that this will bring about. Relying on a microsimulation approach, based on a discrete choice joint labor supply and child care choice model, we have assessed the effects on labor supply of mothers of preschool children of various policy changes. In addition, effects on child care choices, distributional effects and consequences for public spending are described. A special novelty of this analysis is that it presents measures of compensating variation of reforms, when choices are based on a random utility model that is nonlinear in income.

Evaluations of new policy reforms depend on their effects on numerous characteristics. Table 2 provides a condensed account of some relevant information for the decision makers, in order

to compare effects of the reforms. With respect to descriptions of the distributional effects, effects of changes that distribute equally (in absolute terms) across quintiles are labeled "no effect".

Among the alternatives considered here rescinding the home care allowance is the only reform that means reduced financial expenditures. This reform increases labor supply and has (weak) positive distributional effects. However, the horizontal equity argument of "equal support" across choices of child care was emphasized when this transfer was introduced, and, moreover, there might be "quality of care" arguments for supporting care by parents, as is the case with the home care allowance. These effects are not represented in Table 2, but both they and other possible arguments in the social welfare function can be weighed against the information presented in Table 2.

Table 2. Summary of effects of various family policy reforms

<i>Reform</i>	<i>Total revenue costs</i> <i>Billion</i> <i>NOK(NOK≈\$0.14)</i>	<i>Increased labor</i> <i>supply, mothers</i> <i>Percent</i>	<i>Increased</i> <i>demand for</i> <i>center-based care</i> <i>Percent</i>	<i>Distributional</i> <i>effects</i>
Abolishing queues	0.76	4.0	18.6	No effect
Rate cuts	1.25	7.8	23.4	Weak negative
Rescinding the home care allowance	-1.89	5.9	7.2	Weak positive
Modified WFTC	4.55	9.3	7.9	Strong positive

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A more detailed exposition of the decision model

The following description of the labor supply model is based on Kornstad and Thoresen (2006). The model is a family decision model, where choices are made with respect to female labor supply, whereas male labor supply decisions are given. In its determination of hours of work and child care arrangement the household chooses a job for the mother from a finite choice set B and child care alternatives from a finite choice set S . The preferences over jobs and child care arrangements are given by

$$(A1-1) \quad U(H_k, C_{kr}, k, r) = v(H_k, C_{kr}) + \varepsilon^*(H_k, C_{kr}, k, r), \quad k \in B, \quad r \in S,$$

where the deterministic part of preferences is given by

$$(A1-2) \quad v(H_k, C_{kr}) \equiv \gamma_0 \frac{C_{kr}^{\alpha_1} - 1}{\alpha_1} + \frac{\left(1 - \frac{H_k}{M}\right)^{\alpha_2} - 1}{\alpha_2} X\beta.$$

Here H_k is female hours of work in job k , C_{kr} is total family consumption of goods corresponding to job k and child care arrangement r , $M = 8760$ is the total number of annual hours, X is a vector of household characteristics, and γ_0 , α_1 , α_2 and β are parameters. The analysis assumes a "fixed link" (Ilmakunnas 1997) between hours of work and hours in care for working mothers, but this is suppressed in the notation.

The consumption corresponding to job k and child care arrangement r is given by the budget constraint

$$(A1-3) \quad C_{kr} = wH_k + I - Q_r - T(wH_k, I, Q_r),$$

where I is (exogenous) family income except for the mother's own wage earnings, Q_r is the price of child care in choice r and T is the tax function. The wage rate (w) is assumed to be person-specific, but independent of hours of work. To take into account that wage rates vary across jobs, we let each person face a wage distribution consisting of 30 wage rates, established by making drawings of the wage rate equation error term.

To consider the effects of latent variables influencing preferences, we introduce stochastic error terms, $\varepsilon_{kr}^* \equiv \varepsilon^*(C_{kr}, H_k, k, r)$, in the specification of preferences. These are assumed to be i.i.d. according to the standard type I extreme value distribution,

$$(A1-4) \quad P(\varepsilon_{kr}^* < x) = \exp(-\exp(-x)), \quad x \in R.$$

All jobs and child care arrangements are classified into combinations as described by Table 1 above. Let B_j be the choice set of jobs with hours of work in interval j and S_{jm} be the choice set of child care arrangements of type m with opening hours in interval j . It can be demonstrated that (A1-1) and (A1-4) imply that

$$(A1-5) \quad U_{jm}^* \equiv \max_{k \in B_j, r \in S_{jm}} U(H_k, C_{kr}, k, r) \stackrel{d}{=} \log \left(\sum_{k \in B_j} \sum_{r \in S_{jm}} \exp(v(H_k, C_{kr})) \right) + \varepsilon_{jm},$$

where d denotes equality with respect to distribution, and ε_{jm} is an error term with the same distributional property as $\varepsilon^*(H_k, C_{kr}, k, r)$. Moreover, we assume that the following approximation is close:

$$(A1-6) \quad \frac{1}{n_{jm}} \sum_{k \in B_j} \sum_{r \in S_{jm}} \exp(v(H_k, C_{kr})) \approx \exp(v(\tilde{H}_j, \tilde{C}_{jm})),$$

where n_{jm} is the number of opportunities in $B_j \times S_{jm}$, \tilde{H}_j is the average working time in hours of work group j , and \tilde{C}_{jm} is consumption, corresponding to working time, \tilde{H}_j , and the price of non-parental care, Q_{jm} .

Substituting (A1-6) into equation (A1-5), gives

$$(A1-7) \quad U_{jm}^* = \log n_{jm} + v(\tilde{H}_j, \tilde{C}_{jm}) + \varepsilon_{jm},$$

where we recall that the residuals, ε_{jm} , are independently and identically distributed with the type I extreme value distribution. Hence, (A1-7) can be seen as a particular specification of the utility function applied in McFadden's conditional logit model, see Maddala (1983). Before we present the

specification of the likelihood function, some further comments regarding the model specifications are required.

A majority of places at day care centers are full-time places. Similarly, there might be more full-time jobs than part-time jobs, not least due to economies of scale in production. By allowing varying numbers of alternatives across groups, these market features are considered in the estimation. We assume that the number of possibilities within the groups long part-time work/child care center ($j = 4, m = 1$), full-time work/child care center ($j = 5, m = 1$) and not working/parental care ($j = 1, m = 3$) differ relative to the other states. For the other states, the number of possibilities is normalized to one.

In the estimation information from respondents on their access to care at centers is employed. Mothers that report unsuccessful applications for center-based care (about 16 per cent of all mothers in the sample) have a more limited choice set, since we assume that they are effectively denied access to care at centers ($m = 1$). The choice probabilities corresponding to Table 1, are then given by

$$(A1-8) \quad P_{hjm} = \frac{\exp\left(v\left(\tilde{C}_{hjm}, \tilde{H}_j, X_h\right) + \log\left(n_{jm}/n\right)\right)}{\exp\left(v\left(\tilde{C}_{h13}, \tilde{H}_1, X_h\right) + \log n_{13}\right) + \sum_{i=1}^5 \sum_{l \in \Omega_h} \exp\left(v\left(\tilde{C}_{hil}, \tilde{H}_i, X_h\right) + \log n_{il}\right)},$$

where

$$(A1-9) \quad \Omega_h = \begin{cases} (1,2) & \text{if household } h \text{ is constrained in the market for care at centers} \\ (1) & \text{otherwise} \end{cases}.$$

where X_h is the number of children below 19 years of age in household h . In other words, P_{hjm} is the probability that household h chooses a job with hours of work in group j and a child care arrangement in mode m .

Table A1-1 shows the parameter estimates. One outcome of estimations has influenced the final specification of the model: Estimation results show that there is virtually no difference between possibilities in the combinations full-time work/child care center (n_{51}) and not working/parental care (n_{13}). Thus, we constrain these two parameters to be identical.

Table A1-1. Estimates of the parameters in the utility function

<i>Variables</i>		<i>Parameters</i>	<i>Estimates</i>	<i>t-statistic</i>
Consumption	Constant	γ_0	0.503	2.0
	Exponent	α_1	0.847	5.9
Leisure	Intercept	β_0	-0.833	1.6
	Number of children	β_1	1.198	2.0
	Exponent	α_2	-8.265	3.0
Long part-time work/child care center opportunity index		$\log n_{4l}$	1.224	9.6
Full-time work/child care center opportunity index, home work opportunity index		$\log n_{5l} = \log n_{13}$	1.985	17.3
Number of observations			768	
McFadden's ρ^2			0.318	

Calculating compensating variation

This appendix shows the calculation of compensating variation in our random utility model that is non-linear in income.

Let

$$(A2-1) \quad V_{jm} = v_{jm}(W_{jm}, I) + \mu_{jm}, \quad jm \in A$$

be the indirect utility function corresponding to the (direct) utility function (1), where $W_{jm} = [w, Q_{jm}]$ is the price vector of the preferred job in hours of work interval j and the preferred child care arrangement of type m (see Table 1), I is exogenous non-labor income for the female and A is the choice set of jobs and child care arrangements defined in Table 1. It follows from our model specifications presented above that the error term μ_{jm} is i.i.d. according to the extreme value distribution of type I (see equation A1–4).

We define compensating variation (CV) implicitly by

$$(A2-2) \quad \max_{jm \in B} (v_{jm}(W_{jm}^0, I^0) + \mu_{jm}) = \max_{jm \in B} (v_{jm}(W_{jm}^1, I^0 - CV) + \mu_{jm}),$$

where superscript 0 denotes initial attributes and superscript 1 denotes attributes after policy interventions. Thus, CV is that value of a tax free transfer that makes the household as well off under the reference tax and transfer system with prices W_{jm}^0 and taxable and exogenous household income I^0 as it would be under the new regime with prices W_{jm}^1 and the initial income. It is assumed that the policy experiment does not influence the random error terms.

From (A3–2) it follows that CV becomes a stochastic variable that depends on initial income as well as all the error terms and all attributes. The difficulty of attaining a formulae for the distribution of CV follows from the fact that households might choose another job and child care alternative after the policy intervention than it did originally, which makes equation (A3–2) complicated to use in empirical applications.

Our approach is based on Dagsvik and Karlström (2004), who obtain explicit formulae for the Hicksian choice probabilities using duality theory and the (random) expenditure function.

Loosely speaking, the expenditure function $Y_A(W, u)$ is defined as the minimum expenditure required obtaining a particular utility level u given the price vector W . More precisely, it is defined as

$$(A2-3) \quad Y_A(W, u) = \left\{ z : \max_{jm \in A} (v_{jm}(W_{jm}, z) + \mu_{jm}) = u \right\}.$$

Note that the distribution of the error term influences the minimum expenditure. Assuming the extreme value distribution, Dagsvik and Karlström (2004) show that the (cumulative) probability distribution of Y_A is

$$(A2-4) \quad P(Y_A > i) = \frac{\sum_{jm \in A} d_{jm} \exp(v_{jm}(W_{jm}^0, I^0))}{\sum_{jm \in A} \exp(\max(v_{jm}(W_{jm}^0, I^0), v_{jm}(W_{jm}^1, i)))},$$

where i is an income boundary and d_{jm} is a binary variable defined as

$$(A2-5) \quad d_{jm} = \begin{cases} 1 & \text{when } v_{jm}(W_{jm}^0, I^0) > v_{jm}(W_{jm}^1, i) \\ 0 & \text{otherwise} \end{cases}.$$

Equation (A3–4) is referred to as the Hicksian or compensated choice probability. Note that the actual job and child care alternative that is chosen by the household in the reference situation plays no particular role in the calculation of the distribution function. To calculate (A3–4), one summarizes across all elements in the choice set A independently of the chosen alternative.

The mean value of Y_A is given by

$$(A2-6) \quad EY_A = \int_0^\infty P(Y_A > i) di,$$

and in the empirical application of this equation, EY_A is approximated by

$$(A2-7) \quad EY_A \approx \sum_{i>0} P(Y_A > i) \Delta i,$$

where Δi is a number of (small) intervals. Given that $Y_A = I^0 - CV$, it follows that

$$(A2-8) \quad E(CV) = I_0 - EY_A.$$

The figures presented in Section 5 reflect that $E(CV)$ is averaged across households and weighed by an equivalence scale.

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