Labor Supply and Child Care Choices in a Rationed Child Care Market

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Abstract: This paper presents an empirical framework for the analysis of mothers' labor supply and child care choices, explicitly taking into account access restrictions to subsidized child care. This is particularly important for countries such as Germany, where subsidized child care is rationed and private child care is only available at considerably higher cost. I use a discrete choice panel data model controlling for unobserved heterogeneity to simultaneously estimate labor supply and the demand for child care of German mothers with at least one child under the age of seven years. The model can be used to evaluate different kinds of policy reforms, such as changes in the availability or costs of child care. Results from the illustrating policy simulations show that targeting public expenditures at an extension of child care slots has greater effects on maternal employment than a reduction of parents' fees to existing slots.

Keywords: child care, labor supply, discrete choice, panel study, Germany

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1 Introduction

The influence of costs and availability of child care on mothers' employment has long been of interest to politicians and researchers alike. In the US, the effect of child care costs on mothers' labor supply has been studied already in the 1970s and 1980s.[1] More recently, the joint estimation of labor supply and child care choices using structural models[2] prevailed as the analytical framework to estimate the effects of child care costs on mothers' employment and the demand for child care. This approach has also been used to study the effect of child care costs on mothers' labor supply in European countries[3] . While in the US, child care costs and quality seem to be in the center of the child care policy debate, the major concern in most European countries is availability and accessibility of child care. The differing public debate reflects differences in the child care market: In contrast to the US, child care centers are highly regulated and highly subsidized in continental Europe, leading to child care slots of high and homogenous quality in subsidized facilities at low parents' fees on the one hand, but shortages and access restrictions to these facilities on the other hand. In most of the European countries, a private market of center-based child care hardly exists. Parents who do not have access to center-based care, therefore have to rely on informal care arrangements or privately organized day care that comes at relatively high cost.

Thus, for the analysis of labor supply and child care choices in a country like Germany, that is characterized by low parents' fees and at the same time low availability of center-based child care, the modeling of access restrictions to child care is crucial. The methodological approach that I use for the estimation of mothers' labor supply and child care choices in Germany is similar to Kornstad and Thoresen (2007) and Lokshin (2004), who estimate mothers' labor supply and the demand for child care for Norway and Russia, respectively. Both papers use a discrete choice model of labor supply and child care choices and model rationing of formal child care by restricting the choice set of families who report to be rationed. Similarly, Del Boca and Vuri (2007) restrict the choice set of families according to a simulated probability that fam-

[1] See, among others Heckman (1974) and Blau and Robins (1988).

[2] See, among others Michalopoulos, Robins, and Garfinkel (1992), Ribar (1995) or Powell (2002).

[3] Examples are Duncan, Paull, and Taylor (2001) and Parera-Nicolau and Mumford (2005) for the UK, Gustafsson and Stafford (1992) for Sweden, Chone, le Blanc, and Robert-Bobee (2003) for France, Del Boca and Vuri (2007) for Italy, Lokshin (2004) for Russia and Kornstad and Thoresen (2007) for Norway.

ilies face access restrictions to center-based child care. In contrast to this approach, I argue that also families who are restricted in the access to center-based child care have the option of non-parental child care in the form of privately organized care that comes at considerably higher cost. Following this, I model access restrictions to subsidized child care slots in the budget constraint by increasing child care costs to the price of "private market" child care for families who are restricted.

I estimate mothers' labor supply and child care choices jointly on the basis of a structural utility model. Drawing on data from the German Socio-Economic Panel (SOEP), a discrete choice panel model controlling for unobserved heterogeneity is estimated. Access restrictions to center-based child care are explicitly taken into account by increasing child care costs according to the probability of being rationed. Thus, the model can be used to analyze the influence of wages, child care costs and availability of subsidized child care on mothers' labor supply decisions and on the demand for child care.

The contribution of this paper is threefold. First, it suggests a methodological framework for the analysis of labor supply and child care choices in the presence of access restrictions to child care, which might be of use also for studies on other countries facing similar problems. Second, it contributes empirical findings on the elasticities of the demand for child care and mothers' labor supply with respect to wages and child care costs in Germany. Third, the model developed in this paper can be used to evaluate the effects of child care policy reforms such as changes in the parents' fees or the supply of subsidized slots on mothers' working hours and the demand for child care. Results from the illustrating policy simulations show that targeting public expenditures at increasing the supply of subsidized child care for children with working mothers is cheaper and more effective in increasing mothers' labor supply than a reduction of parents' fees to existing slots.

2 Institutional setting and theoretical considerations

2.1 Stylized Facts

The model suggested in this paper is designed to take the characteristics of the German context into account. Germany's child care "market" is characterized by low parents' fees and at the same time low availability of center-based child care, in particular for children under three years. In 2002, there were only 3 slots in child care centers available per 100 children in this age group in west Germany. In east Germany, where availability of child care is traditionally higher, there were 36 slots per 100 children of the same age group in 2002. For children between 3 years and school age (usually 6 years), part-time care is available in almost all parts of Germany.[4] It is important to stress that more than 95 percent of all child care centers are subsidized in Germany. The parents' fees that are charged by child care facilities are related to family income and make up only 30 percent of total costs on average. Thus, in an international comparison of child care expenditures, Germany usually ranks among the countries with the lowest private costs for child care.[5] However, the low availability of subsidized child care slots leads to potentially high actual child care costs. While the average parents' fee for a full-time slot in a subsidized child care facility is about 110 Euro per month, the costs of private child care provided by a nanny or a babysitter lie above 800 Euro per month. This explains the low utilization of private child care. Only 3 percent of all children under 3 years are in private child care, for the other age groups, utilization of this form of care is even lower (see Table 1).

In addition to these institutional characteristics, several other empirical findings have to be considered: First, we observe many children in Germany who attend a child care center at least part of the day even though their mothers are not working. As Table 1 shows, about one third of all mothers whose youngest child is in child care is not working. For mothers whose youngest child is between 3 and 6 years and in child care, the non-participation rate is even 39 percent. The reason for this is that (at least part-time) care for children aged 3 - 6 is seen as preschool education and

[4] Availability of full-time slots, however, is limited also for this older age group of children.

[5] See for example Immervoll and Barber (2006) for an international comparison of child care costs.

not so much as a means to provide the possibilities for both parents to work. On the other hand, we observe working mothers who are not purchasing child care - neither center-based nor private child care. Instead, they rely on informal care arrangements such as unpaid care by relatives. These unpaid care arrangements seem to play an important role in Germany, as can be also seen from Table 1.

Table 1: Different forms of child care and maternal employment in Germany

	Child Care Utilization		
Age of child	Paid child care: center-based	Paid child care: private care	Regular unpaid child care[a]
0-2 years	10%	3%	35%
3-6 years	79%	1%	44%
7-10 years	7%	1%	34%
	Employment of Mothers(All)		
Age of youngest child	Not working	Full-time working	Part-time working
0-2 years	70%	8%	22%
3-6 years	43%	13%	44%
7-10 years	31%	17%	52%
	Employment of Mothers with youngest child in paid child care		
Age of youngest child	Not working	Full-time working	Part-time working
0-2 years	31%	31%	38%
3-6 years	39%	15%	46%
7-10 years	29%	20%	51%
	Employment of Mothers with youngest child not in paid child care		
Age of youngest child	Not working	Full-time working	Part-time working
0-2 years	75%	5%	20%
3-6 years	55%	8%	37%
7-10 years	32%	16%	52%

[a] *Question in the questionnaire:* "Are there additionally (to the utilization of child care facilities and paid nannies) other persons outside the household who regularly watch or take care of your children?" Unfortunately, there is no information on hours and frequency of these care arrangements in the SOEP.
Source: SOEP, wave 2002. All numbers refer to the whole sample of mothers in the SOEP, including single mothers and mothers with non-working partners.

The third empirical finding that has to be considered when estimating maternal labor supply and demand for child care in the German context is that subsidized child care is rationed in many regions for children under 3 years. Wrohlich (2007) has shown that more than a third of all children under 3 years do not have access to center-based child care, although their parents would demand this form of child care. In two recent studies for Russia and Norway, access restrictions to formal child care have been modeled by restricting the choice set of those households who report to be restricted (Lokshin (2004) and Kornstad and Thoresen (2007)). This implies that for families who report to be restricted, the option of paid child care is not available at

all. Similarly, Del Boca and Vuri (2007) in their study on Italy restrict the choice set of families according to a simulated probability that families are restricted in the access to center-based child care. In contrast to this, I model rationing of child care explicitly in the families' budget constraint. I argue argue that for families who are facing access restrictions to formal child care centers, paid child care in the form of privately organized care is still an option, although at much higher cost. This cost might be prohibitive for some families, however; as Table 1 shows, for only about 3 percent of all children under the age of three, this form of child care is used. Thus, I will assume that every household can purchase paid child care at some "expected price". This "expected cost of child care" is a weighted average of the parents' fees to subsidized child care slots and a price of child care that is charged by private nannies (a sort of "market price of child care"), where the weights are determined by the probability of not having access to a subsidized slot.

2.2 Modeling Framework

Mothers' labor supply and child care choices are estimated on the basis of a structural utility model using discrete choice technique. Both, mother's working hours and child care hours are modeled as categorical rather than as metric variables. As far as working hours are concerned, this form of modeling takes into account the fact that hours of work are heavily concentrated at particular points. Further, the specification of a relatively small number of hours categories leads to a substantial reduction in computational burden, as the budget set has to be calculated for a few selected points only. This simplification is in fact a prerequisite for an adequate specification of the budget set given the complexities and the non-linearities induced by the German tax-benefit system. This is important for the purpose of the estimation of women's labor supply, since the joint income taxation of married couples or eligibility to means-tested benefits may result in high marginal tax rates for women from low working hours on. The reason to model child care hours as a discrete variable is that usually, German child care centers offer either part-time or full-time care.

In the following analysis, I consider two-parent families with the father working full-time, and single mothers. The reason to drop two-parent families with a non full-time working father is to keep the model simple: For mothers with a full-time working

partner as well as for single mothers, regular child care by the father during working hours is not available.[6]

The choice set of a mother in my model consists of combinations of 4 working hours categories and 3 hours of paid child care categories. The working hours categories include non-participation, full-time work, part-time work or marginal employment. For mothers who have access to unpaid child care arrangements, there are three possible child care choices for each working hours category: no paid child care, full-time or part-time paid child care. Implicitly, it is assumed that in the case that mother's working hours are greater than zero but no paid child care is used, the family makes use of unpaid, informal care. In the data set I will use for the estimation, it is not possible to distinguish between maternal and other informal unpaid child care. Therefore it is assumed that in the categories where the mother is not working, maternal care is the primary child care choice, whereas in categories in which the mother's working hours are greater than zero and paid care is not observed, informal care is used at the amount of the mother's working hours. Further, it is assumed that a mother cannot work and care for the child herself at the same time.

Mothers who do not have access to unpaid care opportunities, have a restricted choice set: These mothers have to purchase child care in for the hours of their market work. Thus, the choice set following from this time constraint thus consists of 8 categories, including no market work/no child care, no market work/part-time or full-time child care, part-time work/part-time or full-time child care and full-time work/full-time child care.

It should be noted that the assumption concerning the availability of unpaid care by someone else than the parents is a controversial one. Previous studies have dealt with this problem in different ways. While some authors (such as Blau and Robins (1988), Michalopoulos, Robins, and Garfinkel (1992), Ribar (1995), Blau and Hagy (1998) and Lokshin (2004)) explicitly assume that free care is available for all mothers, others (such as Gustafsson and Stafford (1992) and Kornstad and Thoresen (2007)) stress that this assumption is unrealistic. In the latter studies, employment of mothers always implies that child care has to be purchased. As the descriptive data for Germany show, almost 20 percent of mothers are observed to be working but not using paid

[6]In the data set that will be used for the empirical analysis, two-parent families with a not full-time working father make up 10 percent of all families whose youngest child is less than 7 years.

center-based or private child care for their children. However, assuming that this possibility exists for all households, is unlikely to be a realistic representation of their care opportunities. Thus, I decided to restrict the choice set for households who do not have access to these unpaid arrangements. This information is not directly asked in the SOEP data set. As a proxy indicator I use a information from the question *"Are there additionally (to the utilization of child care facilities and paid nannies) other persons outside the household who regularly watch or take care of your children?"* Mothers who answer that relatives or friends regularly care for their children, are assumed to have access to unpaid care arrangements, while the others have not.

The utility function specified in this paper is similar to the one used by Blau and Hagy (1998), although in contrast to them, I do not explicitly model quality characteristics of paid child care.[7] The mother's utility U is assumed to depend on disposable household income y, her leisure time l, "child quality" Q, and a vector of demographic characteristics such as age and number of children (D), formally

$$U = u(y, l, Q; D) \tag{1}$$

where utility is assumed to be increasing in leisure, income and child quality. The "quality" of a child (Q) depends on the hours of maternal care m, hours of paid (formal) child care p and hours of unpaid (informal) child care[8] up,

$$Q = q(m, p, up) \tag{2}$$

and is assumed to be increasing in the hours of maternal care and formal care and decreasing with the amount of informal care. The hypothesis to be tested in the empirical analysis is that the marginal utility of informal child care is smaller than the marginal utility of formal child care, otherwise one could not explain the fact that so many households use paid child care when at the same time it is assumed that

[7]Formal child care facilities are strictly regulated in Germany as far as measurable quality characteristics such as staff/child ratio, other equipment and education of staff are concerned.

[8]In the following, I will use the terms formal and paid child care as synonyms. The same applies to the terms informal and unpaid child care. Strictly speaking, this is not correct, since informal child care can also be paid for, e.g. in the case of babysitters, whereas formal child care can be for free, as it is the case for many low income families in Germany who live in communities who have an income-dependent fee scheme to child care facilities. For simplification, in my model, the term "formal" includes all sorts of paid child care, either in facilities (subsidized or private) or home-based, as well as care in facilities that is for free, whereas "informal" only includes non-institutional, unpaid care arrangements.

all households have access to informal care. Note that the "child quality" Q is only defined for the youngest child. For simplification, it is assumed that in the case that more more than one child is living in the household, all children have the same values of maternal, formal and informal care, which are those of the youngest child. Note that all forms of paid child care - center-based and privately organized child care lead to the same utility for the mother, thus are assumed to be of the same quality.

The household's budget constraint, i.e. its disposable income y, can be formally written as

$$y = t(h \cdot w, Z) - ec \cdot p \tag{3}$$

where $t(\cdot)$ denotes the tax-transfer function, h hours of market work, w the mother's wage rate and Z income from other sources than the mother's wage income. ec denotes expected costs of child care and p is hours of paid child care. Disposable household income, which is a function of mother's market and non-market income and the tax-benefit system, is calculated for all possible choice categories using the tax-benefit simulation model STSM (see section 4).

In the previous literature, the prevalent measure of child care costs has been the expenses reported by families who are actually using child care or official statistics about average parents' fees for child care slots. However, using these concepts, child care costs are only measured appropriately for households who have access to a child care slot when they are demanding one. For households facing access restrictions to child care slots, this measure is not appropriate. For these households the demand for child care cannot be estimated on the basis of the subsidized parents' fees (see also Gustafsson and Stafford (1992)). Most studies mention that in addition to child care costs (as defined above) also availability of child care plays a role in mothers' employment decision, however these studies are unable to quantify this effect. To be able to assess both dimensions, parents' fees as well as accessability of child care, I use a measure of child care costs ("expected costs of child care") that explicitly takes into account rationing of child care slots in facilities. I will assume that rationing occurs only with respect to subsidized child care, not with child care on the "private market", i.e. child care by nannies or babysitters. This follows the argument that at some (potentially very high price), each family could find a person who would look

after the children. Expected costs of child care are thus calculated as weighted average of parents' fees to subsidized slots and the price of privately organized care, where the weights are chosen to reflect the probability of being restricted to subsidized care. Formally, expected costs of child care ec consist of the parents' fee for a subsidized child care slot c^s and a market (non-subsidized) price for child care charged by a nanny c^{ns}, weighted by the probability to get a child care slot π and $1 - \pi$, respectively.

$$ec = c^s \cdot \pi + c^{ns} \cdot (1 - \pi) \tag{4}$$

Section 4.3 explains in more detail how the components c^s, c^{ns} and π of equation 4 are computed.

The time constraint of mothers who have access to unpaid care arrangements can be written as

$$h + m + l = m + p + up = T \tag{5}$$

This equation states that a mother can allocate her time to three activities, which are market work h, maternal child care m and pure leisure l. Since a child has to be cared for over the whole day, hours of maternal care m, paid care p and unpaid (informal) care up must add up to T, which is the total time per week available. I assume that unpaid care does not exceed working hours of the mother. In other words, unpaid care is the residual in the case that working hours of the mother exceed hours of paid care, i.e.

$$up = \max(h - p, 0) \tag{6}$$

From equations 5 and 6, it follows that the mother's pure leisure[9] only takes on positive values in the case that paid child care hours exceed the mother's market work hours, i.e. $p > h$.

For families without access to unpaid child care opportunities, the time constraint from equation 5 changes to

[9]Household activities other than child care are not explicitly modeled. Thus, "pure leisure" might include household activities that a mother undertakes while the child(ren) is(are) cared for by another person. To be more precise, the term "pure leisure" in the context of this model defines non-market work time without children.

$$h + m + l = m + p = T \tag{7}$$

The time constraint of the mother is the same as in the unrestricted care, however the time of the child can now only be spend with the mother (m) or in paid child care (p). From this, it follows that the mother's market work and leisure together cannot exceed the hours that the youngest child spends in paid child care. The choice categories following this model include those from the unrestricted model (see Table 4) except categories 1,2,3 and 8.

Substituting equations 2, 3 and 5 or 7 into the utility function as stated in equation 1 yields the mother's maximization problem

$$\max_{h,f} u = u\{[t(h \cdot w, Z) - ec \cdot f], (T - h - m), Q(m, f, inf); D\} \tag{8}$$

subject to the additional constraint stated in 6 and non-negativity of the choice variables. The utility index should be concave in household income and in the mother's leisure time, i.e.

$$\frac{\partial U(.)}{\partial y} > 0 \quad ; \quad \frac{\partial^2 U(.)}{\partial y^2} < 0 \tag{9}$$

$$\frac{\partial U(.)}{\partial l} > 0 \quad ; \quad \frac{\partial^2 U(.)}{\partial l^2} < 0 \tag{10}$$

As far as the expected sign of these derivatives with respect to paid and unpaid child care are concerned, the theoretical predictions are not clear. It cannot be derived from economic theory whether mothers consider non-parental child care as a normal good or whether it constitutes a "bad" that is necessary in order to generate income through employment. Thus,

$$\frac{\partial U(.)}{\partial p} = ? \tag{11}$$

$$\frac{\partial U(.)}{\partial up} = ? \tag{12}$$

Table 4 shows the values of the choice variables (market work and paid child care) and the values of the variables that are given by the constraints (unpaid care, maternal care and pure leisure), when the total time available T is normalized to 80.

Table 2: Values of market work, pure leisure and hours of childcare by choice category

Choice Category	Working hours (h)	Paid childcare (p)	Unpaid childcare (up)	Maternal care (m)	Pure leisure (l)
1	0	0	0	80	0
2	8	0	8	72	0
3	20	0	20	60	0
4	37	0	37	43	0
5	0	20	0	60	20
6	8	20	0	60	12
7	20	20	0	60	0
8	37	20	17	43	0
9	0	37	0	43	37
10	8	37	0	43	29
11	20	37	0	43	17
12	37	37	0	43	0

Source: Own calculation.

3 The econometric model

The discrete choice model used for the estimation is based on the mothers' utility comparisons of the different choice categories in every period. Regarding the specification of the utility function, I will assume that the terms of the "child quality" function linearly enter the utility function as stated in equation 8. The utility function itself is assumed to have a quadratic form. Thus, the utility index U of mother i for a particular working/child care hours category k at time period t can be stated as follows:

$$U_{ikt} = V_{ikt} + \epsilon_{ikt} = X'_{ikt}\beta + X'_{ikt}AX_{ikt} + \epsilon_{ikt} \tag{13}$$

with

$$X_{ikt} = (p_{ikt}, up_{ikt}, l_{ikt}, y_{ikt})' \tag{14}$$

The components of X_{ikt} are disposable household income y, the mother's pure leisure time l, hours of paid and unpaid care p and hours of unpaid care up, which all vary by household (i), choice category (k) and time period (t). ϵ_{ikt} is an unobserved error term that is assumed to follow an extreme value distribution and to be independently distributed over time, households and choice categories. Matrix A contains the coefficients of the quadratic terms and the cross terms. Vector β contains the coefficients of the linear terms. Preferences are allowed to vary across mothers through

taste shifters of the linear terms of paid child care. In addition to the variation of choices across households that can be explained by differences in the levels of income and its interactions with demographic variables, there are many other sources of heterogeneity, in particular differences in the access to paid and unpaid child care and differences in attitudes towards these forms of child care, which are unobserved. I will account for this unobserved heterogeneity by letting the preference parameter on the linear term of hours of paid child care, β_p vary across households:

$$\beta_{p_i} = \alpha_p^0 + D'\alpha_p^1 + \nu_i \tag{15}$$

where D is a column vectors including age of the mother, number of children less than three years, number of children between 3 and 6 years, region of residence, a dummy variable indicating whether the mother holds a university degree and a dummy variable indicating whether the mother is single. Following Heckman and Singer (1984), it is assumed that ν can be described by an arbitrary discrete probability distribution G with a small number of mass points $M^r, \forall r(r = 1, 2, ..., R)$ and corresponding probabilities τ^r, where

$$E(\nu) = \sum_{r=1}^{R} \tau^r M^r = 0 \tag{16}$$

and

$$\sum_{r=1}^{R} \tau^r = 1 \tag{17}$$

Mass points and their probabilities are jointly estimated with the parameters of the model using maximum likelihood. The estimation is based on the assumption that unobserved heterogeneity is uncorrelated to the explanatory variables. Since β_{p_i} is not known to the researcher, the unconditional probability P_{ikt} has to be estimated using

$$P_{ikt} = \sum_{r=1}^{R} \tau^r(M^r) \frac{\exp(V_{ikt})}{\sum_{j=1}^{J} \exp(V_{ijt})}; \quad k \in J \tag{18}$$

Since I observe many households in more than one period, the individual likelihood contribution is

$$L_i = \sum_{r=1}^{R} \tau^r(M^r) \prod_{t=1}^{T_i} \prod_{j=1}^{J} \left(\frac{\exp(V_{ikt})}{\sum_{j=1}^{J} \exp(V_{ijt})} \right)^{d_{ikt}}; \quad k \in J \tag{19}$$

where d_{ikt} is a dummy variable that takes on value 1 if the household i chooses category k in time period t and 0 otherwise.

This model is estimated using an unbalanced panel. Households are observed 1, 2 or 3 periods. In addition to cross-section variation, variation over time in disposable income comes from various sources. First, since child care costs are a decreasing function of a child's age, disposable household income changes due to the fact that children grow older every year. Second, in the observed period from 2000 - 2002, several reforms have been implemented also lead to variation in disposable household income, such as the German tax reform (see Haan and Steiner (2005)), and a reform of the child benefit, which has been increased in 2001.

4 Description of the Data

The model described above is estimated on three waves (2001 - 2003) of the German Socio Economic Panel (SOEP). The SOEP is a representative sample of households living in Germany with detailed information on household incomes, working hours and household structure.[10] While there is information on formal child care utilization in all waves, the 2002 wave also includes detailed information on child care expenditures.

4.1 Sample characteristics

The sample used for the analysis in this paper is constrained to married or cohabiting couples and single mothers with at least one child aged up to 6 years and not yet enrolled in school. Two-parent families in which the father is working less than full-time are excluded. The reason for this restriction is to keep the child care possibilities simple. In the case that the father is working full-time, it seems plausible to assume that he cannot provide part-time or full-time child care.[11] Households with self-employed mothers, mothers who are still in education or training or are severely disabled are also dropped. This gives a sample size of 1558 households, of which 551 are observed in one wave, 424 are observed in two waves and 583 are observed in three waves. In total, this adds up to 3148 observations.

[10] For more information on the SOEP, see http://www.diw.de/english/sop/.

[11] Dropping all families in which the father is not working full-time reduces the number of observations by 10 percent.

Table 4 shows some basic descriptive statistics, such as the distribution of households across categories and the corresponding average number of children as well as the age of the youngest child. More than a third of all households are observed in the category with no child care and zero working hours of the mother. As expected, in this category the average age of the youngest child (1.3 years) is lower than in all other categories, while the average number of children per household (1.9) is high. In all categories with paid child care hours, the average age of the youngest child is above three. The share of single mothers is above average in categories with full-time working hours and in categories with full-time child care hours.

4.2 Net household income

Net household income is calculated for the actual working hours category and simulated for alternative hours categories on the basis of the microsimulation model STSM. [12] This tax-benefit model contains the main features of the German tax and transfer system. The calculation of taxable income is based on information on earnings from dependent employment, income from capital, property rents and other income. For most households, earnings from dependent employment is the most important source of income. These earnings are calculated by multiplying gross hourly wages by the respective working hours in each category. For non-working individuals, wages are estimated on the basis of a Heckman (1979) type selection correction model.[13]

Gross household income is the sum of all income components of all household members. Taxable income is calculated by deducting child allowances and other expenses from gross household income. The income tax is computed by applying the income tax formula to the individual incomes of unmarried spouses; for married spouses, income is taxed jointly, with an income splitting factor of 2. Income tax and social security contributions are deducted from gross income, and social transfers such as child benefits, child-rearing benefits, unemployment compensation, housing benefits and social assistance are added to get net household income.[14]

[12] For a detailed documentation of the STSM, see Steiner, Haan, and Wrohlich (2005).

[13] Estimation results of the wage estimation can be found in Steiner, Haan, and Wrohlich (2005).

[14] STSM uses retrospective information of income components in order to compute net household incomes for a given year. Thus, the incomes computed on basis of the SOEP waves 2001-2003 are in fact incomes for the years 2000-2002.

Table 3: Descriptive Statistics

Choice Categories		Frequency			
working hours of the mother	child care hours of the youngest child	All Households		Single mothers	
		Absolute Number	Share (in %)	Absolute Number	Share (in %)
0	0	1223	41	114	39
marginal (8)	0	104	4	7	2
part-time (20)	0	108	4	8	3
full-time (37)	0	45	2	10	3
0	part-time (20)	328	11	31	11
marginal (8)	part-time (20)	285	10	18	6
part-time (20)	part-time (20)	429	14	35	12
full-time (37)	part-time (20)	61	2	9	3
0	full-time (37)	46	2	17	6
marginal (8)	full-time (37)	4	< 1	0	0
part-time (20)	full-time (37)	87	3	16	5
full-time (37)	full-time (37)	258	9	31	11
Sum		2978	100	296	100

Choice Categories		Frequency			
working hours of the mother	child care hours of the youngest child	Families with youngest child < 3 years		Families with youngest child aged 3-6	
0	0	978	64	245	17
marginal (8)	0	76	5	28	2
part-time (20)	0	71	5	37	3
full-time (37)	0	23	2	22	2
0	part-time (20)	28	2	300	21
marginal (8)	part-time (20)	124	8	161	11
part-time (20)	part-time (20)	114	7	315	22
full-time (37)	part-time (20)	13	1	48	3
0	full-time (37)	12	1	34	2
marginal (8)	full-time (37)	1	< 1	3	< 1
part-time (20)	full-time (37)	21	1	66	5
full-time (37)	full-time (37)	71	5	187	13
Sum		1532	100	1446	100

Choice Categories		Average over all households		
working hours	child care hours	Age of youngest child	Number of children under 6	Total number of children in the household
0	0	1.5	1.4	2.0
marginal (8)	0	1.8	1.3	1.8
part-time (20)	0	2.2	1.2	1.7
full-time (37)	0	2.5	1.1	1.8
0	part-time (20)	3.9	1.1	2.0
marginal (8)	part-time (20)	2.8	1.2	1.9
part-time (20)	part-time (20)	3.4	1.1	1.7
full-time (37)	part-time (20)	3.4	1.1	1.6
0	full-time (37)	3.3	1.2	1.4
marginal (8)	full-time (37)	4.2	1.0	0.7
part-time (20)	full-time (37)	3.4	1.1	1.3
full-time (37)	full-time (37)	3.4	1.1	1.6
Overall average		2.5	1.3	1.9

Source: SOEP, waves 2001 - 2003.

4.3 Child care costs

From this net household income, expected child care costs as stated in equation 4 are deducted according to the child care category in order to calculate the household's disposable income. The monthly parents' fees for center-based child care (c^s) are estimated on the basis of a Tobit model, since about 10 percent of parents do not have to pay for center-based child care. Explanatory variables include the age of the child, number of siblings in center-based care, regional variables and net household income. Since detailed information on child care expenses are only available for the year 2002, the estimated coefficients are used in order to predict the parents' fees for 2001 and 2003. Furthermore, these fees are predicted for each household for all working hours categories since the fees vary with net household income. The results of this estimation as well as predicted values are shown in tables 8 and 10 in Appendix 1.

The costs of private child care (c^{ns}) cannot be estimated on the basis of the SOEP data, since only very few families are observed to use this sort of child care. Therefore, I set the market price of child care at 5 Euro per hour for all households, which seems to be the national average of the price charged by nannies in 2002 (see Beblo et al. (2005)).

The individual probability of getting a slot in a child care facility (π) is estimated on the basis of a partial observability model. This is necessary since the SOEP data only provide information on utilization of center-based child care and not on its actual demand. In the presence of rationing, it is known whether families who are not observed to use center-based child care do not demand this form of child care or they demand it but are not offered a slot. On the basis of a partial observability model, demand and supply of child care can be disentangled. The partial observability model used here has been developed in Wrohlich (2007) and is a bivariate probit model where the dependent variable is utilization of center-based care. This is the joint outcome of the unobserved variables demand and supply of center-based child care. Explanatory variables for the demand for child care include characteristics of the child (e.g. age), the mother (education, nationality, age) and the household (number of siblings in child care centers, number of adult persons, region etc.). The individual probability to be offered a child care slot is assumed to depend on the regional availability of child care slots as well as child and household characteristics. The likelihood function of

this model and estimation results can be found in the Appendix. Using the estimated coefficients, it is possible to predict the individual probability that a child is restricted in the access to center-based child care, which is the probability parents demand child care for a child but are not offered a slot. These probabilities are used as weights $(1 - \pi)$ in equation 4. As can be seen from Table 10 in the Appendix, the average probability that families whose youngest child is under three years is rationed amounts to 0.37, while families whose youngest child is between three and six years are rationed only with a probability of 0.10. Average fees to center-based child care and average expected child care costs are also shown in the Appendix, illustrating by how much the "expected" costs of child care differ from parents' fees that subsidized institutions charge.

After expected child care costs are calculated for every child, the sum over child care costs for all children in the household is subtracted from net household income according to child care hours. Table 4 lists net household incomes for all choice categories before and after deducting child care costs. This table shows how child care costs affect work incentives for secondary earners with young children in Germany.

If a mother who has a child under three years starts working, net household income on average increases by 231 Euro in the case of marginal employment (8 hours per week), by 465 Euro in the case of part-time employment (20 hours per week) and by 837 Euro per month if she takes up full-time work. These relatively low net income gains from employment reflect the high marginal tax rates that are induced by joint income taxation of married couples and by the withdrawal of social transfers in the case of single mothers. If child care has to be purchased for the time the mother is working, net household income can hardly be increased by taking up employment. If a mother whose youngest child is less than three years takes up a full-time job and has to purchase full-time child care, disposable income of the family only increases by 336 Euro per month. For families whose youngest child is between three and six years, child care costs are considerably lower. On average, disposable income increases by 527 Euro per month in the case that a mother takes up a full-time job and needs to buy full-time child care.

Table 4: Net Household Incomes by Choice Categories

Choice Categories		Net Household Income					
		Before	After	Before	After	Before	After
		Deducting child care costs		Deducting child care costs		Deducting child care costs	
working hours	child care hours	All Households		Single Parents		Families with children <3 years	
0	0	2551	2551	1015	1015	2521	2521
marginal	0	2667	2667	1085	1085	2668	2668
part-time	0	2904	2904	1211	1211	2906	2906
full-time	0	3295	3295	1518	1518	3288	3288
0	part-time	2551	2342	1015	853	2521	2273
marginal	part-time	2667	2577	1085	1010	2668	2504
part-time	part-time	2904	2806	1211	1110	2906	2738
full-time	part-time	3295	3093	1518	1366	3288	3045
0	full-time	2551	2132	1015	719	2521	2007
marginal	full-time	2667	2361	1085	864	2668	2232
part-time	full-time	2904	2586	1211	962	2906	2461
full-time	full-time	3295	2954	1518	1198	3288	2825
working hours	child care hours	Families with 1 child ≤6 years		Families with 2 children ≤6 years		Families with 3 children ≤6 years	
0	0	2463	2463	2793	2793	3099	3099
marginal	0	2617	2617	2897	2897	2797	2797
part-time	0	2857	2857	3128	3128	3050	3050
full-time	0	3257	3257	3501	3501	3433	3433
0	part-time	2463	2279	2793	2513	3099	2655
marginal	part-time	2617	2518	2897	2739	2797	2892
part-time	part-time	2857	2748	3128	2968	3050	3133
full-time	part-time	3257	3080	3501	3225	3433	3023
0	full-time	2463	2097	2793	2225	3099	2196
marginal	full-time	2617	2331	2897	2444	2797	2422
part-time	full-time	2857	2557	3128	2666	3050	2657
full-time	full-time	3257	2932	3501	3019	3433	2996

All amounts refer to Euro per month.

Source: Calculations based on SOEP, waves 2001 - 2003 and the micro-simulation model STSM. Note: SOEP weighting factors are used.

5 Results

5.1 Estimation Results

The coefficients of the estimated model described in section 3 are shown in Table 5. The coefficients of the variables can be interpreted as effects on the mother's utility. The coefficients of the linear terms of income, leisure and formal child care have a positive sign, whereas the coefficient of informal care has a negative sign. The interpretation of these coefficients is not straight-forward due to the large number of interaction terms. Calculating first and second derivatives of the utility function with respect to income, leisure, paid and unpaid child care, thus is more informative as far as the plausibility of the estimation results is concerned. It turns out that the model yields results that are in line with predictions based on theoretical considerations: The first derivatives of the utility function with respect to income and leisure are positive for all households. The second derivatives of these variables are all negative. The first derivative of the utility function with respect to formal child care is positive for about 25 percent of all households, for the other 75 percent it is negative. A more disaggregate analysis shows that for the majority if households in east Germany, the first derivative is positive. For mothers whose youngest child is older than three years, this derivative is positive for almost 50 percent of all households. The first derivative of unpaid (informal) child care is negative for all households. These results suggest that some households consider paid child care to be a good, whereas other households consider paid child care as a "bad", i.e. having a negative influence on the mothers' utility. Unpaid child care seems to have a negative influence on the mothers' utility in all cases. This reflects the fact that either parents do not consider informal child care of being of the same quality as formal child care, or that there are some costs associated with this form of child care that are not measured in the budget constraint.

A comparison with estimation results of a model without unobserved heterogeneity shows that unobserved heterogeneity is present in this model. The Akaike Information Criterion is larger for the model with unobserved heterogeneity than for the one without unobserved heterogeneity.[15] For the distribution of β_p, two mass points could be

[15] I also estimated several models with different specifications of unobserved heterogeneity, such as a parametric specification of the random term of formal child care and both a parametric and a semi-parametric specification of a random term on net income. All these specifications lead to very similar results as the ones reported here.

identified.[16] The corresponding probabilities can be interpreted as respective shares of groups of households in the population. There is one large group for whom the coefficient of formal child care hardly changes, however for the smaller group, the positive effect of formal child care on utility is much larger than for the other group.

Table 5: Estimation Results

	Model with unobserved heterogeneity		Model without unobserved heterogeneity	
Explanatory Variables	Coeff.	St. Err.	Coeff.	St. Err.
net income	0.2282	.0276	0.2368	0.0253
net income squared	-0.0001	.0004	-0.0001	0.0003
leisure	0.0039	.0106	0.0048	0.0104
leisure squared	-0.0005	.0002	-0.0004	0.0002
paid child care	0.0494	.0112	0.0110	0.0088
paid child care squared	-0.0028	.0002	-0.0016	0.0001
unpaid child care	-0.1265	.0131	-0.1268	0.0127
unpaid child care squared	0.0015	.0002	0.0014	0.0002
unpaid child care * youngest child u3	-0.1182	.0055	-0.0900	0.0037
paid child care * east Germany	0.0641	.0063	0.0615	0.0046
paid child care * German nationality	0.0132	.0071	0.0080	0.0051
paid child care * single mother	0.0076	.0078	0.0097	0.0059
paid care * mother holds university degree	0.0342	.0075	0.0302	0.0055
net income * leisure	0.0007	.0002	0.0007	0.0002
net income * paid child care	-0.0003	.0002	-0.0004	0.0001
net income * unpaid child care	-0.0011	.0003	-0.0010	0.0003
Probabilities and locations of random effects				
location of mass point 1 (M^1)[a]	-.02105	.0030		
log-odd of probability 1 [b]	1.8435	0.1961		
log likelihood	-4990.9261		-5052.692	
Akaike Information Criterion (AIC)	10017.852		10137.384	
number of observations	30152			
number of households	1558			

[a] The location of the second mass point can be calculated using the formula $M^2 = -\frac{M^1 \cdot \tau_1}{\tau_2}$ and amounts to 0.1329.

[b] The two corresponding probabilities, τ_1 and τ_2 are 0.8634 and 0.1366.

Source: Estimations based on SOEP, wave 2001-2003.

In order to compare the estimation results with the previous literature, I calculate wage elasticities and child care costs elasticities of labor supply by simulating a one percent increase in gross hourly wages and expected child care costs, respectively. These elasticities are presented in Table 6. According to these estimates, a 1 percent increase of the gross hourly wage leads to an increase in the participation rate of mothers with at least one child under 6 years by 0.14 percentage points and an increase in average working hours by 0.52. These are very similar to elasticities that previous studies found for German mothers (see Beblo, Lauer, and Wrohlich (2005) or Steiner

[16] In a model with three mass points, convergence of the likelihood function could not be achieved.

and Wrohlich (2004)).[17]

Labor supply elasticities with respect to child care costs are found to be relatively low, compared to previous estimates in Germany and also compared to estimates for other countries: A one percent increase in expected costs of child care would lead to a 0.13 percent decrease in average working hours. For Germany, Beblo, Lauer, and Wrohlich (2005) estimate a decrease in average working hours by 0.11 percent in east and 0.25 percent in west Germany in the case that child care costs increase by one percent. These results however, have been estimated on a sample of mothers with children aged 7 to 10 years. Second, Beblo et al. use a model that does not allow the option of unpaid non-parental child care, which also leads to higher elasticities than the more flexible model used here. Compared to the international literature, the estimated elasticities of labor supply with respect to child care costs lie at the lower end of what different authors find for various countries. For example, Kornstad and Thoresen (2007) find for Norway that the mothers' participation rate would fall by 0.12 percentage points in the case of a one percent increase in child care costs. Similar results are reported for Russia by Lokshin (2004). For the French case, however, Chone, le Blanc, and Robert-Bobee (2003) find values more similar to those for Germany, amounting to -0.04 percentage points. For the US, different authors report a wide range of values lying between -0.03 and -0.09 such as reported by Ribar (1995) up to -0.20 found by Blau and Hagy (1998). The reason for the relatively low child care costs elasticities of maternal labor supply in Germany might be the relatively weak link between employment and child care for children aged less than six years, as has been described in section 2.

The model estimated here also allows to calculate elasticities of the demand for child care. The demand for child care is positively influenced by wage increases, a one percent increase of the gross hourly wage leading to an increase in the "child care participation" by 0.04 to 0.06 percentage points. The own-price elasticities of the demand for child care are quite large, a one percent increase in expected child care costs leading to a decrease in "child care participation" between 0.05 and 0.07 percentage points.

[17] In Steiner and Wrohlich (2004) labor supply of men and women in couple households has been estimated jointly. The similarity of the elasticities obtained from this model as compared to the elasticities obtained by Steiner and Wrohlich (2004) is encouraging evidence that the simple assumption that the labor supply behavior of the husband can be treated as exogenous does not lead to biased estimates.

Table 6: Elasticities of labor supply and demand for childcare

	Elasticities of labor supply	
	1% increase in gross hourly wage	1% increase in expected childcare costs
	Change in participation rates (in percentage points)	
All mothers	0.14	-0.04
	(0.12 - 0.15)	(-0.04 - -0.03)
Mothers whose youngest child is <3	0.13	-0.03
	(0.12 - 0.15)	(-0.04 - -0.03)
Mothers whose youngest child is ≥ 3	0.14	-0.04
	(0.13 - 0.16)	(-0.05 - -0.04)
	Change in working hours (in percent)	
All mothers	0.53	-0.13
	(0.47 - 0.58)	(-0.14 - -0.11)
Mothers whose youngest child is <3	0.57	-0.16
	(0.51 - 0.63)	(-0.18 - -0.13)
Mothers whose youngest child is ≥ 3	0.47	-0.09
	(0.42 - 0.51)	(-0.10 - -0.08)
	Change in childcare "participation" (in percentage points)	
All mothers	0.05	-0.06
	(0.04 - 0.06)	(-0.07 - -0.05)
Mothers whose youngest child is <3	0.04	-0.05
	(0.03 - 0.05)	(-0.06 - -0.04)
Mothers whose youngest child is ≥ 3	0.06	-0.07
	(0.05 - 0.07)	(-0.08 - -0.06)

Note: Numbers in parentheses show 95%-confidence intervals obtained by the boostrap method (100 repetitions).
Source: Estimations based on SOEP, wave 2001-2003.

5.2 Results from Policy Simulations

The model can be used to calculate the effect of various policy reforms such as a change in parents fees to existing slots or an extension of subsidized slots. These reforms can be simulated by changing parameters such as the parents' fees (c^s in equation 4) or the availability of subsidized slots (π). In fact, reforms of this kind are currently discussed in Germany: For example, in 2005 a law has been passed that aims at providing child care slots for all children under three years whose parents both work or wish to work.[18] On the other hand, the abolishment of parents' fees to child care slots in care centers for all children between three and six years - independent of the parents' employment status - is currently discussed.

Table 7 shows the results of simulations of these two policy reforms. Labor supply effects of both reforms are moderate, however reform 1 leads to a larger increase in

[18]This reform is simulated in the following by setting the probability of getting a subsidized child care slot in the calculation of expected child care costs to 1 for those choice categories in which the mother has positive working hours.

Table 7: Behavioural effects resulting from the two child care policy reforms

	Reform 1 increasing slots	Reform 2 abolishing fees
	Change in participation rates (in percentage points)	
All mothers	1.39	0.77
	(1.22 - 1.64)	(0.66 - 0.89)
Mothers whose youngest child is <3	2.53	0.29
	(2.20 - 2.96)	(0.23 - 0.39)
Mothers whose youngest child is ≥ 3	–	1.37
		(1.21 - 1.53)
	Change in working hours (in percent)	
All mothers	5.58	2.33
	(4.84 - 6.59)	(2.02 - 2.72)
Mothers whose youngest child is <3	10.07	1.83
	(8.74 - 11.88)	(1.57 - 2.18)
Mothers whose youngest child is ≥ 3	–	2.97
		(2.54 - 3.43)
	Change in child care "participation"(in percentage points)	
All children	1.31	1.32
	(1.08 - 1.63)	(1.17 - 1.54)
Children <3	2.38	0.51
	(1.96 - 2.95)	(0.39 - 0.70)
Children ≥ 3	–	2.34
		(2.09 - 2.66)

Note: Numbers in parentheses show 95%-confidence intervals obtained by the bootstrap method (100 repetitions).
Source: Estimations based on SOEP, wave 2001-2003.

mothers' participation rates and working hours than reform 2. Overall, increasing availability of center-based child care for children under three years (reform 1) would increase the participation rate of mothers with preschool children by 1.3 percentage points, working hours would increase by more than 5 percent. Abolishing parents' fees for center-based child care for children aged three to six years (reform 2) would increase the participation rates of mothers with children in this age group by 0.8 percentage points and average working hours would increase by 2.3 percent. The effect on child care "participation" is similiar for both reforms and amounts to an increase of about 1.3 percentage points. Due to the design of the two the reforms, the effects of reform 1 are driven by the mothers with children under three years, whereas under reform 2, mostly mothers with children between 3 and 6 years would adjust their behaviour.

A comprehensive comparison of two reforms also needs to take the costs of the different scenarios into account. Using SOEP weighting factors, it is possible to aggregate the parents' fees paid for children aged three to six, which yields the costs of reform 2, amounting to about 1.4 billion Euro per year. Reform 1 would cost about

the same amount. The costs of reform 1 are composed of the fact that first, for all children with already working mothers who are in child care, slots have to be subsidized (about 865 million Euro per year), and that about 50,000 children of working mothers would additionally demand child care slots after the reform (about 500 million Euro per year, assuming yearly costs of 10,000 Euro per year per slot[19]).

Thus, both reforms would need about the same amount of fiscal funds, however, mothers' labor supply is more affected by reform 1. This is clearly a result from the fact that subsidies under this reform are targeted at children with working mothers only, while in reform 2, the subsidies are not tied to the mothers' employment status. Note, however, that even if the absolute effect of both - mothers' labor supply and child care utilization - measured in percentage points is similar, the relative effect is much higher in Reform 1, since mothers of younger children have a lower labor force participation and child care utilization rate.

6 Conclusion and Policy Implications

The model developed in this paper is suitable to analyze labor supply and child care choices in a setting of a child care market characterized by low fees to subsidized institutions and high costs for privately organized child care. These characteristics of the child care market, that lead to a shortage of subsidized child care slots, can be found in many continental European countries. An empirical application is presented for the case of mothers with preschool-aged children in Germany. Since access restrictions to subsidized child care are explicitly taken into account, the effect of parents' fees and availability of child care on the demand for child care and maternal employment decisions can be disentangled.

Policy simulations show that an increase in the availability of center-based child care for working mothers with children under three years would lead to an increase in the labor force participation of mothers by 1.3 percentage points. The abolishment of parents' fees to existing child care slots for children aged three to six would increase mothers' labor force participation by 0.8 percentage points. Both reforms, however, lead to the same absolute effect as far as the utilization of child care is concerned. Utilization of child care would increase by 1.3 percentage points. Given that costs

[19] See Schilling (2004)

are very similar in both reform scenarios, it is noteworthy that reform 1 leads to a higher increase in mothers' labor supply than reform 2. If the goal of family policy is to facilitate work-life balance of two-earner families, policy reforms aiming at an extension of child care slots should be the government's choice.

References

Beblo, M., C. Lauer, and K. Wrohlich (2005): "Ganztagsschulen und Erwerbstaetigkeit von Muettern. Eine Mikrosimulationsstudie fuer Deutschland," *Zeitschrift fuer ArbeitsmarktForschung - Journal for Labour Market Research*, 38/2+3, 357–372.

Blau, D. M., and A. P. Hagy (1998): "The Demand for Quality in Child Care," *The Journal of Political Economy*, 106/1, 104–146.

Blau, D. M., and P. K. Robins (1988): "Child-Care Costs and Family Labor Supply," *The Review of Economics and Statistics*, 70/3, 374–381.

Chone, P., D. le Blanc, and I. Robert-Bobee (2003): "Female Labor Supply and Child Care in France," *CESifo Working Paper*, 1059.

Del Boca, D., and D. Vuri (2007): "The Mismatch between Employment and Child Care in Italy: The Impact of Rationing," *Journal of Population Economics*, forthcoming.

Duncan, A., G. Paull, and J. Taylor (2001): "Mothers' Employment and the Use of Childcare in the United Kingdom," *IFS Working Paper*, 01/23.

Gustafsson, S., and F. Stafford (1992): "Child Care Subsidies and Labor Supply in Sweden," *The Journal of Human Resources*, 27/1, 204–230.

Haan, P., and V. Steiner (2005): "Distributional Effects of the German Tax Reform 2000 - A Behavioral Microsimulation Analysis," *Journal of Applied Social Science Studies*, 125, 39–49.

Heckman, J. (1979): "Sample Selection Bias as a Specification Error," *Econometrica*, 47, 153–162.

Heckman, J., and B. Singer (1984): "A Method for Minimizing the Distributional Assumptions in Econometric Models for Duration Data," *Econometrica*, 52, 271–320.

Heckman, J. J. (1974): "Effects of Child-Care Programs on Women's Work Effort," *The Journal of Political Economy*, 82/2, 136–163.

Immervoll, H., and D. Barber (2006): "Can Parents Afford to Work? Childcare Costs, Tax-Benefit Policies and Work Incentives," *IZA Discussion Paper*, 1932.

Kornstad, T., and T. O. Thoresen (2007): "A Discrete Choice Model for Labor Supply and Child Care," *Journal of Population Economics*, forthcoming.

Lokshin, M. (2004): "Household Childcare Choices and Women's Work Behavior in Russia," *The Journal of Human Resources*, 39/4, 1094–1115.

Michalopoulos, C., P. K. Robins, and I. Garfinkel (1992): "A Structural Model of Labor Supply and Child Care Demand," *The Journal of Human Resources*, 27/1, 166–203.

Parera-Nicolau, A., and K. Mumford (2005): "Labour Supply and Childcare for British Mothers in Two-Parent Families: A Structural Approach," *IZA Discussion Paper Series*, 1908.

Powell, L. M. (2002): "Joint Labor Supply and Childcare Choice Decisions of Married Mothers," *The Journal of Human Resources*, 37/1, 106–128.

Ribar, D. C. (1995): "A Structural Model of Child Care and the Labor Supply of Married Women," *Journal of Labor Economics*, 13/3, 558–597.

Schilling, M. (2004): "Berechnung der Platzkosten als finanzielle Grundlage für den qualitativen Ausbau," in *Kitas und Kosten. Die Finanzierung von Kindertageseinrichtungen auf dem Prüfstand*, ed. by H. R. L. Diller, Angelika, and T. Rauschenbach, pp. 31–54. DJI Verlag Deutsches Jugendinstitut, Munich.

Steiner, V., P. Haan, and K. Wrohlich (2005): "Dokumentation des Steuer-Transfer-Mikrosimulationsmodells 1999-2002," *DIW Data Documentation 9*.

Steiner, V., and K. Wrohlich (2004): "Household Taxation, Income Splitting and Labor Supply Incentives. A Microsimulation Study for Germany," *CESifo Economic Studies*, 50, 541–568.

Wrohlich, K. (2007): "The Excess Demand for Subsidized Child Care in Germany," *Applied Economics*, forthcoming.

Appendix: Calculation of expected child care costs

Tobit Estimation of the Parents' Fees for Center-Based Child Care

Table 8: Estimation of parents' fees for center-based childcare (Tobit)

	Part-time care		Full-time care	
Explanatory Variables	Coeff.	St. Err.	Coeff.	St. Err.
dummy variable indicating that child is aged 0-3	7.4184	10.8023	43.4753	13.0425
net monthly income	0.0076	0.0016	0.0220	0.0038
number of siblings aged 0-2 in childcare	-18.1861	6.6246	-26.4059	11.9324
number of siblings aged 3-6 in childcare	-23.7067	6.7316	-36.4697	10.5190
North-West	28.5948	8.6460	14.2949	18.0786
Middle-West	3.9476	8.5101	26.2354	13.3217
Northrhine-Westphalia	-4.5614	8.6056	26.5227	14.5548
Baden-Wuerttemberg	-2.0203	8.6098	-1.3348	16.3141
Bavaria	-7.4778	8.8023	11.7826	18.4299
constant	36.3428	8.3372	19.3916	11.9123
s.e. (ancilliary parameter)	45.9441	1.5701	63.0967	3.3076
Log-Likelihood		-2500.93		-1062.62
Number of observations		533		204
Thereof: Left-censored		72		16

Source: Estimations based on SOEP, wave 2002.

Estimation of the individual probability of being restricted to center-based child care

The likelihood function of the partial observability model is

$$\begin{aligned} L &= \Pi_{NC=1}[\Phi(X_D\beta_D)]^C[1-\Phi(X_D\beta_D)]^{1-C} \cdot \\ &\quad \Pi_{NC=0}[\Phi_2(X_D\beta_D, X_S\beta_X;\rho)]^C \cdot [1-\Phi_2(X_D\beta_D, X_S\beta_X;\rho)]^{1-C} \end{aligned}$$

where $NC = 1$ are the children who are known to be not restricted in their access to child care and $NC = 0$ are the children who might be restricted. X_D denotes the variables in the demand equation, X_S the variables in the supply equation and β_D and β_S the respective coefficients. C is the outcome variable "child is in center-based child care" which is the joint outcome of the two latent variables demand for and supply of center-based child care. More details about this model can be found in Wrohlich (2007).

Table 9: Estimation results of demand and supply of center-based childcare (partial observability model)

	Demand equation		Supply equation	
Explanatory variables	Coeff.	St. Err.	Coeff.	St. Err.
mother holds high school degree	0.2832	0.1057	–	–
mother holds university degree	0.0032	0.1871	–	–
mother holds university degree*child aged 0-3	0.8073	0.8040	–	–
mother visits church frequently	-0.1709	0.0966	–	–
other adult apart from parents living in the household	-0.3691	0.1884	–	–
mother has German nationality	0.0101	0.1557	0.0265	0.2580
father is living in the same household	-0.2206	0.1754	0.0847	0.2308
child is aged 0-1	-1.6848	0.8244	-1.6165	0.6211
child is aged 2	-1.9280	0.4611	-0.3783	0.6896
child is aged 3	-0.3869	0.1330	-0.6745	0.3640
child aged 0-3 * family living in east Germany	2.1704	0.6313	–	–
child aged 7-10 * family living in east Germany	0.5931	0.3638	–	–
child is aged 7-10	-1.5757	0.3154	-1.0631	0.8136
number of sisters aged 10-16	-0.2964	0.1316	–	–
number of siblings aged 0-3	-0.2370	0.1121	–	–
number of siblings aged 4-6	-0.7366	0.3263	–	–
number of siblings aged 7-10	-0.2092	0.0871	–	–
number of siblings aged 0-3 in child care	0.1603	0.1727	0.0170	0.1288
number of siblings aged 4-6 in child care	0.8426	0.3254	-0.0652	0.1811
North-West	-0.3668	0.1960	-0.1942	0.6054
Middle-West	-0.1217	0.1691	-0.2234	0.5194
Northrhine-Westphalia	-0.3428	0.1788	-0.0494	0.5381
Baden-Wuerttemberg	-0.0926	0.1774	-0.3920	0.4910
Bavaria	-0.2972	0.1740	0.1076	0.4799
rural area	-0.0715	0.1446	0.0726	0.1985
local availability of child care slots	–	–	1.0101	.5569
constant	1.6237	0.2446	0.1656	0.7596
rho	-0.2710	0.6946		
Number of observations	3103			
Log pseudolikelihood	-937.56108			
Wald chi2(25)	90.68			

Source: Estimations based on SOEP, wave 2002.

Table 10: Average estimated parents' fees for a subsidized slot and expected costs of child care

	Children aged		
	0-2 years	3-6 years	7-10 years
Probability of being restricted to center-based care	0.37	0.10	0.28
Parents' fees for center-based care:			
part-time	62	60	49
full-time	127	96	–
Total expected costs of child care			
part-time	183	90	144
rfull-time	397	167	–

Note: Euro per month.
Source: Own calculations on basis of SOEP, wave 2002.