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# ABSTRACT

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

In this paper, I suggest 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 the demand for child care as well as on maternal employment than a reduction of parents' fees to existing slots.

JEL Classification: J22, J13, C35

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.[4] 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 a slot in 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 (2006) 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

[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, Locatelli, and Vuri (2004) for Italy, Lokshin (2004) for Russia and Kornstad and Thoresen (2006) for Norway.

[4] The target formulated at the EU Summit in Barcelona 2002 to provide child care slots for 33 percent of children aged less than three is an example for the current political importance of public child care provision in the EU.

restricting the choice set of families who report to be rationed. In contrast to this approach, I argue that also families who are restricted in the access to child care in a formal care center 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 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 used. Access restrictions to formal 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 twofold. 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. The model can furthermore 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 is more effective in increasing both mothers' labor supply and the demand for child care than a reduction of parents' fees to existing slots.

# 2 Institutional setting and theoretical considerations

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 up to three years. In 2002, there were only 3 child care slots available per 100 children under the age of 3 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 all parts of Germany. Availability of full-time slots, however, is limited also for this older age group of children. Table 1 gives an overview of availability of child care by age group and region in Germany. The low availability of subsidized child care facilities 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 child minder lie above 800 Euro per month.

[Table 1 about here]

In addition to this institutional characteristics, several other empirical findings have to be considered: First, we observe many children in Germany who are in formal child care at least part of the day even though their mothers are not working. Traditionally, the link between mother's employment and the use of child care is not very strong in west Germany. As Table 2 shows, about one third of all mothers whose youngest child is in child care is not working. For mothers whose youngest child is between three and six years and in child care, the non-participation rate is even 39 percent. The reason for this is that part-time care for children aged 3 - 6 is seen as preschool education and not so much as a means to provide the possibilities for both parents to work. Working mothers often have to rely on informal care arrangements, either paid babysitters or unpaid care by relatives, to be able to take up a full-time job. These informal care arrangements, especially unpaid care by relatives, seem to play an important role in west Germany, as can be also seen from Table 2. Thus, a model that does not explicitly allow non-working mothers to purchase child care (such as the models used by Ribar (1995), Powell (2002), Del Boca, Locatelli, and Vuri (2004) or Lokshin (2004)) is not appropriate for Germany. Second, not all

working mothers purchase (paid) child care, indicating that many households make use of some sort of informal, unpaid child care arrangements. A model that assumes that all households have to purchase child care at least for the time the mother is working (such as used by Kornstad and Thoresen (2006) or by Duncan, Paull, and Taylor (2001)), would thus also be inappropriate. Unfortunately, I have no information on access to these unpaid care arrangements in the data. Information is only available on the utilization of these care arrangements, and this information is not very detailed as far as frequency and hours of care are concerned. Therefore, I will assume that all households have the possibility of unpaid care, which can be care by relatives or friends, or - in the worst case - leaving the child alone.

[Table 2 about here]

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 less than three years, as has been shown by Wrohlich (2005). In addition to that, children aged three to six may also be rationed as far as full-time care is concerned. In two recent studies, 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 (2006)).[5] This implies that for families who report to be restricted, the option of paid child care is not available at all. In contrast to this, I will 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 2 shows, for 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" consists of the parents' fees to subsidized child care slots times the probability of getting a slot and a price of child care that is charged by private child minders (a sort of "market price of child care") times the probability of not getting a subsidized slot. As a proxy for these probabilities, the availability of subsidized child care slots on the local level will be used.

[5] In a recent study, Del Boca and Vuri (2005) suggest a theoretical framework of a choice model of labor supply and child care, where access restrictions to formal child care are modeled by a probabilistic distribution of availability of formal child care slots, i.e. a probabilistic distribution of the household's choice set.

Mothers' labor supply and child care choices will be estimated on the basis of a structural utility model using discrete choice technique. Both, mother's working hours and child care hours will be modeled as categorical rather than 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 hours. 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 of 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 in German child care facilities, it is the general practice to offer either part-time or full-time child care. Further, also in the data set I will use for the estimation, information of child care hours is available according to these two states.

In the following analysis, I consider two-parent families where the father is 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 for as 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 12 categories: Apart from non-participation, a mother can choose to work full-time, part-time or being marginally employed. For each working hours category, there are three possible child care choices, which are 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 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.

[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.

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 formal (paid) child care $f$ and hours of informal (unpaid) child care[8] $inf$,

$$Q = q(m, f, inf) \tag{2}$$

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 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.

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

[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.

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

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 $f$ is hours of formal 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 on 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. In particular, 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, are unable to quantify this effect. To be able to assess both dimensions, child care costs as 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 do so by arguing 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. By weighting the parents' fees with the probability that the family has access to subsidized child care for a particular child and adding the market price of child care (i.e. wage of a babysitter or child minder) weighted by the probability not to get access to subsidized child care, expected costs of child care are calculated.

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 child minder ($c^{ns}$), weighted by the probability to get a child care slot ($p$) and $(1-p)$, respectively. The probability to get a part-time slot is much higher than the probability to get a full-time slot. It is assumed that in the case that parents

do not get a full-time slot for their child, they opt for a part-time slot (if available) and use "market-price" child care only for the second half of the day. Child care fees for part-time ($pt$) and full-time ($ft$) slots can thus be stated as follows:

$$ec_{pt} = c^s_{pt} \cdot p_{pt} + c^{ns}_{pt} \cdot (1 - p_{pt}) \tag{4}$$

$$ec_{ft} = c^s_{ft} \cdot p_{ft} + (c^s_{pt} + c^{ns}_{pt}) \cdot (p_{pt}) + (1 - p_{pt} - p_{ft}) \cdot c^{ns}_{ft} \tag{5}$$

The parents' fee $c^s$ is estimated on the basis of information about child care expenditures of households for the two categories. Since there are only very few observations in the data set who use private child care, the market price $c^{ns}$ is not estimated but assumed to be the national average for all households. The probability of getting a slot in a subsidized child care facility is assumed to be the age-specific availability ratio of child care slots in the county of residence.[9] For a more detailed description of the calculation of expected costs of formal child care, see section 4.

The time constraint of the mother can be written as

$$h + m + l = m + f + inf = T \tag{6}$$

Equation 6 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 $m$, formal care $f$ and informal care $inf$ must add up to T, which is the total time per week available. I assume that informal care does not exceed working hours of the mother. In other words, informal care is the residual in the case that working hours of the mother exceed hours of formal care, i.e.

$$inf = \max(h - f, 0) \tag{7}$$

[9]There are 440 counties ("Kreise") in Germany.

From equations 6 and 7, it follows that the mother's pure leisure[10] only takes on positive values in the case that formal child care hours exceed the mother's market work hours, i.e. $f > h$.

Substituting equations 2, 3 and 6 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 7 and non-negativity of the choice variables. Table 3 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 3 about here]

# 3 The econometric model

The discrete choice model used for the estimation is based on the households' utility comparisons of the 9 different choice categories in every period. Concerning the parametric 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:

$$U_{ikt} = X'_{ikt}\beta + X'_{ikt}A \cdot X_{ikt} + \epsilon_{ikt} \tag{9}$$

with

$$X_{ikt} = (m_{ikt}, f_{ikt}, inf_{ikt}, l_{ikt}, y_{ikt})' \tag{10}$$

[10]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.

The components of $X_{ikt}$ are disposable household income $y$, the mother's pure leisure time $l$, hours of maternal care $m$ and hours of formal and informal care, $f$ and $inf$, which all vary by household $(i)$, choice category $(k)$ and time period $(t)$. $\epsilon_{ikt}$ 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. The variables that do not vary across choice categories, i.e. the socio-demographic variables such as age of the youngest child, number of children, age and nationality of the mother, are interacted with net income, leisure, paid child care and maternal care.

I include households that are observed 1, 2 or 3 periods. 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.

In the model as stated in equation 9, variation in choices across households can only be explained by differences in the levels of disposable household income and its interactions with demographic variables. However, there are many other possible sources of heterogeneity, in particular differences in access to formal and informal care arrangements and differences in attitudes towards formal child care, which are unobserved. I will account for this unobserved heterogeneity by letting the preference parameter on the linear term of hours of formal child care vary across households. Vector $\beta$ from equation 9 therefore is replaced by vector $\beta_i$, which consists of parameters that are constant and an individual-specific parameter $\beta_{f_i}$, i.e.

$$\beta_i = (\beta_y, \beta_{f_i}, \beta_m, \beta_l, \beta_{inf})' \tag{11}$$

with

$$\beta_{f_i} = \beta_f + \nu_i \tag{12}$$

Following Heckman and Singer (1984), it is assumed that $\nu$ 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 $\pi^r$, where

$$E(\nu) = \sum_{r=1}^{R} \pi^r M^r = 0 \tag{13}$$

and

$$\sum_{r=1}^{R} \pi^r = 1 \tag{14}$$

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. According to this specification, the decision rule for an individual $i$ to choose alternative $k$ in period $t$, conditional on $\beta_i$, becomes

$$P_{ikt} = \frac{\exp(X_{ikt}\beta_i)}{\sum_{j=1}^{J} \exp(X_{ijt}\beta_i)}; \quad k \in J \tag{15}$$

Since $\beta_i$ is not known to the researcher, the unconditional probability $P_{ikt}$ has to be estimated using

$$P_{ikt} = \sum_{r=1}^{R} \pi^r(M^r) \frac{\exp(X_{ikt}\beta^r)}{\sum_{j=1}^{J} \exp(X_{ijt}\beta^r)}; \quad k \in J \tag{16}$$

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

$$L_i = \sum_{r=1}^{R} \pi^r(M^r) \prod_{t=1}^{T_i} \prod_{j=1}^{J} \left( \frac{\exp(X_{ikt}\beta^r)}{\sum_{j=1}^{J} \exp(X_{jt}\beta^r)} \right)^{d_{ikt}}; \quad k \in J \tag{17}$$

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.

# 4 Description of the Data

The model outlined in section 4 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.[11] While there is information on formal child care utilization in all waves, the 2002 wave also includes detailed information on child care expenditures. Information on child care availability on the county level is matched to household data.

The sample used for the analysis in this paper is constrained to married and cohabiting couples with at least one child aged up to 6 years and not yet enrolled in school. Further, the sample does not include two-parent families with a not full-time working father. 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. Households with self-employed mothers, mothers who are still in education or training or are severely disabled are also dropped. Further, I only include households that are observed in at least two waves. This gives a sample size of 1597 households, of which 572 are observed in one wave, 434 are observed in two waves and 591 are observed in three waves. In total, this adds up to 3213 observations.

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 zero 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 (1.8) is the highest. 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.

[Table 4 about here]

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

## 4.1 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.

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.[13]

## 4.2 Child care costs

From this net household income, expected child care costs as stated in equations 4 and 5 are deducted according to the child care category in order to calculate the household's disposable income. The monthly parents' fee for child care in a subsidized facility is estimated separately for part-time slots and full-time slots. The 2002 wave of the SOEP provides information on child care expenditures and hours. A Tobit model is used for the estimation, since a considerable part of parents does not have to pay for child care slots. As explanatory variables only the age of the child, the region ("Bundesland") and the size of the county are used.[14] For

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

[13] 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.

[14] The details of this estimation can be obtained from the author upon request.

the waves of 2001 and 2003, for which information on child care expenditures is not existent in the SOEP, the estimated coefficients are used in order to predict the parents' fees for part-time and full-time care slots.

As already stated above, the market costs of child care cannot be estimated on the basis of the SOEP data. 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 childminders.[15]

The probability of getting a slot in a child care facility is assumed to be the availability ratio by age group on the county level. There are three different age groups for which data are available, namely 0-2, 3-6 and for schoolchildren aged 7-10. For preschoolers, availability ratios differ considerably for full-time and part-time slots, as already described in section 2.[16] It is assumed here that even if full-time slots are available, parents can choose to purchase a part-time slot only. Therefore, the probability to get a part-time slot is simply the overall availability of child care slots by age group. While there is information on the overall availability rates by age group on a county level [17], the share of full-time slots by age group is available only on the more aggregate state level ("Bundeslaender"). The probability to get a full-time slot is thus calculated as the product of the overall availability of child care slots on the county level and the share of full-time slots on the regional level for each age group.

In order to illustrate by how much the "expected" costs of child care differ from parents' fees that subsidized institutions charge, table 5 shows the average subsidized and expected child care costs by age group.

[Table 5 about here]

By definition, the difference between expected child care costs and parents' fees for a subsidized slot is highest for those groups of children who face the lowest supply of subsidized care facilities. While parents' fees and expected costs do not differ so much for part-time slots for children of the older age group, the difference between

[15] see http://www.tagesmutter.de.

[16] Obviously, for schoolchildren, who are in school at minimum 4 hours in the morning, only part-time care slots are needed.

[17] These administrative data are collected and provided by the Deutsches Jugendinstitut (DJI) in Munich. I would like to thank Hiltrud Bayer for the provision of these data. Special permission was granted by DIW Berlin to use the regional code of the SOEP data.

fees for a subsidized slot and expected child care costs is large for full-time slots in both age groups and also for part-time slots for children of the younger age group.

After expected child care costs are calculated for every child [18], the sum over child care costs for all children in the household is subtracted from net household income according to child care hours. Table 6 lists net household incomes for all choice categories before and after deducting child care costs. This table gives some interesting hints about work incentives induced by child care costs for secondary earners with small children in Germany.

If a mother whose youngest child is less than three years starts working, net household income on average increases by 230 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.[19] 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 is working full-time and has to purchase full-time child care, the family even faces a loss in net household income by 105 Euro per month. It has to be stressed that these are average numbers. For mothers with high wages who have one child in this age group only, there is actually an income gain from full-time work (and full-time child care) relative to non working.

The picture is different for households whose youngest child is between three and six years, since for these children, child care costs are considerably lower than for younger children. For these families, net household income increases by 150 Euro per month if the mother is marginally employed and the child is in part-time care.

[18] In the case that there are also children aged 7-10 years in a household, child care costs for these children are considered in the calculation of net household income in those categories where the youngest child is in full-time care. The calculation of expected child care costs for children aged 7-10 follows the same framework as those for younger children, i.e. the probability that a child does not get a child care slot in a subsidized facility is taken into account. For more details on the calculation of child care costs for children of this age group see Beblo, Lauer, and Wrohlich (2005). For children who are older than ten years, no child care costs are assumed.

[19] Net household income before deduction of child care costs need not be the same in choice categories with same working hours but different child care hours since under the current tax legislation, child care costs can be deducted from taxable income within certain limits.

If the mother is working part-time, income increases by 378 Euro per month. If the mother is working full-time and the child is in full-time care, net income is on average 473 Euro higher than in the case that the mother is not working and no child care is used.

[Table 6 about here]

# 5 Results

## 5.1 Estimation Results

Table 7 presents the coefficients from the estimation of the model. The coefficients can be interpreted as effect of the respective variable 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. For example, the negative sign of the interaction term between formal child care and youngest child less than three years leads to a negative influence of formal care on the mother's utility of households in this group. Living in east Germany, on the other hand, increases the utility of formal child care.

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.[20] For the distribution of $\beta_f$, two mass points could be identified. 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.

The calculation of second and first derivatives of the utility function with respect to

[20] Estimates of the model without unobserved heterogeneity are available from the author upon request. 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.

income, leisure, formal and informal child care allows to check whether the estimates are in line with predictions based on theory. It turns out that the model yields plausible estimates: The first derivatives of the utility function with respect to income and leisure are positive for all households, while the second derivatives of these variables are negative. The first derivative of the utility function with respect to formal child care is positive for about 50 percent of all households, for the other 50 percent it is negative. The first derivative of informal child care is negative for all households. This suggests that some households consider formal child care to be a good, whereas other households consider formal child care as a "bad", i.e. having a negative influence on the mothers' utility. Informal child care seems to have a negative influence on the mothers' utility in all cases, which is also in line with what the theoretical predictions of the model outlined in section 2 suggest.

[Table 7 about here]

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 8. The labor supply elasticities that result from my model are similar to values that previous studies found for Germany (see Beblo, Lauer, and Wrohlich (2005) or Steiner and Wrohlich (2004)).

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 less than 0.1 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 (2006) 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.

[Table 8 about here]

The model estimated here also allows to calculate elasticities of the demand for child care, which are also shown in Table 8. The demand for child care is positively influenced by wage increases, a one percent increase of the gross hourly wage leading to an increase of the demanded hours of formal child care by 0.2 to 0.3 percent. 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 the demanded hours of formal child care between 0.4 and 0.6 percent.

## 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 publicly subsidized slots. These reforms can be simulated by changing parameters such as the parents' fees ($c^s_{pt}$ and $c^s_{ft}$ in equations 4 and 5) or the availability of subsidized slots ($p_{pt}$ and $p_{ft}$). 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 (see section 1).[21] 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 9 shows the results of simulations of these two policy reforms. Overall, reform 1 (increase in availability of subsidized child care slots for children less than three)

[21] 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.

leads to a larger increase in mothers' participation rates and working hours as well as in a larger increase in the demand for child care than reform 2 (abolishment of parents' fees to existing slots for children aged three to six). While reform 2 has only moderate effects on the labor supply of mothers, reform 1 leads to an increase of the participation rates of mothers with preschool-aged children by 1.6 percentage points. For mothers whose youngest child is less than three years, the participation rate would rise by 3 percentage points, which corresponds to an increase of about 10 percent. These results are influenced by the design of the two reforms - reform 1 being conditional on employment, whereas reform 2 leads to a reduction of child care costs independent of the parents' employment status.

The reforms have also different effects on the demand for child care. Reform 1 leads to a 2.3 percentage points increase in the demand for child care, whereas the demand would only rise by 1.3 percentage points under reform 2. Mothers with children less than three, who are the target group of reform 1, would increase the demand for child care by even 4.1 percentage points.

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 1.9 billion Euro per year. As stated above, reform 1 implies an increase in the demand for child care by about 4 percentage points, i.e. about 73,700 new places would be needed. Assuming yearly public expenditures of 10,000 Euro per slot[22], this reform would not even make up half of the expenditures that are required to finance reform 2.

[Table 9 about here]

# 6 Conclusion and Policy Implications

In this paper, I develop a model to analyze labor supply and child care choices of mothers with preschool-aged children in a setting of a child care market characterized by low fees to subsidized institutions and high costs for privately organized child care. This 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

[22] See Schilling (2004).

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. Results from the policy simulations based on the model estimates show that a reform aiming at increasing the provision of child care has a greater impact on both, the demand for paid child care and maternal employment, than a reduction of parents' fees to existing child care slots. This result is influenced by the design of the two proposals, in particular the idea of providing slots to children from two-earner families (or working single parents) only, whereas the reduction of parents' fees of existing slots would be granted to everybody.

Given that the first reform only costs about half as much as the second reform, my results show that investing in the provision of child care at the existing parents' fee structure would lead to a higher increase in maternal labor supply and a higher demand for child care than a reduction of fees to existing slots. If the goal of family policy is to facilitate work-life balance of two-earner families and to boost the demand for formal child care for educational reasons, policy reforms aiming at an extension of child care slots should be the government's choice.

Apart from these results that are interesting for the on-going debate in Germany, the model and the results can yield interesting implications also for countries facing similar institutional settings as Germany.

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Table 1: Availability of child care slots in subsidized facilities

| | Children aged 0-2 | | Children aged 3-6 | | Children aged 7-12 | |
|---|---|---|---|---|---|---|
| | East | West | East | West | East | West |
| Slots per 100 children | 37 | 2.7 | 105.1 | 88.1 | 4.5 | 40.8 |
| *thereof: full-time slots* | *96%* | *79%* | *98%* | *18%* | - | - |

*Source:* Statistisches Bundesamt 2004.

Table 2: Different forms of child care and maternal employment in Germany

| | Child Care Utilization | | |
|---|---|---|---|
| Age of child | Paid child care: centre-based | Paid child care: private care | Regular unpaid child care (relatives, friends, etc.)[1] |
| 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 (including "Marginal Employment" |
| 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 (including "Marginal Employment" |
| 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 (including "Marginal Employment" |
| 0-2 years | 75% | 5% | 20% |
| 3-6 years | 55% | 8% | 37% |
| 7-10 years | 32% | 16% | 52% |

*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.

[1] *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.

Table 3: Values of market work, pure leisure and hours of child care by choice category

| Choice Category | Working hours (h) | Paid child care (f) | Unpaid child care (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 | 0 |
| 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.

Table 4: Descriptive Statistics

| | Choice Categories | | Frequency | age of youngest child | number of children | share of single mothers |
|---|---|---|---|---|---|---|
| | working hours | child care hours | | | | |
| 1 | 0 | 0 | 1171 (36%) | 1.3 | 1.8 | 0.09 |
| 2 | marginal | 0 | 219 (7%) | 1.6 | 1.7 | 0.05 |
| 3 | part-time | 0 | 186 (6%) | 1.7 | 1.5 | 0.06 |
| 4 | full-time | 0 | 57 (2%) | 2.1 | 1.5 | 0.16 |
| 5 | 0 | part-time | 451 (14%) | 4.2 | 1.7 | 0.09 |
| 6 | marginal | part-time | 202 (6%) | 4.2 | 1.7 | 0.07 |
| 7 | part-time | part-time | 403 (13%) | 4.2 | 1.5 | 0.10 |
| 8 | full-time | part-time | 150 (5%) | 3.8 | 1.4 | 0.13 |
| 9 | 0 | full-time | 64 (2%) | 3.7 | 1.3 | 0.40 |
| 10 | marginal | full-time | 7 (¡1%) | 4.6 | 1.1 | 0.14 |
| 11 | part-time | full-time | 109 (3%) | 3.7 | 1.2 | 0.22 |
| 12 | full-time | full-time | 194 (6%) | 3.6 | 1.2 | 0.15 |
| Total | | | 3213 (100%) | 2.7 | 1.6 | 0.10 |

*Source*: Own calculation based on SOEP, waves 2001-2003.

Table 5: Average estimated parents' fees for a subsidized slot and expected costs of child care

| | Children aged 0-2 | | Children aged 3-6 | |
|---|---|---|---|---|
| | parents' fees | expected costs | parents' fees | expected costs |
| | | *part-time care* | | |
| *east Germany* | 74 | 261 | 57 | 60 |
| *west Germany* | 82 | 332 | 64 | 76 |
| | | *full-time care* | | |
| *east Germany* | 115 | 515 | 70 | 83 |
| *west Germany* | 161 | 664 | 110 | 354 |

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

Table 6: Average Net household income by choice categories

| | Choice Categories | | Youngest child 0-2 years | | Youngest child 3-6 years | |
|---|---|---|---|---|---|---|
| | working hours | childcare hours | net household income | | net household income | |
| | | | before child care costs | after child care costs | before child care costs | after child care costs |
| 1 | 0 | 0 | 2508 | 2508 | 2576 | 2576 |
| 2 | marginal | 0 | 2739 | 2739 | 2813 | 2813 |
| 3 | part-time | 0 | 2973 | 2973 | 3041 | 3041 |
| 4 | full-time | 0 | 3345 | 3345 | 3424 | 3424 |
| 5 | 0 | part-time | 2508 | 2103 | 2576 | 2489 |
| 6 | marginal | part-time | 2748 | 2342 | 2813 | 2727 |
| 7 | part-time | part-time | 2984 | 2577 | 3042 | 2955 |
| 8 | full-time | part-time | 3357 | 2951 | 3424 | 3337 |
| 9 | 0 | full-time | 2508 | 1564 | 2576 | 2191 |
| 10 | marginal | full-time | 2752 | 1800 | 2824 | 2436 |
| 11 | part-time | full-time | 2988 | 2032 | 3053 | 2665 |
| 12 | full-time | full-time | 3362 | 2403 | 3438 | 3050 |

All amounts refer to Euro per month.
*Source:* Own calculations on basis of SOEP, wave 2001-2003 and the microsimulation model STSM.

Table 7: Estimation Results

| Explanatory Variables | Coefficient | Standard Error |
|---|---|---|
| net income | .2615 | .0265 |
| net income squared | -.0008 | .0003 |
| leisure | -.0126 | .0219 |
| leisure squared | .0006 | .0003 |
| formal child care | .0574 | .0147 |
| formal child care squared | -.0036 | .0002 |
| informal child care | -.1927 | .0076 |
| informal child care squared | .0019 | .0002 |
| leisure * age | .0005 | .0004 |
| leisure * youngest child u3 | -.0011 | .0099 |
| leisure * youngest child 3 to 6 | .0186 | .0128 |
| leisure * east Germany | -.0367 | .0062 |
| formal child care * youngest child u3 | -.1377 | .0087 |
| formal child care * youngest child 3 to 6 | .0173 | .0094 |
| formal child care * east Germany | .0987 | .0074 |
| formal child care * German nationality | .0011 | .0076 |
| net income * leisure | .0001 | .0003 |
| net income * formal child care | -.0003 | .0002 |
| net income * single mother | .0156 | .0342 |
| leisure * single mother | -.0104 | .0101 |
| formal * single mother | .0319 | .0096 |
| Probabilities and locations of random effects | | |
| loc1: -.0140, .2253 | | |
| var(1): .0032 | | |
| prob: 0.9415, 0.00585 | | |
| number of observations = 3213 | | |
| number of households = 1597 | | |
| log likelihood = -5482.4748 | | |

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

Table 8: Elasticities of Labor Supply and Demand for Child Care

| | Elasticities of Labor Supply | |
|---|---|---|
| | 1% increase in gross hourly wage | 1% increase in expected child care costs |
| | *Change in participation rates (in percentage points)* | |
| All mothers | 0.15 | -0.02 |
| Mothers with children less than 3 | 0.16 | -0.02 |
| | *Change in working hours (in percent)* | |
| All mothers | 0.56 | -0.06 |
| Mothers with children less than 3 | 0.62 | -0.08 |

| | Elasticities of the Demand for Child Care | |
|---|---|---|
| | 1% increase in gross hourly wage | 1% increase in expected child care costs |
| | *Change in participation rates (in percentage points)* | |
| All mothers | 0.04 | -0.05 |
| Mothers with children less than 3 | 0.03 | -0.06 |
| | *Change in hours of formal child care (in percent)* | |
| All mothers | 0.18 | -0.38 |
| Mothers with children less than 3 | 0.27 | -0.64 |

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

Table 9: Results of the Policy Simulations

| | Changes in Labor Supply | |
|---|---|---|
| | Reform 1 | Reform 2 |
| | *Change in participation rates (in percentage points)* | |
| All mothers | 1.5 | 0.4 |
| Mothers with children less than 3 | 2.8 | 0.2 |
| | *Change in working hours (in percent)* | |
| All mothers | 4.6 | 0.9 |
| Mothers with children less than 3 | 8.6 | 0.7 |

| | Elasticities of the Demand for Child Care | |
|---|---|---|
| | Reform 1 | Reform 2 |
| | *Change in participation rates (in percentage points)* | |
| All mothers | 2.0 | 1.2 |
| Mothers with children less than 3 | 3.8 | 0.7 |
| | *Change in hours of formal child care (in percent)* | |
| All mothers | 23.4 | 4.1 |
| Mothers with children less than 3 | 43.7 | 5.5 |

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