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Abstract

Consistent with facts for a cross-section of OECD countries, I document that the labor force participation rate of West German mothers with children aged zero to two exceeds the corresponding child care enrollment rate whereas the opposite is true for mothers with children aged three to mandatory school age. I develop a life-cycle model that explicitly accounts for this age-dependent relationship through various types of non-paid and paid child care. The calibrated version of the model is used to evaluate two recently passed policy reforms concerning the supply of subsidized child care for children aged zero to two in Germany. These counterfactual policy experiments suggest that the lack of subsidized child care constitutes indeed for some females a barrier to participate in the labor market and depresses fertility.

Keywords: Child Care, Fertility, Life-cycle Female Labor Supply

JEL classification: D10, J13, J22

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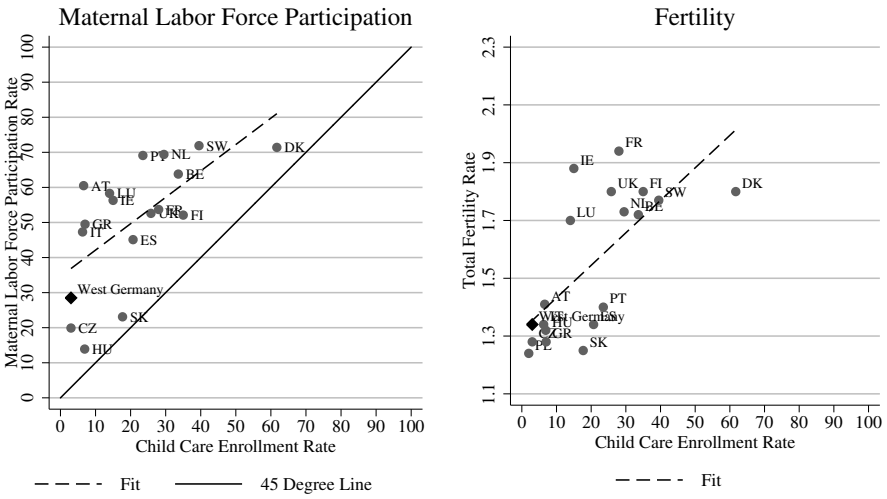
1 Introduction

At the Barcelona meeting in March 2002, the European Council recommended that its member states remove "barriers and disincentives for female labor force participation by, inter alia, improving the provision of child care facilities", European Council (2002). Even quantitative targets for the level of provision were set. By 2010, the EU member states shall provide child care for 33% of all children younger than age three and for 90% of all children aged three to mandatory school age. In 2008, the German government passed a law that aims at implementing the target value for children younger than age three. In a dossier accompanying the actual bill, the German Federal Ministry of Family Affairs, Senior Citizens, Women and Youth further motivated this target value by recognizing that for women "good conditions for the compatibility of family and working life are a prerequisite to fulfill their desired fertility level" and by "the exemplary standards in Western and Northern European countries, for which a relationship between child care enrollment, maternal employment and fertility is observed", see Sharma and Steiner (2008). Governments may provide child care and promote female labor force participation and fertility for several reasons, e.g. investment in children's human capital, gender equality or to alleviate the economic consequences of the demographic change for the labor market and social security system. In this paper I am after a more basic question, namely to quantify in how far (not) providing child care constitutes a barrier or disincentive for female labor force participation and fertility choices.

Figure 1 shows for a cross-section of EU countries (those which are also in the OECD) the significant positive correlation of the enrollment rate in paid child care of children aged zero to two with both, the labor force participation rate of mothers with children aged zero to two and the total fertility rate.[1] However, these correlations do not necessarily reflect causality, in particular because due to data availability only the actual enrollment rates and not the provision rates are displayed. Hence, these figures do not permit to draw conclusions on how far (not) providing child care constitutes a barrier or disincentive for female labor force participation and fertility choices. Moreover, the relationships crucially hinge on the age of the children. For children aged three to five the previously significant positive correlations become negative or much weaker and are no longer statistically significant, see Figure 2. This suggests a very different role of child care for maternal labor force participation decisions in the two age groups. In this context, Figures

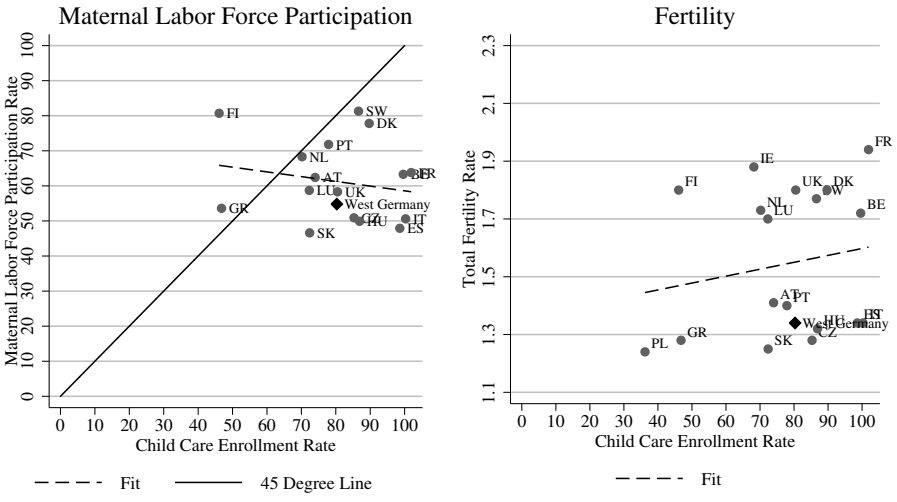
[1] In OECD (2007) the enrollment rates for children aged zero to two concern formal child care arrangements such as group care in child care centers, registered child minders based in their homes looking after one or more children, and care provided by a carer at the home of the child. For children aged three to five enrollment rates concern formal pre-school services including daycare facilities and in some countries primary schooling.

Figure 1: Child Care Enrollment of Children Aged 0 to 2 in the EU



Source: OECD (2007), own calculations

Figure 2: Child Care Enrollment of Children Aged 3 to 5 in the EU



Source: OECD (2007), own calculations

1 and 2 reveal another important relationship. The labor force participation rate of mothers with children aged zero to two exceeds the corresponding child care enrollment rate on average by 29 percentage points. To the contrary, for mother with children aged three to five the child care enrollment exceeds the maternal labor force participation rate on average by 19 percentage points. Put differently, paid child care is used heavily by non-working mothers (of children between age three and five) whereas a substantial fraction of mothers (of children below age three) works without using any paid child care. It is worthwhile to mention that this latter fact is also true for the US and Canada where 18.5 and 39.7 percentage points more of the mothers with children aged zero to two are working than using paid child care, see OECD (2007).

The major contribution of this paper is to analyze the role of child care for maternal labor force participation and fertility decisions taking into account the age-dependent relationships between the variables of interest through various types of child care. I set up a quantitative, dynamic life-cycle model with labor force participation and fertility choices and distinguish between maternal time, paid child care provided in public (subsidized) and market (non-subsidized) arrangements as well as non-paid child care (e.g. grandparents). This contrasts to a number of recent papers using static or dynamic quantitative models to analyze the impact of child care (e.g. Wrohlich, 2006; Attanasio et al., 2008; Haan and Wrohlich, 2009; Domeij and Klein, 2010) which apart from Haan and Wrohlich (2009) treat fertility as exogenous and, except Wrohlich (2006), require mothers to buy one hour of paid child care for each hour worked. This latter assumption is clearly at odds with the facts for children aged zero to two, compare Figure 1.[2]

I calibrate the model for a sample of West German married females.[3] West Germany is an ideal candidate for the analysis for two reasons. First in terms of data availability, the German Socioeconomic Panel is the only European household panel with continuous information on paid child care usage along the extensive and intensive (part- vs. full-time) margin. Moreover, the characteristics of the German child care market permit to infer whether a child attends market (non-subsidized) or publicly (subsidized) provided child care.

[2]Kornstad and Thoresen (2007) list further studies with a focus on child care and maternal labor force participation which as well, including Kornstad and Thoresen (2007), do not incorporate a fertility choice. A subset of these papers relaxes the strict link between paid child care and maternal labor force participation. Del Boca (2002), and Del Boca and Sauer (2009) constitute a special case. They investigate the impact of child care provision as an "economy-wide factor" on fertility and maternal labor force participation without modeling child care as a choice or as a requirement for working mothers.

[3]I restrict the analysis to West Germany since, originating from the pre-reunification period, maternal labor force participation and child care enrollment rates differ even today strongly between West and East Germany. In a companion paper (Bick, 2010) I document these differences in detail and analyze them with the model presented here.

In addition, the number of subsidized child care slots per hundred children is available from the German Statistical Office. Second, the low maternal labor force participation, child care enrollment and fertility rates in Germany are representative for Continental Europe (with the exception of France and BeNeLux), such that the results from counterfactual policy experiments should be of interest to other Continental European countries.

I evaluate for Germany a recently passed law which becomes effective in October 2010 and aims at implementing the target for the provision of child care for children aged zero to two set by the European Council at the 2002 Barcelona meeting. Under this reform all working females are granted access to subsidized child care. According to my results the lack of subsidized child care constitutes indeed for some females a barrier to participate in the labor market and depresses fertility. The predicted increase of the labor force participation rate is 23% (7.4 percentage points) for mothers with children aged zero to two and the fertility rate increases by 3% (0.05 children per female). The implied child care enrollment rate is 41% and thus relatively close to the targeted level of 33%. I consider a further law that has already been passed but will not become effective until 2013. It is a natural extension of the previous reform and grants access to subsidized part-time child care for all children aged zero to two, i.e. unconditional on the maternal labor force status. This reform results in a higher child care enrollment rate but has neither an impact on maternal labor force participation nor on fertility relative to the first reform. Hence, only females that are constrained in their labor force participation choice by the lack of subsidized child care are also constrained in their fertility choice. Summing up, the results suggest that at least for married females the importance of child care is too low to explain the maternal labor force participation and fertility differences between Germany or Continental Europe and the Western and Northern European countries.

The structure of the paper is as follows: In Section 2, I describe the data set, and how the sample is selected and constructed. Section 3 documents facts about maternal labor force participation, child care usage and the supply of subsidized child care in West Germany. I introduce the model in Section 4 and discuss the calibration in Sections 5 and 6. Section 7 presents the results from a set of counterfactual policy experiments and Section 8 concludes.

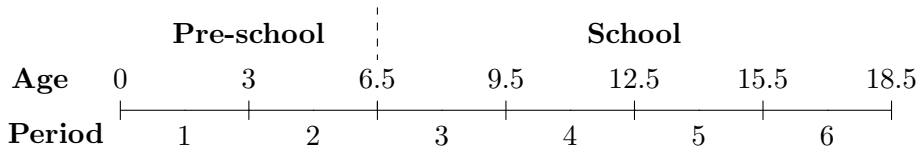
2 Data

The analysis in this paper is based on the German Socioeconomic Panel (GSOEP), an annual household panel comparable in scope to the American

PSID.[4] The GSOEP provides all information required for the pursued question, i.e. female cohabitation, labor force participation and birth histories, child care enrollment choices, paid child care fees, and income. In particular, it is the only European household panel with information on paid child care usage along the extensive and intensive (part- vs. full-time) margin over the entire sample period.[5] The data are drawn from the first wave in 1984 through 2007 spanning the years 1983 to 2006 since the variables on labor force participation and income refer to the year prior to each interview.

Following the common practice in the literature on female labor supply and fertility, only females living in a continuous relationship (marriage or cohabitation) with the same partner are included in the sample.[6] I include only the most recent relationship but require that it is still intact at the last interview and that all children (if present) are from the current partner. The analysis focuses entirely on West German females and consequently only females that lived there throughout the whole observation period are considered. Finally, given a trade-off between sample size and potential cohort effects females born between 1955 and 1975 are included. The number of individuals satisfying the respective selection criteria are shown in Table A.1 in Appendix A.1.

Figure 3: A Child's Life from Birth to Adulthood



Maternal labor force participation and child care enrollment choices by the children's age constitute the core of the analysis in this paper. Similarly to Apps and Rees (2005), my focus is however not on the maternal labor force participation status in each month of a child's life but during the different stages of a child's adolescence. For pre-school ages I follow the usual convention and split them up in two periods, ages zero to two and ages three to mandatory school age where children in Germany are on average six and a half years old. To keep the periods at a similar length, the subsequent age brackets cover three years until adulthood is reached. Figure 3 summarizes

[4] A detailed description of the GSOEP can be found in Wagner et al. (2007).

[5] The European Statistics on Income and Living Conditions (EU-SILC) also has detailed information on child care usage but started only in 2004.

[6] The implied selection bias of focussing on this group of females may go in opposite directions. For example, the unobservables that produce long-term relationships could make women more desirable in the labor market (e.g., good communication and conflict management skills) but could also reflect preferences for non-market activities as household production. A more detailed discussion can be found in Francesconi (2002).

Table 1: Observations

Age Youngest Child	Current Nr. of Children 1	2	3	4+
$<$ **3**	400	458	126	39
$<$ **6.5**	186	332	99	27
$<$ **9.5**	131	274	85	30
$<$ **12.5**	111	212	59	15
$<$ **15.5**	86	129	38	8
$<$ **18.5**	64	106	22	8

Note: To avoid biased means if there are trends in labor participation or child care enrollment within a period, i.e. during a stage of a child's adolescence, only periods that are neither interrupted by another birth nor left or right censored through the first or last interview are included.

this mapping. Table 1 presents the final number of observations for each period grouped by the current number of children, e.g. the sample contains 458 females with currently two children and the youngest child being younger than three. Given the low number of observations for females with currently four and more children, the analysis on maternal labor force participation and child care enrollment in this paper focuses on females with one to three children only.

For each period the female labor supply is constructed similar to Francesconi (2002): I assign 0 to each month in which the female does not work, 0.5 to each month in which she works part-time and 1 to each month in which she works full-time.[7] The period labor force participation status is then defined by the mean over all months. Period means below 0.25 correspond to not working, between 0.25 and 0.75 to part-time working, and above 0.75 to full-time working. As an implication, a female working part-time in each month of a period and one not working in the first half of a period but full-time in the second half have the same period labor force participation status, namely part-time working. In line with the objective of this paper this definition reflects how much a female has worked in total during certain stages of her children's adolescence.

The GSOEP asks for enrollment in two different categories of child care,

[7]The monthly labor force participation status is based on the retrospective information for the year prior to each interview. For the classification of part- and full-time work in each month I follow the convention outlined in the GSOEP documentation (`http://www.diw.de/documents/dokumentenarchiv/17/60055/pgen.pdf`).

namely daycare centers and nannies, and whether the child is enrolled part- (during the morning or afternoon) or full-time (all day). Since virtually every daycare centers receive public subsidies I use this category for publicly provided child care, henceforth called subsidized child care. During the observation period parents could claim only in special circumstances, e.g. severe diseases, financial support for hiring a nanny reflecting that nannies rather constitute a market arrangement. Accordingly, I label them as non-subsidized child care. The corresponding period enrollment status for subsidized and non-subsidized child care is then calculated in the same way as the labor force participation status.[8] Finally, aggregate statistics on the provision of subsidized part- and full-time child care by age groups (zero to two and three to six and a half) are available from the Germans Statistical Office.[9]

3 Stylized Facts

This section documents labor force participation and child care enrollment choices for the selected sample of West German married females.[10] These facts will be either used as calibration targets for the model developed in Section 4 or for the evaluation of the model by providing a set of overidentifying restrictions. I further describe features of the German child care market, namely the provision of subsidized child care as well as the parental fees for subsidized and non-subsidized child care, that can be considered as exogenous for the individual choices and will serve as model inputs.

I start with the discussion of the total maternal labor force participation and child care enrollment rates and will turn to the part- and full-time differences further below.

3.1 Maternal Labor Force Participation and Child Care

Figure 4 shows that the maternal labor force participation rate increases with the youngest child's age but at a strongly decreasing rate. In particular,

[8] The child care enrollment status is only known for the interview month. The imputation for the remaining months and how I deal with changes in the GSOEP child care questions over time is described in Appendix A.2.

[9] In Appendix A.3 I describe how I calculate the period provision rates of subsidized child care such that they are consistent with the definition of the period labor force participation and child care enrollment status as discussed before.

[10] Since the fraction of females with one, two and three children varies by the youngest child's age, see Table 1, I weight the corresponding labor force participation and child care enrollment rates by the fraction of females in the sample with one, two and three children (conditional on having children) which are given in Table 3. This adjustment has only a small quantitative but no qualitative impact on the presented facts.

the major increase happens during pre-school ages (from 31% to 61%) and at school entry (from 61% to 73%). The subsequent increases are far smaller and when the youngest child turns adult (ages 16 to 18.5) 80% of the mothers in the sample are working.

The increase of the child care enrollment rate, comprising subsidized and non-subsidized child care, from 6% for children aged zero to two to 95% for children aged three to six and a half is much larger than the corresponding increase in the maternal labor force participation rate. Accordingly, the selected sample displays a similar relationship as the cross-section of EU countries shown in Figures 1 and 2: the maternal labor force participation rate for the age group zero to two is much larger than the enrollment rate in paid child care (31% vs. 6%), whereas the opposite is true for the age group three to six and a half (61% vs. 95%). Table 2 takes a closer look at this relationship. Only 13.7% of the working mothers whose youngest child is of age zero to two use paid child care. Given the age of the children the remaining 86.3% of the working mothers necessarily use some form of non-paid child care to free up the time to work. Although 95% of the husbands are working full-time, they could still take care of the children if the females work at another time of the day than their husbands. Grandparents, other family members or friends might also take care of the children at no monetary costs. Since the total enrollment rate in paid child care is 95% for children aged three to six and a half, it is not surprising that the respective conditional child care enrollment rates hardly vary with the maternal labor force participation status.

Overall, the correlation between the maternal labor force participation and child care enrollment rate is weak whereas the correlation of both variables, particularly the child care enrollment rate, with the children's age is large. In fact as can be seen in Figure 4, the child care enrollment rate matches up perfectly with the provision rate of subsidized child care: 6.2% vs. 6.1% for children aged zero to two, and 95.4% vs. 95.6% for children aged three to six and a half. A key question is whether this concurrence is an equilibrium outcome in the sense that the demand for and supply of subsidized child care equal each other. Several arguments speak against that conjecture. First, the fees for subsidized child care are highly regulated and are rather set by the (local) administration than adjusting freely. Second, throughout the 1960's and 1970's political initiatives lead to a huge expansion of subsidized child care facilities with the aim to provide affordable, high quality pre-school education for children from age three onwards, see Kreyenfeld et al. (2002), which explains the extremely low (high) provision rates for children aged zero to two (three to six and a half). Only in recent years the political focus has shifted to the view of child care also as a means to enable mothers to work. Furthermore, the experience from the actual implementation of legislative changes on the provision of subsidized child care during the mid

Figure 4: Maternal Labor Force Participation and Child Care

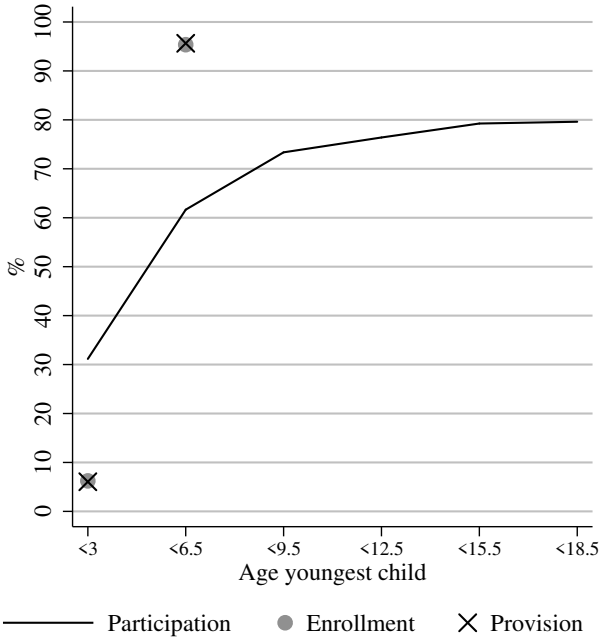
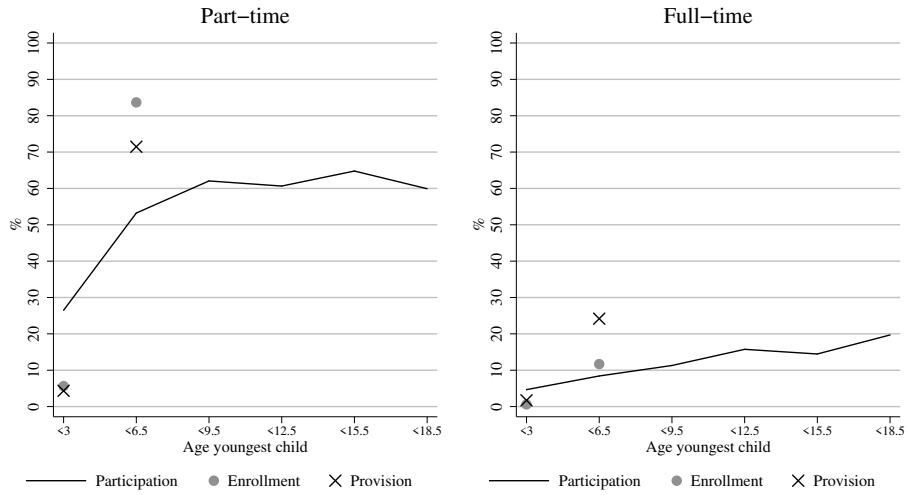


Table 2: Child Care Enrollment Rate
Conditional on Maternal Labor Force Participation Status

	Ages	
	0 to 2	**3 to 6.5**
At least part-time care		
Not Working	2.9	93.2
Working	13.7	96.7

Figure 5: Maternal Labor Force Participation
and Child Care: Part- vs. Full-time



1990's strongly suggests that the supply of subsidized child care slots adjusts only very slowly and is rather fixed in the short run, see Kreyenfeld et al. (2002) and Kolvenbach et al. (2004). Third, given the lack of aggregate statistics on the demand for subsidized child care, Wrohlich (2008) estimates the excess demand for subsidized child care to be close to zero for children from age three onwards but far above zero for the younger age group. In line with these estimates, the fraction of children enrolled in non-subsidized child care in the sample, either exclusively or in addition to subsidized child care, conditional on being enrolled in child care is only 0.8% for the age group three to six and a half but 40.4% for the age group zero to two. Assuming that the only distinctions between subsidized and non-subsidized child care are the availability (rationed vs. non-rationed) and the parental fees (non-subsidized child care is three to four times as expensive as subsidized child care, see Table C.6 in Appendix C.3) at least qualitatively this outcome could have been expected.

3.2 Part- vs. Full-time

Another important feature of the data is the prevalence of part-time maternal labor force participation, child care enrollment and subsidized child care provision, see Figure 5. The profile of the total maternal labor force participation rate follows the profile of the part-time maternal labor force participation rate until age nine and a half, while the increase afterwards mainly stems from the full-time labor force participation rate. Although the

full-time child care enrollment for children aged three to six and a half is above the corresponding full-time maternal labor force participation rate, the usage of non-paid child care is still pervasive among full-time working mothers in this age group. Only 32.4% of them actually use full-time child care. About three fourth of the subsidized child care slots are part-time with the actual enrollment rater in part-time child care being even higher because some full-time slots are only use part-time.[11]

3.3 Summary Key Facts

The facts documented in this section about labor force participation of married females with children and their child care enrollment decisions can be summarized as follows:

1. The maternal labor force participation rate grows as the children age but at a strongly decreasing rate.
2. Many non-working females use paid child care and many working females do not use paid child care.
3. Enrollment rates in child care match up with the provision rates of subsidized child care. Non-subsidized child care is only important for children aged zero to two.
4. While subsidized child care is three to four times as cheap as non-subsidized child care, it is only provided for very few children aged zero to two. Although for nearly all children aged three to six and a half a subsidized child care slot is available, the majority of those slots is only part-time.
5. For both, child care enrollment and maternal labor force participation, the part-time rates exceed the full-time rates.

In the next section, I develop a life-cycle model to explain the set of presented facts on maternal labor force participation and child care enrollment taken as given the fixed supply of subsidized child care slots and parental fees for subsidized and non-subsidized child care.

[11] Note that these facts are neither an artifact of distinguishing only by part- and full-time labor force participation nor of the aggregation of the monthly to the period statuses. The documented patterns also hold qualitatively if one considers hours worked which are however only available at the interview months. In particular, the results are not driven by mothers working very few hours. Conditional on working, only 15.6% (10.6%) of those whose youngest child is of age zero to two (three to six and a half) are working less than 10 hours. The detailed results are available upon request.

4 The Model

This section introduces a stylized life-cycle model for married females featuring fertility, labor force participation and child care choices.

4.1 Demographics

A female lives for six periods, each of three year length, reflecting the distinctive stages of a child's adolescence, as shown in Figure 3.[12] At the beginning of her life she is exogenously matched with a man and then chooses how many children to have. Both the husband and the children stay with her throughout her whole life. If a female chooses to have more than one child, all children are born as multiples. This simplifying assumption is made for tractability.

4.2 Endowments

Females and their husbands are indexed by income shocks ϵ and ϵ^* which determine the stochastic component of their market incomes. Asterisks refer to parameters for the husband. Both spouses are assigned initial income shocks $(\epsilon_1,\ \epsilon_1^*)$ in period one which subsequently evolve stochastically over time according to an AR(1) process:

$$\begin{aligned} \epsilon_t &= \rho\epsilon_{t-1} + \varepsilon_t \text{ with } \varepsilon_t \sim N(0, \sigma_\varepsilon^2) \\ \epsilon_t^* &= \rho^*\epsilon_{t-1}^* + \varepsilon_t^* \text{ with } \varepsilon_t^* \sim N(0, \sigma_{\varepsilon^*}^2) \end{aligned} \tag{1}$$

In the first two periods while children are not yet in school, females can enroll them in subsidized and/or non-subsidized child care. Both types of child care are perfect substitutes with the exception of the price and availability. In contrast to non-subsidized child care, I assume that access to subsidized child care slots, denoted as a_t, is rationed and randomly assigned to mothers by a lottery with age-dependent success probabilities.[13]

4.3 Preferences

The female is assumed to be the household's sole decision maker, i.e. she has the full bargaining power. Her per-period utility function consists of four additive parts reflecting the utility from her share of consumption $(\psi(n)c_t)$,

[12] For period two the overlap is not exact since the mean duration in the data is three and a half years.

[13] I assume that these success probabilities are independent of the maternal labor force participation status or number of children as their is no information in the data that would allow me to identify such dependencies.

her leisure $(1 - l_t - m_t)$, the number of children (n) less a fixed cost ζ of having children and a child-related quality measure $(\mathbf{Q}_t)$:

$$\begin{aligned} u_t =& \frac{(\psi(n)c_t)^{1-\gamma_0} - 1}{1-\gamma_0} + \delta_1 \frac{(1 - l_t - m_t)^{1-\gamma_1} - 1}{1-\gamma_1} \\ &+ \delta_2 \frac{(1+n)^{1-\gamma_2} - 1}{1-\gamma_2} - \mathbf{I}_{\{n>0\}}\zeta + \mathbf{I}_{\{n>0\}}\mathbf{Q}_t. \end{aligned} \tag{2}$$

Obviously, the fixed cost of having children and child quality matter only if a female has children in which case the indicator function $\mathbf{I}_{\{n>0\}}$ takes the value one and zero otherwise. With the exception of the fixed cost (ζ) the specification of the utility function is relatively standard, see e.g. Greenwood et al. (2003) or Jones et al. (Forthcoming). Household consumption (c_t) is transformed into the consumption realized by an adult, the female's share, using the OECD equivalence scale (Oxford scale):

$$\psi(n) = \frac{1}{1.7 + 0.5n}. \tag{3}$$

A female's leisure time is the normalized time endowment of one unit of non-sleeping time reduced by her labor supply (l_t) and the time she spends with her children (m_t). The fixed cost (ζ) of having children only affects the $n = 0$ vs. $n = 1$ choice but not any other decision conditional on having children. It counteracts the large utility gain females receive from having the first child through the direct utility derived from children $(\delta_2,\ \gamma_2)$ and through $\mathbf{Q}_t$.[14] The latter introduces the main behavioral trade-offs with the concrete specification being motivated by the facts outlined in Section 3. I deviate from previous formulations used in the literature, as this paper is the first attempt to explain the joint labor force participation and child care usage decisions of females within this class of models. $\mathbf{Q}_t$ gives the utility that a mother receives from spending time with her children (m_t) less the utility cost of using non-paid child care $(cc_{np,t})$, i.e. time neither spend with the mother nor in subsidized $(cc_{s,t})$ or non-subsidized $(cc_{ns,t})$ child care:

$$\begin{aligned} \mathbf{Q}_t =& \delta_3 \xi(t) m_t^{\gamma_3} - \phi(t) cc_{np,t}^{\phi_2} \\ =& \delta_3 \xi(t) m_t^{\gamma_3} - \phi(t) \left(1 - m_t - cc_{s,t} - cc_{ns,t}\right)^{\phi_2}. \end{aligned} \tag{4}$$

It is important to mention that it is out of the scope of this paper to investigate the impact of the different sources of maternal and non-maternal child care on children's human capital and that the employed specification of $\mathbf{Q}_t$ should not be interpreted in this direction.

[14] Some sort of fixed costs of having children are crucial for inducing some females to not get any children. I also have setup and calibrated a model with a fixed time cost of having children instead of a pure fixed cost. This model was however not able to explain the labor force participation behavior of mothers because of the relatively large fixed time cost needed to match the fraction of females without children.

Spending time with her children increases the mother's utility directly because she enjoys doing so and indirectly via a reduction of $cc_{np,t}$. The utility cost of using non-paid child care reflects e.g. the effort to organize care provided by grandparents, other family members or friends, the foregone joint leisure-time with the husband if he takes care of the children or the disutility of taking care of the children while working from home (e.g. as self-employed). Still, these costs can be avoided by using paid child care instead which however reduces the available resources for consumption. There cannot be an utility increasing effect of non-paid child care because otherwise there would be no reason to use paid child care. Thus, the above setup does not require that for each unit of labor supply one unit of paid child care has to be bought since instead non-paid child care could be used. Without this assumption the documented fact that not all working females use paid child care, compare Table 2, could not be generated.

Hotz and Miller (1988) assume that mothers incur a time cost of having children that declines geometrically with the age of the children to capture that children of different ages have different needs. I make a similar assumption and allow for the possibility that the utility mothers receive from spending time with their children declines geometrically over time, i.e. as the children get older. This increases both the incentive to use (more) paid and non-paid child care and to participate (more) in the labor market as the children get older. The speed of the reduction is given by the parameter $\xi_1 > 0$ whereas the lower bound, i.e. the utility in the last period when children are of age 15.5 to 18.5, is governed by $\xi_2 \in [0, 1]$ through the following linear transformation:

$$\xi(t) = \xi_2 + \frac{t^{-\xi_1} - T^{-\xi_1}}{1 - T^{-\xi_1}}(1 - \xi_2) \text{ for } t = 1, \ldots, T \text{ and } T = 6. \tag{5}$$

With the focus being on pre-school child care, I assume that the costs of non-paid child care usage only accrue while children are of pre-school age, i.e.

$$\phi(t) = \begin{cases} \phi_1 & \text{for } t \leq 2 \\ 0 & \text{else.} \end{cases} \tag{6}$$

Put differently, a mother does not have to organize child care if she does not spend time with her children after the end of the school day. Recall that the utility costs of non-paid child care are required to be negative in order to induce females to use paid child care. I assume that every female can use as much non-paid child care as she desires and that the associated utility costs are homogenous among females. This assumption can be justified as follows. First, the husbands could always take care of the children while the female is working. The only requirement, given that all husbands are working full-time, is that the spouses are working at different

times of the day. At least in principle this arrangement is open to all females, although frictions in the real world labor market might limit the choice of when to work. Second, Table B.1 in Appendix B presents evidence in favor of homogenous costs. The children's grandparents, i.e. the female's or husband's parents, are (next to the husband) the most likely provider of non-paid child care. The geographical distance towards grandparents is probably one of the most important sources for heterogeneity in access to and thus the cost of non-paid child care. Table B.1 shows that this heterogeneity does hardly translate in any statistically significant differences of the maternal labor force participation and child care enrollment rates. Although this is not a proof for homogenous costs of non-paid child care, it is clearly not a rejection of the assumption.

4.4 Budget Constraint

The per-period budget constraint is given by:

$$c_t = \tau \left[y_t(l_t, x_t, \epsilon_t), y_t^*(t, \epsilon_t^*) \right] - f_{cc} \left[n, t, cc_{s,t}, cc_{ns,t}, y_t, y_t^* \right] + \Upsilon \left[n, t, l_t \right]. \quad (7)$$

The function τ calculates the after tax household income from the female's (y_t) and husband's (y_t^*) gross income. The latter depends on two components: a deterministic component in time t, i.e. all husbands are assumed to work full-time and thus accumulate full-time experience,[15] and a stochastic component represented by the husband's current period income shock (ϵ_t^*). In contrast, the female's income depends on her labor supply (l_t), accumulated experience (x_t) through past labor force participation

$$x_t = x_{t-1} + l_{t-1}, \text{ with } x_1 = 0 \quad (8)$$

and her current period income shock (ϵ_t). Similar to the vast majority of structural models investigating labor supply and fertility choices of married females, see e.g. Hotz and Miller (1988), Francesconi (2002) or Haan and Wrohlich (2009), I abstract from savings. Child care fees f_{cc} depend on the number (n) and age (t) of the children, the utilized amount of subsidized ($cc_{s,t}$) and non-subsidized ($cc_{ns,t}$) child care as well as the gross household income. In addition, households receive transfers Υ conditional on the time period/age of the children (t) and choices (n, l_t). The functional forms for the gross incomes y and y^*, the tax schedule τ, the child care fees f_{cc} and transfers Υ are specified further below in Section 5.1.

[15] In the data, 95% of all husbands in the selected sample work full-time.

4.5 Choice Variables

All choices are assumed to be discrete. Labor supply l_t can take on three values:

$$l_t = \begin{cases} 0 & \text{for non-working} \\ \frac{1}{4} & \text{for part-time work} \quad \forall\ t = 1, \ldots, 6. \\ \frac{1}{2} & \text{for full-time work} \end{cases} \tag{9}$$

If the (non-sleeping) time endowment would be 16 hours, then part-time labor force participation would correspond to four and full-time work to eight hours. Similarly, subsidized $cc_{s,t}$ and non-subsidized child care $cc_{ns,t}$ can take on three values:

$$cc_{i,t} = \begin{cases} 0 & \text{for no paid child care} \\ \frac{1}{4} & \text{for paid part-time child care} \quad \forall\ t = 1, 2 \text{ and } i = s, ns. \\ \frac{1}{2} & \text{for paid full-time child care} \end{cases} \tag{10}$$

The actual choice of subsidized child care is however restricted by the access a_t to a subsidized child care slot:

$$cc_{s,t} \leq a_t \ \forall\ t = 1, 2, \tag{11}$$

with

$$a_t = \begin{cases} 0 & \text{no access to subsidized child care} \\ \frac{1}{4} & \text{access to subsidized part-time child care} \quad \forall\ t = 1, 2. \\ \frac{1}{2} & \text{access to subsidized full-time child care} \end{cases} \tag{12}$$

As already mentioned, access to a subsidized child care slot is determined by a lottery with age- and type-dependent, i.e. part- or full-time, success probabilities. Paid child care in subsidized and non-subsidized arrangements is restricted to

$$cc_{s,t} + cc_{ns,t} \leq \frac{1}{2} \ \forall\ t = 1, 2, \tag{13}$$

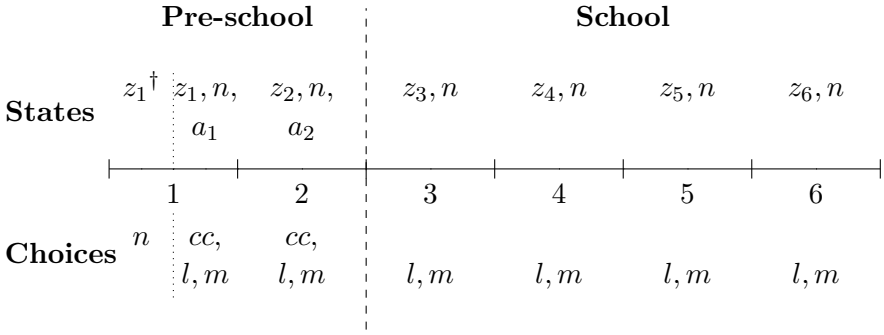
i.e. child care facilities are only open during the first half of the day in the morning and early afternoon. A mother can still spend time with her children in the late afternoon and evening such that in principle

$$m_t \in \left\{0, \frac{1}{4}, \frac{1}{2}, \frac{3}{4}, 1\right\}. \tag{14}$$

However, while she is working and/or the children are in paid child care or later in life in mandatory costless schooling (s_t), she cannot spend any time with her children:

$$m_t \leq \begin{cases} 1 - \max\{l_t, cc_{s,t} + cc_{ns,t}\} & \forall\ t \leq 2 \\ 1 - \max\{l_t, s_t\} & \forall\ 3 \leq t \leq 6. \end{cases} \tag{15}$$

Figure 6: Life Cycle



† $z_t = \{\epsilon_t, \epsilon_t^*, x_t\}$

4.6 Dynamic Problem

Figure 6 presents the timing of events during a female's life which is defined by the stages of her children's adolescence (compare also Figure 3). The term z_t combines the income shocks of both spouses ($\epsilon_t,\ \epsilon_t^*$) and the female's experience level (x_t, with $x_1 = 0$). The first period is split up in two stages with different state and decision variables. In the first stage, the initial income shocks are assigned and the female chooses the optimal number of children (n) taking into account the uncertainty with respect to the access to subsidized child care:

$$\max_n \ \{E_{a_1} V(1, \epsilon_1, \epsilon_1^*, x_1, n, a_1),\ n = 0, 1, 2, ..., N\}\,, \tag{16}$$

with $V(\cdot)$ being the female's value function. Once the optimal number of children (n) is chosen, n becomes a state variable as the children stay with the mother throughout her entire life. After access to subsidized child care is determined by the lottery, the female decides on her labor supply (l_1) and those with children, on how much time to spend with them (m_1) and on their enrollment in subsidized child care ($cc_{s,1}$), possibly restricted by a_1, and non-subsidized child care ($cc_{ns,1}$). The following Bellman equation represents the female's problem in the second stage:

$$\begin{aligned} V(1, \epsilon_1, \epsilon_1^*, x_1, n, a_1) = \max_{m,l,cc_s,cc_{ns}} & \ u_1 + \beta E_{\epsilon,\epsilon^*,a_2} V(2, \epsilon_2, \epsilon_2^*, x_2, n, a_2) \\ & \text{subject to (7), (8), (11), (13) and (15).} \end{aligned} \tag{17}$$

u_1 is the period-specific utility function (Equation (2)) and β is the discount factor. At the beginning of period two, the new income shocks ($\epsilon_t,\ \epsilon_t^*$) realize according to the AR(1) process specified in Equation (1) and access to child care (a_2) is drawn from a new lottery. The set of choice variables in period

two is identical to the second decision stage in period one and the value function is given by

$$V(2, \epsilon_2, \epsilon_2^*, x_2, n, a_2) = \max_{m,l,cc_s,cc_{ns}} u_2 + \beta E_{\epsilon,\epsilon^*} V(3, \epsilon_3, \epsilon_3^*, x_3, n, 0) \quad \text{subject to (7), (8), (11), (13) and (15).} \tag{18}$$

From period three onwards, children attend mandatory school and females cannot use child care anymore ($a_t = 0$ for $t \geq 3$). Hence, a female only decides on how much to work and how much time to spend with her children:

$$V(t, \epsilon_t, \epsilon_t^*, x_t, n, 0) = \max_{m,l} u_t + \beta E_{\epsilon,\epsilon^*} V(t+1, \epsilon_{t+1}, \epsilon_{t+1}^*, x_{t+1}, n, 0) \; \forall \; 3 \leq t \leq 6$$
$$\text{subject to (7), (8) and (15)}$$
$$\text{and } V(7, \dots) = 0. \tag{19}$$

4.7 Maternal Leave

An important element affecting labor force participation decisions of females with children aged zero to two is the German maternal leave regulation. It permits every mother who worked until the birth of a child to return to her pre-birth employer at her pre-birth wage within three years after birth. Since in the model life starts with the birth decision, there is no pre-birth labor supply and I therefore grant all females the right to go on maternal leave.[16] Relevant in this setup is the stochastic part of income. By construction, part- and full-time working mothers work at their initial or pre-birth wage income shock in period one. Hence, the maternal leave regulation has only to be modeled explicitly for mothers that do not work in the first period, i.e. for which $l_1 = 0$ or equivalently $x_2 = 0$. I assume that they draw a new income shock at the beginning of the second period according to Equation (1) (e.g. an offer for a new position) but can opt for the pre-birth income shock (e.g. return to the pre-birth position) such that the offered wage in the second period is given by $y_2(l_2, 0, \max\{\epsilon_1, \epsilon_2\})$. The third period income shock is then determined by

$$\epsilon_3 = \begin{cases} \rho \max\{\epsilon_1, \epsilon_2\} + \varepsilon_3 & \text{if } l_1 = 0, \; l_2 > 0 \\ \rho\epsilon_2 + \varepsilon_3 & \text{else.} \end{cases}$$

5 Calibration

In the following paragraphs, I specify the functional forms for the exogenous model inputs which are, where applicable, either presented as monthly or

[16] In the sample investigated here, 94% of all mothers work prior to the first birth.

annual values. When used in the model all variables are transformed to correspond to the model period length of three years. All monetary values are expressed in real terms in 2008 €. In this section I further discuss the target moments for the calibration exercise and the calibrated preference parameters.

5.1 Functional Forms

5.1.1 Income

Husbands In line with the data, all husbands are assumed to work full-time. I assume that the log of their gross income y_t^* is a concave function of time in the model or, respectively, of the youngest child's age in the data:

$$\ln y_t^* = \eta_0^* + \eta_1^*(t-1) + \eta_2^*(t-1)^2 + \epsilon_t^* \tag{20}$$

The gross full-time income $y_t(l_t = \frac{1}{2}, x_t, \epsilon_t)$ of a female is given by a classical Mincer (1974) earnings equation with returns to experience. As a normalization x_t is multiplied by two ($\tilde{x}_t = 2x_t$) such that part-time work increases $\tilde{x}$ by 0.5 and full-time work by 1:

$$\ln y_t = \eta_0 + \eta_1 \tilde{x}_t + \eta_2 \tilde{x}_t^2 + \epsilon_t. \tag{21}$$

I assume that there is no part-time penalty, i.e. the gross part-time income is half of the gross full-time income for the same level of experience and the same income shock.

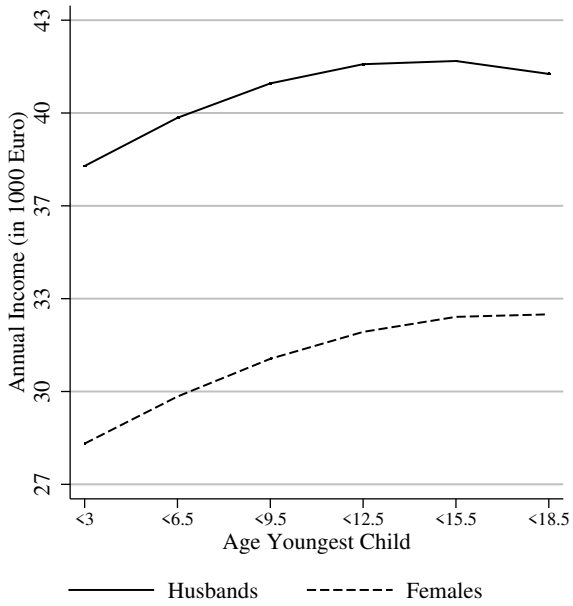
Appendix C.1 describes how the income processes are estimated. The predicted income profiles are displayed in Figure 7. For the numerical solution of the model, the AR(1) process for the income shock (Equation (1)) is discretized into 20 states using the method proposed by Tauchen (1986).

5.1.2 Taxes and Transfers

The tax code implemented in the model incorporates the three key elements of the German tax system: mandatory social security contributions, progressive and joint taxation.

Employees, excluding civil servants, have to make mandatory contributions to the pension system, unemployment, long-term care and public health insurance which accrue proportionally to income up to a contribution limit. In the model I use the average contribution limits and rates for each type of insurance over the years 1983 to 2006. Similarly, the implemented tax code is based on the average income taxes over the sample period. The construction

Figure 7: Income Profiles



of the tax code is described in Appendix C.2 which also shows the final social security contributions and tax rates used in the model. In Germany legally married couples are taxed jointly, i.e. the tax code is applied to half of the sum of the spouses' incomes and the resulting tax burden is doubled. By the progressivity of the tax system the joint net income is always at least as large as the sum of the individually taxed incomes. Although my sample includes some cohabitating but not legally married couples, I apply joint taxation.

The transfers considered include the average child benefits over the the years 1983 through 2006 which are paid each period depending on the total number of children. The average benefit per child is slightly increasing in the number children, see Table C.4 in Appendix C.2. Based on the description in Ludsteck and Schönberg (2007) non- and part-time working mothers receive in period one a maternity benefit of 2414.19 € which comprises the maternity benefits in paid during the first six months after a child is born if the mother does not work.

5.1.3 Child Care Fees

The child care fees $f_{cc}[n, t, cc_{s,t}, cc_{ns,t}, y_t, y_t^*]$ consist of two parts: the per-child fees for subsidized and non-subsidized child care in multiplied by the

Table 3: Fertility Distribution

	Nr. of Children			
	0	**1**	**2**	**3**
Fraction	10.7	21.0	50.4	17.8

Note: Figures are based on the 1140 females from the sample selected in Section 2 who have completed their fertile period, assumed to end at the age of forty.

number of children. The per-child fees for subsidized child care are the predicted values from a Tobit-regression with censoring at 0€ and at 447.72 €, the lowest and highest observed monthly fee for subsidized child care with the following set of regressors: an intercept, a full-time dummy, a dummy for ages zero to two, number of further siblings enrolled in subsidized child care, and household income.[17] The per-child fees for non-subsidized child care are the predicted values from an OLS-regression on a constant and a full-time dummy, the only two regressors that turned out to be statistically significant. The coefficients for both regressions and predicted fees are shown in Tables C.5 and C.6 in Appendix C.3.

5.1.4 Subsidized Child Care Provision Rates

The age- and type-dependent, i.e. part- and full-time, success probabilities in the lottery determining access to subsidized child care are taken from Figure 5 and are also shown in Table A.3 in Appendix A.3.

5.1.5 School Hours

I assume that children attend school part-time ($s_t = \frac{1}{4}$) in periods three and four, i.e. for ages seven to 12.5, and full-time ($s_t = \frac{1}{2}$) in periods five and six, i.e. for ages 13 to 18.5. Schooling hours matter by limiting the maximum amount of time the mother can spend with her children, compare Equation (15).

[17] The sibling discount and income dependence are part of the regulations for the subsidized child care fees. I define household income as the average monthly income of both spouses in the year the fee is observed deflated by the OECD equivalence scale given by Equation (3) to account for different household sizes.

5.2 Data Targets

The discount factor β is set to $\left(\frac{1}{1.04}\right)^3$ as in Kydland and Prescott (1982). The remaining 12 preference parameters are calibrated by matching 12 moments that are grouped in three data categories. I assign each parameter to the group where the influence is felt the heaviest. Since all parameters jointly determine the model statistics, the following discussion is only suggestive and informal.

Fertility While ζ reflects the fixed costs of having a positive number of children, δ_2 and γ_2 govern the direct utility of having children. Accordingly these three preference parameters strongly influence the fertility outcomes. I target the fraction of females without, with one and with two children. Table 3 shows the empirical fertility distribution for a maximum of three children per female which are adjusted for the fact that around 3.5% of all couples are unable to get children at all, see Robert Koch Institut and German Statistical Office (2004).

Labor Force Participation Since the focus of the analysis is on child care and thus the pre-school ages, I target the average (over all mothers) part- and full-time labor force participation rate when children are of ages zero to two and three to six and a half. In addition, both rates are targeted in the last period considered, i.e. when children are of ages 15.5 to 18.5. The six parameters governing the time allocation of the mother, i.e. leisure (δ_1 and γ_1) and time spend with the children (δ_3, γ_3, ξ_1 and ξ_2) have the tightest link to this data category. In particular, in period one neither ξ_1 nor ξ_2 have a direct impact on the utility of time spent with children since $\xi(1) = 1 \; \forall \; \xi_1, \xi_2$. The labor force participation decision in period six is as well independent of ξ_1 but strongly influenced by ξ_2 which sets the utility of time spent with children in the last period. ξ_1 in turn determines how fast the utility of time spent with the children decreases and the functional form of Equation (5) implies the largest decrease to happen between period one and two. Accordingly the value of ξ_1 has a strong influence on the labor force participation rate in period two.

Furthermore, I target the difference in the part-time labor force participation rate between mothers with one and two children of age zero to two. This statistic is affected by γ_0 through the budget constraint where the effect of labor force participation is interacted with the number of children via the equivalence scale adjustment.

Child Care Enrollment I target the part- and full-time child care enrollment rate of children aged three to six and a half (again as averages over all mothers). The parameter ϕ_1 gives the weight on the disutility of using non-paid child care and ϕ_2 governs how costly it is to increase the usage of non-paid child care.

Table 4: Targeted Data and Model moments

Target	**Data**	**Model**	$\Delta_{\textbf{Data-Model}}$
Fertility			
Fraction of females			
without children	10.7	10.1	0.6
with one child	21.0	20.0	1.0
with two children	50.4	51.2	−0.8
Maternal Labor Force Participation Rate			
Part-time			
$t = 1$	26.5	26.5	0.0
$t = 2$	53.2	54.3	−1.1
$t = 6$	60.0	59.0	1.0
$t = 1;\ \Delta_{\{n=1\}-\{n=2\}}$	10.9	10.9	0.0
Full-time			
$t = 1$	4.7	4.8	−0.1
$t = 2$	8.4	8.2	0.2
$t = 6$	19.7	19.5	0.2
Child Care Enrollment Rate			
Part-time			
$t = 2$	83.7	81.8	1.9
Full-time			
$t = 2$	11.6	12.9	−1.3

Table 5: Preference Parameters

Fertility				
Number of children	δ_2= 1.12	γ_2= 1.39		
Fixed cost of children	ζ= 0.59			
Maternal Labor Force Participation				
Consumption	γ_0= 1.98			
Leisure	δ_1= 0.23	γ_1= 2.33		
Maternal time	δ_3= 2.23	γ_3= 0.45	ξ_1= 0.03	ξ_2= 0.41
Child Care Enrollment				
Non-paid child care	ϕ_1= 0.46	ϕ_2= 2.45		

Since no closed form solution of the corresponding model moments is available, I simulate 100,000 individuals. The initial income shocks are drawn from the stationary distribution implied by the estimated parameters of Equation (1). Despite the discrete nature of all choices, small changes around the calibrated parameters induce small changes of the model statistics because of the large heterogeneity. This is also true for the fertility outcomes. Even the most likely initial combination of spousal income shocks occurs only with a probability of 1.7%.[18]

5.3 Results

Table 4 shows the data moments along with the simulated model moments for the calibrated model version. Table 5 lists the calibrated preference parameters sorted by the calibration targets with a reference to the corresponding parts in the utility function. Let me briefly comment on a few of

[18] I used for the calibration of the model parameters the asynchronous parallel pattern search algorithm described in Gray and Kolda (2006), and Kolda (2005). The corresponding software (APPSPACK) is freely available on the web (`https://software.sandia.gov/appspack/version5.0/index.html`) and was run in parallel mode on the Deutsche Bank/E-Finance Lab House of Finance Servercluster.

the calibrated preference parameters. First, the curvature of consumption is in the range of usually cited values. Second, the fixed cost ζ rescales the utility from having children such that the direct utility from having the first child (δ_2, γ_2) is 0.09 instead of 0.68. Third, the utility of maternal time spent with the children decreases at a very modest speed as the children age ($\xi_1 = 0.03$) and is for children aged 15.5 to 18.5 ($\xi_2 = 0.41$) less than half of the utility for children aged zero to two.

6 Model Evaluation

To judge the model's performance, I now turn to a set of overidentifying restrictions. In particular, I focus on non-targeted moments that are at the core of the analysis, namely child care enrollment for children aged zero to two and the joint maternal labor force participation and child care enrollment choices.[19]

6.1 Child Care Enrollment

In the model two mechanisms are at work that both generate a lower child care enrollment rate for children aged zero to two compared to children aged three to six and a half. First, the utility mothers receive from spending time with their children declines as the children get older. This in turn increases the incentive to use (more) paid and non-paid child care and to participate (more) in the labor market when the children are of ages three to six and a half compared to when the children are of ages zero to two. Second, the cost of using paid child care relative to non-paid child care are higher for children aged zero to two. While the usage of non-paid child care is assumed to be associated with the same utility costs for both pre-school age groups, the utility loss from the usage of paid child care through reduced consumption is very different. Mothers with children aged zero to two who want to use paid child care will mainly have to resort to non-subsidized child care because of the low availability of subsidized child care. In addition, paid child care is more expensive for children aged zero to two: in relative terms because the household income (conditional on the maternal labor force participation status) is on average lower; in absolute terms because subsidized child care fees are on average associated with an extra charge of around 19 € per month, compare Table C.6 in Appendix C.3.

The question is now how well these two mechanisms are jointly able to predict child care enrollment for children aged zero to two. E.g. it could be

[19] In Appendix D I discuss a set of non-targeted moments which were were only touched on in the presentation of stylized facts in Section 3.

Table 6: Non-Targeted Moments: Child Care Enrollment Rates

	Ages 0 to 2		**Ages 3 to 6.5**	
	Data	**Model**	**Data**	**Model**
Part-time	5.6 [3.1 ; 8.2]	4.0	TARGET	
Full-time	0.6 [0.0 ; 1.3]	0.5	TARGET	
Fraction Enrolled in Non-Subs. Care	40.4 [14.1 ; 66.7]	14.8	0.8 [0.0 ; 2.0]	0.1

Note: 95% confidence intervals for the data moments are given in brackets.

that the higher costs of paid child care do not matter at all if for working mothers without access to a subsidized slot, the costs of non-subsidized child care are still below the costs of using non-paid child care. As an implication, the predicted child care enrollment rates for children aged zero to two by the model would be much higher than in the data. The upper panel of Table 7 demonstrates that this is not the case. The two model mechanisms described above predict the full-time child care enrollment rate precisely (0.5% vs. 0.6%) and part-time enrollment falls only slightly short relative to the data (4.0% vs. 5.6%). The latter difference mainly stems from a too low usage of non-subsidized child care in the model compared to the data (14.8% vs. 40.4%). Nevertheless, both rates in the model still fall in the respective 95% confidence intervals and are qualitatively consistent with the low part-time child care enrollment rate for children aged zero to two in the data.

The model further predicts correctly that for children aged three to six and a half non-subsidized child care is irrelevant. This result is basically implied by the choice of calibration targets, i.e. by matching the part- and full-time child care enrollment rates for this age group at the prevailing provision rates of subsidized child care.

6.2 Conditional Child Care Enrollment

The lower panel of Table 7 shows that the child care enrollment rates conditional on the maternal labor force participation status predicted by the model are as well close to the data for both age groups. Very different outcomes for the conditional child care enrollment rates would have also been

Table 7: Non-Targeted Moments: Conditional Child Care Enrollment Rates

	Ages 0 to 2		Ages 3 to 6.5	
	Data	**Model**	**Data**	**Model**
At least part-time care				
Not Working	2.9 [0.6 ; 5.1]	2.7	93.2 [87.9 ; 98.7]	92.1
Working	13.7 [7.3 ; 20.5]	11.6	96.7 [94.2 ; 99.1]	96.4
Full-time care				
Full-time Working	3.9 [0.0 ; 11.2]	2.7	32.4 [16.7 ; 47.6]	28.8

Note: 95% confidence intervals for the data moments are given in brackets.

consistent with matching and explaining the (unconditional) child care enrollment and maternal labor force participation rates. E.g. all and not only 28.8% of the full-time working females with children aged three to six and a half (8.2 %, see Figure 4) could have been using full-time child care and the full-time child care enrollment rate (12.9%, see Figure 4) could have been generated by a lower usage of full-time child care of non- and part-time working mothers.

The successful prediction of the conditional child care enrollment rates cannot be explained by a single mechanism in the model but rather reflects that the main trade-offs mothers face in real life are captured well by the model. Just to give one example: the assignment of subsidized child care slots is random and does not favor working women. This contributes to the relative low full-time child care enrollment rates conditional on working full-time. These outcomes are of course not independent from the costs of non-paid child care (also relative to non-subsidized child care) and the selection into full-time participation.

To sum up, with the focus of the paper being on the joint labor force participation and child care enrollment choices of mothers, the good predictions of the non-targeted child care moments provide confidence in the model's explanatory power.

7 Policy Experiments

In April 2008 the German Federal government, back then a coalition of christian (CDU/CSU) and social democrats (SPD), passed a law on the supply of subsidized childcare (Kinderförderungsgesetz [Kifög]). I evaluate the major parts of this law.

7.1 Setup of the Reforms

Reform 1: For all children younger than age three a subsidized child care slot shall be provided from October 2010 onwards if both parents are working. (§24 I 2 and §24a III Sozialgesetzbuch 8)

The bill on the Kifög was introduced with the following statement: "Many parents do not realize their desired fertility level, because of the incompatibility of family and working life ... Therefore it is necessary to improve the compatibility of family and working life. To achieve this, we need more high quality child care for children younger than age three." (German Federal Parliament, 2008) By this article, the coalition expected to achieve a child care enrollment rate of 35% of all children younger than age three, and thus compliance with the target of 33% set by the European Commission at its Barcelona meeting in 2002, and to close the gap to the "exemplary standards in Western and Northern European countries, for which a relationship between child care enrollment, maternal employment and fertility is observed", see Sharma and Steiner (2008). The reform is straightforward to implement in the context of the model by conditioning access to subsidized child care (a_1) on the labor force participation status (l_1):

$$a_1 \geq l_1. \tag{22}$$

While full-time working females can always use subsidized part-time or full-time child care, I maintain the assumption that non-working females rely on the initially specified slot lottery to have access to subsidized child care. Part-time working females are in between because they can always use subsidized part-time child care but subsidized full-time child care only if they are successful in the slot lottery.

Reform 2: From August 2013 onwards all children of age one and two are entitled to a subsidized child care slot. (§24 II Sozialgesetzbuch 8)

This passage can be seen in the tradition of providing subsidized child care as a means of affordable, high quality pre-school education also for children aged one to two. This view is confirmed in a dossier of the Federal Ministry of Family Affairs, Senior Citizens, Women and Youth (Sharma and Steiner,

Table 8: Policy Regimes

	Access Probability (in %) to ... Subsidized Child Care					
	No		**Part-time**		**Full-time**	
Ages 0 to 2						
Baseline	*94.0*	$\forall\, l$	*4.3*	$\forall\, l$	*1.7*	$\forall\, l$
Reform 1	94.0	if $l = 0$	4.3	if $l = 0$	1.7	if $l \leq \frac{1}{4}$
	0.0	else	100.0	else	100.0	else
Reform 2	0.0	$\forall\, l$	100.0	$\forall\, l$	1.7	if $l \leq \frac{1}{4}$
					100.0	else

Note: $l = 0/\frac{1}{4}/\frac{1}{2}$ corresponds to non-/part-/full-time working.

2008) accompanying the Kifög in which among others the beneficial aspects of the enrollment in high-quality child care for infantile education are pointed out. Already in the 1990's an entitlement to a subsidized child care slot was introduced for children aged three to six and a half which referred to part-time slots only.[20] I therefore assume that the "new" entitlement also refers to part-time subsidized child care. The actual law applies to all children of age one and two whereas the model period comprises ages zero to two, i.e. one year more. Given the variables definition employed in Section 2 and Appendix A.3, access to a subsidized part-time child care slot for only two years in the data still corresponds to access to a subsidized part-time child care slot for the whole model period. Hence, Reform 2 will be implemented such that all mothers of children aged zero to two have at least access to a subsidized part-time child care slot for their children independent of their labor force participation status. Non- and part-time working mothers might still draw from the lottery a subsidized full-time child care slot with the success probability from the baseline setup.

Table 8 compares the baseline setup with the previously described reforms. The parental fees for subsidized and non-subsidized child care are kept at the values of the baseline setup.

I evaluate the impact of the reforms in three steps. I first compare the out-

[20]Note that in the baseline setup the total provision rate of subsidized child care for children aged three to six and a half is only 95.6% because of the lower provision rates in the first half of the observation period (up to the mid 1990's). Increasing the provision rate of part-time subsidized child care from 71.5% to 75.9% for children aged three to six and a half in the calibrated model such that for each child at least a part-time subsidized child care slot is available has no qualitative impact on the results.

come from the baseline setup with the two experiments holding the fertility choice fixed, i.e. I ask: how would the females behave if they had have made their fertility choice under the baseline setup but then faced a setup as described by the respective reforms? This permits to disentangle the direct effect on maternal labor force participation and child care enrollment from the one induced through changes in the fertility choices. In the second step, I discuss the impact of each reform on the fertility choices. Afterwards I summarize the results for the female and maternal labor force participation rates and the child care enrollment rates taking the changes in the fertility outcomes into account.

7.2 Labor Force Participation and Child Care Enrollment with Fixed Fertility

Table 9 restates the maternal labor force participation and child care enrollment rates from the baseline setup and the resulting change in percentage points under each reform. The fertility choices are held constant at their values from the baseline setup.

Ages 0 to 2 Under Reform 1, all working mothers with children aged zero to two have access to subsidized child care according to the their labor force participation status but may gain access to more subsidized child care through the initial lottery. This policy increases the part- and full-time maternal labor force participation rate by 3.2 and 1.7 percentage points. Thus in total 5.9 percentage points or 15.7% more mothers are working. For these mothers the lack of subsidized child care constituted a barrier to work. Although the results are not fully comparable, the increase in maternal labor force participation is very similar to difference-in-differences estimates from a drastic increase of subsidized child care in the late 1990's in the Canadian province of Quebec. Baker et al. (2008) estimate for two-parent families an increase of the maternal labor force participation rate of 7.7 percentage points or 14.5% and Lefebvre and Merrigan (2008) estimate for all mothers an increase of up to 8.1 percentage points or 13%. The increase in the child care enrollment rates induced by Reform 1 is with 27.3 and 6.3 percentage points much larger than for maternal labor force participation because mothers that worked in the baseline setup without using paid child care now substitute non-paid with subsidized child care. This documents a large excess demand for subsidized child care among working mothers.

The difference between Reform 1 and Reform 2 for children aged zero to two is that non-working females also have access to a subsidized part-time child care slot. Under this setup an additional 26.4% (53.7-27.3) of the mothers are starting to use subsidized part-time child care, while none of the other variables changes. This means that under Reform 1 no mother

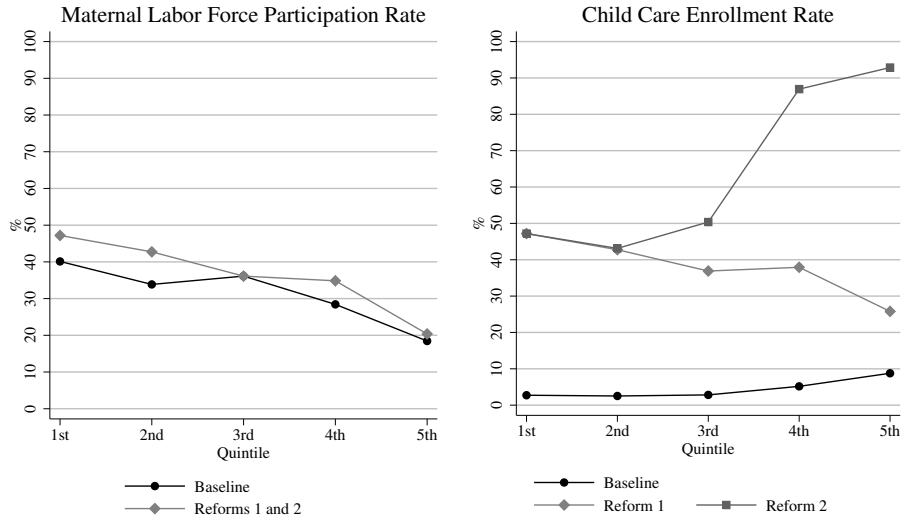
Table 9: Policy Effects with Fixed Fertility

	Participation		Enrollment	
	Part-time	**Full-time**	**Part-time**	**Full-time**
Ages 0 to 2				
Baseline	*26.5*	*4.8*	*4.0*	*0.5*
Reform 1	+3.2	+1.7	+27.3	+6.3
Reform 2	+3.2	+1.7	+53.7	+6.3
Ages 3 to 6.5				
Baseline	*54.3*	*8.2*	*81.8*	*12.9*
Reform 1	−0.3	0.0	+0.2	−0.2
Reform 2	−0.3	0.0	+0.2	−0.2
Ages 7 to 18.5 (Avg.)				
Baseline	*61.4*	*11.5*	–	–
Reform 1	+0.1	0.0	–	–
Reform 2	+0.1	0.0	–	–

is working just to be able to use subsidized child care. As mentioned before, the policy maker have set up Reform 2 to provide affordable, high quality pre-school education also for children in this age group. This presumes that child care has a beneficial aspect on the children's human capital which is however not captured by the child quality measure employed in this paper and also out of the scope of the analysis. Nevertheless, from the perspective of policy makers the higher enrollment rates can thus be judged as a success of Reform 2. Of further interest might be which mothers and thus which children are most affected by Reforms 1 and 2 as it is often argued that high quality child care is particular beneficial for children from low income families. While this latter hypothesis cannot be addressed, the model makes predictions on the former question.

Figure 8 compares the maternal labor force participation rates (left panel) and child care enrollment rates (right panel) under the baseline scenario and Reforms 1 and 2 by potential income quintiles. These are constructed with the period one, gross joint income of all couples with children assuming the

Figure 8: Policy Effects with Fixed Fertility by Potential Income



female would be working full-time. This measure has two advantages over the actual gross joint income. First, otherwise the quintiles of the baseline scenario would not be comparable to those of Reforms 1 and 2 because of the change in the labor force participation choices. Second, one and two earner couples with the same actual gross (or even net) income might have very different incentives to use child child care because of the different female labor force participation statuses.

Under Reform 1 the largest (percentage point) increase of the maternal labor force participation rate occurs for mothers from the first and second quintile. As all working mothers in this scenario use subsidized child care, the increase and the level of the child care enrollment rate in the two lowest potential income quintiles is as well the highest. This is in stark contrast to Reform 2 where only households where the woman is not working from the upper quintiles, mainly the fourth and the fifth, afford the additionally available subsidized child care. Hence, while potential income poor families benefit disproportional from Reform 1, only potential income rich households benefit from Reform 2.

A last interesting aspect regards the comparison of the baseline setup with Reform 2. With the exception of the access to subsidized full-time child care, Reform 2 introduces a setup for children aged zero to two comparable to the baseline setup for children aged three to six. In this age group in the baseline setup, but also under Reforms 1 and 2, only 63% of the mothers are working but 95% are using subsidized child care. The implied gap of 32 percentage points is very similar to the gap of 29 percentage points for children aged zero to two under Reform 2 , where 36% of the mothers

are working but 65% are using child care. Put differently, with the same access to subsidized part-time child care for both age groups, the fraction of females not working but using paid child care is nearly the same for both age groups under Reform 2.

Ages 3 to 6.5 The higher accumulated experience when the children were of ages zero to two does not change the full-time maternal labor force participation rate when the children are of ages three to six. The small decrease of the part-time maternal labor force participation rate can be explained by the maternal leave regulation. Compare two females, with exactly the same realizations of their own and husband's income shocks in periods one and two. One lives under Reform 1 (or Reform 2) and works in the first period whereas the other lives under the baseline setup but does not work due to the lack of subsidized child care. Through the maternal leave the baseline female may "return" to work at her pre-birth income shock (ϵ_1) in period two if the period two draw of the income shock (ϵ_2) is worse. The Reform 1 female can however only work for ϵ_2. Compared to the baseline setup, 0.3 percentage points of them draw such bad ϵ_2's that they are not willing to work anymore.

Ages 7 to 18.5 The maternal labor force participation rates as averages over the school years display only very small increase of 0.1 percentage points in the maternal part-time labor force participation rate relative to the baseline setup. The effects on the maternal labor force participation rate from age three onwards are so small because almost all females affected by the reforms would anyway participate in the labor market once their children turn three.

To sum up, for the same fertility choices as in the baseline setup Reform 1 demonstrates that the lack of subsidized child care for children aged zero to two constitutes a barrier to start working or to work more. The total maternal labor force participation rate goes up by 15% or 5.9 percentage points, comparable to the Quebec experience, and the full-time maternal labor force participation rate even by 35% or 1.7 percentage points. Still, the changes in the maternal labor force participation rates do hardly lead to an increased labor supply later in life. Furthermore, according to Reform 2 a substantial excess demand for subsidized child care exists also among non-working mothers of children aged zero to two. Finally, while potential income poor families benefit disproportional from Reform 1, only potential income rich households benefit from Reform 2.

7.3 Fertility

Table 10 restates the fraction of females with zero to three children as well as the implied fertility rate in the baseline setup and presents the resulting

Table 10: Policy Effect on Fertility

	Fraction with n children				Fertility
	0	**1**	**2**	**3**	**Rate**
Baseline	*10.1*	*20.0*	*51.2*	*18.7*	*1.78*
Reform 1	−2.9	+2.1	0.0	+0.8	+0.05
Reform 2	−2.9	+2.1	0.0	+0.8	+0.05

changes through the reforms.

Under Reform 1 the fraction of females without children decreases by 2.9 percentage points, i.e. by nearly 30%. For the fraction of females with two children only the net change is 0.0. In fact, 0.8 percentage points of the females with one children switch to having two children and 0.8 percentages of the females with two children switch to having three children. The total increase in the fertility rate amounts to 0.05 children per female. In analogy to the previously cited introductory statement of the Kifög (German Federal Parliament, 2008), Reform 1 allows more parents to have their first child or more children by improving the compatibility between family and working life through the provision of subsidized child care.

Under Reform 2 additionally non-working mothers of children aged zero to two are granted access to subsidized child care. There is no further reaction in the fertility distribution or fertility rate relative to Reform 1. Put differently, only those females who are constrained in their labor force participation choice through the lack of subsidized child care are also constrained in their fertility choice.

7.4 Labor Force Participation and Child Care Enrollment with Flexible Fertility

Table 11 summarizes the results from Reforms 1 and 2 with the endogenous fertility choice. For a final judgement on the effectiveness of each reform I present in addition to the outcomes for children aged zero to two the life-cycle averages of the maternal and female labor force participation rates (average over periods one to six/ages zero to 18.5).

As seen in Section 7.3 fertility choices do change. Table 11 demonstrates that it is important to endogenize fertility despite the relative low changes in the fertility rate. In comparison to a fixed fertility choice (see Table 9), the part-time labor force participation rate of mothers with children aged

Table 11: Policy Effects with Flexible Fertility

	Mothers		All Females	
	Part-time	**Full-time**	**Part-time**	**Full-time**
Participation				
Ages 0 to 2				
Baseline	*26.5*	*4.8*	*23.8*	*14.4*
Reforms 1 and 2	+5.0	+2.4	+5.4	−0.5
Life-cycle Averages				
Baseline	*54.4*	*9.8*	*49.3*	*18.5*
Reforms 1 and 2	+0.9	+1.0	+2.3	−1.5
Enrollment Ages 0 to 2				
Baseline	*4.0*	*0.5*		
Reform 1	+29.1	+7.0	−	−
Reform 2	+54.6	+7.0	−	−

zero to two increases by 5.0 percentage points if fertility is flexible but only by 3.2 percentage points if fertility is held fixed. The difference is smaller for full-time maternal labor force participation (2.4 vs. 1.7 percentage points) and most pronounced when considering the female labor force participation rates. If fertility is held fixed, the part- and full-time female labor force participation rates increase by 2.9 and 1.5 percentage points. The increase in the former rate with flexible fertility is much larger (5.4 percentage points) whereas the latter rate even decreases by 0.5 percentage points.

With flexible fertility also the labor force participation rates from age three onwards change for two reasons. First, the sample of mothers is increased by the previously childless females which have a higher tendency to participate in the labor market. Second, to support the larger family more mothers are working (more). The maternal part- and full-time labor force participation rates increase on average by 0.9 and 1.0 percentage points over the life-cylce. The total female labor force participation rate increases as well but only because the increase in the part-time female labor force participation rate is larger than the decrease in the full-time female labor force participation rate. The latter rate decreases because in the baseline setup essentially all

childless females work full-time, but those who get their first child under Reform 1 switch to part-time labor force participation.

7.5 Summary

Reform 1 achieves both goals it was set out to. Through the provision of subsidized child care conditional on the maternal labor force participation status not only barriers for the labor force participation of mothers with children aged zero to two but also for the fertility choices are removed. The fertility rate increases by 0.05 children per female and even over the whole life cycle the female labor force participation rate increases on average along the extensive margin. Furthermore, the German government expected to achieve a child care enrollment for children aged zero to two of 35%. The resulting child care enrollment rate is with 40.6% not that much above the expected level. Given the higher maternal labor force participation rates, households with a low potential income benefit disproportional from Reform 1.

Under Reform 2 which will become effective three years after Reform 1 additional 25.5 percentage points of the children will be enrolled in child care. This was the intention of the reform. There is however no additional effect on the fertility rate as only females constrained in their labor force participation choice are constrained in their fertility choice through the lack of subsidized child care. In contrast to Reform 1, only the potential income rich households with non-working mothers take advantage of the additional subsidized child care slots provided by Reform 2.

A final interesting question concerns the government budget effects of the two reforms. Obviously, given the pure life-cycle setup I am not able to account for any general equilibrium effects, e.g. the effect of the increased labor supply on equilibrium wages or of a higher fertility rate on the social security system in the future. Nevertheless, it is relatively simple to calculate the net effects at the given tax rates and costs of subsidizing a particular child care slot. For the latter concrete numbers are not available. According to Kolvenbach et al. (2004) the subsidies cover on average around 75% of the operating expenses per subsidized child care slot. I therefore assume that the costs for each type of subsidized child care slot (distinguished by age group and part- or full-time) correspond to four times the average reported fee in the GSOEP for the specific category less the actual fees paid. For children aged zero to two, the additional tax revenues generated by the changes in the female labor force participation rate exceed the additional subsidies under Reform 1 by 1.67% and nearly offset those under Reform 2 (-0.04%). Accounting also for the change in female labor force participation later in life, the discounted revenues less the subsidies are still positive for Reform 1

(0.12%) but become more negative for Reform 2 (-0.18%).[21] Furthermore, the discounted social security contributions under Reforms 1 and 2 increase by 0.24%. While these numbers certainly have to be taken with caution, e.g. any fixed costs of offering more subsidized child care slots are ignored, they suggest that the effects on the government budget are small.

8 Conclusion

At its Barcelona meeting in March 2002, the European Council recommended its member states to improve the provision of child care and even set explicit target levels. The intention of the initiative was to remove barriers for female labor force participation and possibly foster fertility. This paper asks within the context of a life-cycle model how important the provision of child care is quantitatively for female labor force participation and fertility.

In line with the facts of a cross-section of OECD countries, I document for a sample of married females in West Germany that the maternal labor force participation rate is substantially larger than the child care enrollment rate for children aged zero to two whereas the opposite is the case for children aged three to six and a half. Put differently, the correlation between the maternal labor force participation and child care enrollment rates is weak whereas the correlation of both variables, particularly the child care enrollment rate, with the childrens' age is large. The child care enrollment rates however match up perfectly with the provision rate of subsidized child care. Historical experience and empirical evidence for Germany suggest that the supply of subsidized child care is fixed in the short run despite an excess demand for it. The major contribution of this paper is to investigate in how far this fixed supply of subsidized child care at the given prices for rationed subsidized and non-rationed non-subsidized child care affects the maternal labor force participation, child care enrollment and fertility choices. I endogenize these choices within a quantitative, dynamic life-cycle model and distinguish between maternal time, paid child care provided in public (subsidized) and market (non-subsidized) arrangements as well as non-paid child care (e.g. by grandparents) to account for the age-dependent relationships between maternal labor force participation and child care enrollment as observed in the data.

I use a calibrated version of the model to evaluate two policy reforms passed by the former German governing coalition in 2008 with the first becoming effective in 2010 and the second in 2013. In particular, the first reform aims at implementing the targets for child care provision set by the European Council. The results of the two experiments can be summarized as follows.

[21] I use the same discount factor as in the optimization problem, i.e. $\left(\frac{1}{1.04}\right)^3$.

Increasing the provision of subsidized child care increases the maternal and female labor force participation rate while children are of ages zero to two and on average over the whole life-cycle. At the current provision levels of subsidized child care for children aged zero to two there is also a substantial excess demand for subsidized child care by non-working females. However, only females that are constrained in their labor force participation choice by the lack of subsidized child care are also constrained in their fertility choice. At least qualitatively, the two reforms achieve their goals. Interestingly, at least with respect to the operating expenses REFORM 1 is self-financing and even the net costs of REFORM 2 are very low. Moreover, it is worth to mention that potential income poor families benefit disproportionally from REFORM 1 whereas only the potential income rich households benefit from REFORM 2. Finally, it has to be kept in mind that the results only apply to a selected sample of females, namely those in stable long-term relationships, and not necessarily to the whole population of females.

Since the low maternal labor force participation, child care enrollment and fertility rates in Germany are representative for Continental Europe the derived policy implications should be of interest for other Continental European countries. The results of the evaluated reforms suggest that increasing the provision of child care may not be sufficient for Continental Europe to catch up to with the high maternal labor force participation and fertility rates in Western and Northern Europe.

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A Data Appendix

A.1 Sample Selection

Table A.1: Sample Selection Criteria

Criterion	Frequency Absolute	Relative
West German†, born 1955-1975	4921	100.0%
No move to East German territory	4881	99.2%
Mothers	*2868*	*58.8%*
Childless	*2013*	*41.2%*
Mothers	2868	100.0%
Births only in relationships	2276	79.4%
Births only in one relationship	2238	78.0%
Relationship intact at last interview	1938	67.6%
Childless	2013	100.0%
At least age forty at last interview and in a relationship at age forty	424	21.1%
Relationship intact at last interview	177	8.8%

Source: GSOEP 1984-2007.

† Females are assigned to West Germany by their location in 1989 or, if this information is not available, by the sample region at their first interview.

The focus of this paper is on labor force participation choices by mothers rather than childless females. In addition, I do not investigate the timing and spacing of births but only completed fertility choices. Hence, childless females are only used for the fertility analysis and therefore only included if they are at their last interview at least of age forty, the assumed age of the end of a woman's fertile period, and if their current relationship started prior to age forty such that they at least theoretically could have had given birth to a child during that marital spell.

A.2 GSOEP Child Care Questions

Child Care Enrollment Imputation Information on the child care enrollment status for each child is only available at the interview date and is therefore imputed for the other months of the year based on the following reasoning: Since school starts at the same time for all children (at least within one state), the oldest cohort in a daycare center leaves the daycare center together at the same time of the year, i.e. usually at the end of the first half of the year. Therefore the majority of entries into daycare centers occurs at the beginning of the second half of the year. Hence, the child care enrollment status in the first half (January to June) of a year is a good predictor for the status in the second half (July to December) of the previous year. Similarly, the child care enrollment status in the second half of a year is a good predictor for the child care enrollment status in first half of the next year. If the interview month is in the first half of the year, which is the case for more than 90% of the interviews, I use this child care enrollment status also for the second half of the previous year if no interview has been conducted in the second half of the previous year. Analogously, if the interview month is in the second half of the year I use this child care enrollment status also for the first half of the next year if no interview is conducted in the first half of the next year. Although this reasoning applies more to child care provided in daycare centers, I use the same imputation rule for child care provided by nannies.

Aggregate Statistics Prior to 1995, the GSOEP questionnaire only covered enrollment in child care whereas from 1995 onwards a distinction between daycare centers and nannies was made. In particular, between 1995 and 1999 the distinction between daycare centers and nannies was exclusive and from 2000 onwards non-exclusive. Furthermore, for care provided by nannies from 2004 onwards part- and full-time can not be distinguished anymore. I therefore only calculate the following two variables. Child care enrollment comprising subsidized (daycare centers) and non-subsidized (nannies) child care for all years which can be part- or full-time, and from the year 1995 onwards the fraction of children enrolled in non-subsidized child care (nannies) from all children enrolled in child care (daycare centers and/or nannies). This latter variable assumes that the relative usage of care provided by nannies prior to 1995 was the same as the average of the years 1995 to 2007. This strategy is only feasible because for the calibration exercise only aggregate moments are used but no individual observations.

A.3 Subsidized Child Care Slot Provision

The slot provision rates are calculated from the data provided by the German Statistical Office (Statistik der Jugendhilfe, various years). They are only

available for every fourth year between 1986 and 2002. Table A.3 shows the annual averages over the years 1983 to 2006, for which the monthly labor supply status from the GSOEP is used. These averages are constructed for the two age groups zero to two, and three to six and a half as follows: Years before the earliest observation of the slot provision rates, i.e. 1983 to 1985, will be assigned the same value as the first observation of the slot provision rate (1986). Similarly, years after the last observation, i.e. 2003 to 2006, will be assigned the same value as the last observation (2002). For the years between two observations the mean of the corresponding two observations will be used. The overall provision rates are then obtained as the mean over all years. From 1994 onwards the provision rates can be further distinguished by part- and full-time from which the fraction of full-time slots from all slots, the full-time share, will be calculated. As for the overall provision rate, the full-time share before the first and after the last observed data points are extrapolated and between two observation interpolated. The annual provision rate of part- and full-time slots is then given by the provision rate of slots times the fraction of part- or full-time slots from all slots. The mean over all these years then finally gives the average provision rate of part- and full-time slots.

These latter rates are used to construct the success probabilities for the slot lottery. If a female would have only one draw from the slot lottery at age zero and age three, the provision rates could be immediately used as model input. There is however no way to determine how often mothers apply for a slot within a period which is regarded as a unified entity in the model. I therefore transform the observed provision rates into period equivalents in the following way: As already described for the imputation of the child care status, the majority of entries into daycare centers happens once a year. In addition, new information on the child care enrollment status is usually only once a year available. I assume that in each year a female can draw once from the lottery and a successful draw implies that the slot is open for the remainder of the period, i.e. until age three is reached or the child enters school. Once a full-time slot is drawn, the female does not have to redraw until the end of the period. Drawing a part-time slot implies that the female can redraw but success is then defined only as drawing a full-time slot because she already has access to a part-time slot for the rest of the period. Since a model period corresponds to three years I assume that within a period there is a maximum of three draws which leads to the set of possible access histories displayed in the left panel of Table A.2.

Table A.2: Access to Subsidized Child Care

Access in Year 1	2	3	Period Access Mean	Status	History Probability
No	No	No	0	No	$(1-P_P-P_F)^3$
No	No	Part	1/6	No	$(1-P_P-P_F)^2P_P$
No	No	Full	1/3	Part	$(1-P_P-P_F)^2P_F$
No	Part	Part	1/3	Part	$(1-P_P-P_F)P_P(1-P_F)$
No	Part	Full	1/2	Part	$(1-P_P-P_F)P_PP_F$
No	Full	Full	2/3	Part	$(1-P_P-P_F)P_F$
Part	Part	Part	1/2	Part	$P_P(1-P_F)^2$
Part	Part	Full	2/3	Part	$P_P(1-P_F)P_F$
Part	Full	Full	5/6	Full	P_PP_F
Full	Full	Full	1	Full	P_F

Consider the case that a female would always use as much subsidized child care as she can get access to. In line with the definition for period child care enrollment status in each year no slot is assigned a 0, part- and full-time slots 0.5 and 1. The mean over the whole period - the three years - is given in column 4 in Table A.2 whereas column 5 corresponds to the associated child care enrollment status for each possible access history using the same thresholds as before (0.25 and 0.75). Since I assume that a female does not have to use the slot she has drawn access to for some part of the period or at all, columns 4 and 5 give the period access status as opposed to the period enrollment status. Column 6 displays the probability of observing a specific access history. P_P and P_F are the probabilities of drawing a part- or full-time slot in a given year and correspond to the observed slot provision rates which differ by age. Finally, the probability for having access to no, a part- or full-time slot over the whole period, which then corresponds to the period provision rate, is equal to the sum of the history probabilities that are associated with the respective period access status. For example, the probability to have no slot as defined by the period access status would be the sum over the two first histories ([**No, No, No**], [**No, No, Part-time**]) and equal to $(1-P_P-P_F)^3+(1-P_P-P_F)^2P_P$.

Table A.3 presents the annual, i.e. observed, slot provision rates and the period provision rates after the transformation. E.g. while there are 62.5 part-time and 14.9 full-time slots per 100 children aged three to six and

Table A.3: Annual and Period Provision Rates of Subsidized Child Care Slots

	Ages 0 to 2		**Ages 3 to 6.5**	
	Annual	Period	Annual	Period
Part-time	0.5	4.3	62.5	71.5
	$\Rightarrow$		$\Rightarrow$	
Full-time	1.7	1.7	14.9	24.2

a half, the probability for a female that she has access to a part-time slot over the whole period where the child is between age three and six and a half is 71.5% and 24.2% for a full-time slot. Note that by construction, the period provision rates have to be larger than the annual/observed provision rates. This is also the case for children aged zero to two for the non-rounded numbers.

B Model Appendix

Table B.1 shows in column one the fraction of females living within a certain distance to the children's grandparents, i.e. the female's or husband's parents. Columns two and three display the corresponding maternal labor force participation and child care enrollment rates for each category. This information is only available in the years 1991, 1996 and 2001 and has been matched with the corresponding period labor force participation and child care enrollment status. The last category ("Farther away") also includes females without any own parent or parent in law.

Table B.1: Minimum Distance to the Children's Grandparents

	Fraction	**Participation**	**Enrollment**
Ages 0 to 2			
Same house	13.1 [10.9 ; 15.4]	32.4 [23.7 ; 41.2]	1.8 [0.0 ; 4.3]
Same neigbourhood	19.8 [17.1 ; 22.4]	38.9 [31.5 ; 46.3]	7.8 [3.7 ; 11.9]
Same city	21.8 [19.0 ; 24.6]	29.3 [22.8 ; 35.9]	6.5 [2.9 ; 10.1]
Within 1h driving distance	25.1 [22.2 ; 28.0]	30.7 [24.4 ; 36.9]	5.2 [2.2 ; 8.2]
Farther away	20.2 [17.5 ; 22.9]	29.2 [22.4 ; 36.1]	5.8 [2.3 ; 9.4]
Ages 3 to 6.5			
Same house	11.7 [9.5 ; 14.0]	63.0 [53.1 ; 73.0]	89.1 [82.7 ; 95.5]
Same neigbourhood	19.5 [16.7 ; 22.2]	66.0 [58.5 ; 73.5]	90.8 [86.3 ; 95.4]
Same city	21.2 [18.4 ; 24.1]	58.1 [50.6 ; 65.6]	87.4 [82.4 ; 92.5]
Within 1h driving distance	24.0 [21.1 ; 27.0]	61.9 [55.0 ; 68.8]	81.5 [75.9 ; 87.0]
Farther away	23.5 [20.6 ; 26.5]	51.9 [44.7 ; 59.1]	77.8 [71.8 ; 83.8]

Note: 95% confidence intervals are given in brackets. The information on distance to the (children's) grandparents is only available in the years 1991, 1996 and 2001.

C Calibration Appendix

C.1 Income

The husband's income process (Equation (20)) as well as the persistence parameter ρ^* of the income shock ϵ_t^* (Equation (1)) are estimated directly from the data. I first calculate for each year the total annual labor income, including side jobs and self-employment, pensions, unemployment benefits (to capture the full risk of the income process), compensation for further training or education, and any additional payments as boni, 13^{th} and 14^{th} salary, vacation and Christmas pay received during the year. I then assign to each month in a year the corresponding monthly average of the corresponding annual income. Finally, the period income is defined as the sum of these average monthly incomes over all months in a period.

While for the husbands the earnings equations (20) and (1) can be estimated directly, this is more difficult for females since a consistent mapping between the measure of experience in the model and experience in the data is only feasible for females observed prior to their first birth. I therefore assume that females face the same earnings process as their husbands but take into account that they are on average 2.9 years younger and introduce a gender gap in mean wages to capture gender differences in education, occupations and potentially discrimination.

The age difference of nearly three years corresponds approximately to one model period. A female who has worked full-time in all periods, i.e. $\tilde{x}_t = t-1$, should receive the same (deterministic) wage a male had in the period before because of the age difference. I therefore shift the income process for husbands by one period to obtain that of females:

$$\ln Y_t(\tilde{x}_t = t-1) = \ln Y_{t-1}^* = \eta_0^* + \eta_1^*(\underbrace{t-1}_{\tilde{x}_t} - 1) + \eta_2^*(\underbrace{t-1}_{\tilde{x}_t} - 1)^2 + \epsilon_t \tag{C.1}$$

Equation (C.1) can then be reformulated to obtain the coefficients of the female income process:

$$\ln Y_t = \underbrace{\eta_0^* - \eta_1^* + \eta_2^*}_{\eta_0} + \underbrace{[\eta_1^* - 2\eta_2^*]}_{\eta_1}\tilde{x}_t + \underbrace{\eta_2^*}_{\eta_2}\tilde{x}_t^2 + \epsilon_t \tag{C.2}$$

This implies that in the model in a given period, where husbands and females by construction have the same age, females have a lower mean wage and face larger returns to experience than their spouses if $\eta_2^* < 0$. Using the full-time log wages of both sexes prior to the first birth,[22] the gender wage gap in

[22] By then 75% of the females are working full-time.

mean income controlling for age can be estimated and added to the log of the gross income:

$$\eta_0 = \eta_0^* - \eta_1^* + \eta_2^* + \Delta_{gender}. \tag{C.3}$$

The last missing piece of the income process concerns the stochastic part (Equation (1)) where I follow Attanasio et al. (2008) and use the male estimates for the females. Table C.1 summarizes the estimation results on the income process.

Table C.1: Income Process

	Estimate
Gender wage gap	
Δ_{gender}	-0.245
Deterministic part	
η_0^* / η_0	11.647 / 11.343
η_1^* / η_1	0.051 / 0.065
η_2^* / η_2	-0.007 / -0.007
Stochastic part	
ρ^*, ρ	0.882
σ_{ε^*}, σ_ε	0.272

Note: Estimation based on incomes in 2008 €. η_0 is calculated as in Equation (C.3) and η_1, η_2 as in Equation (C.2).

C.2 Taxation and Transfers

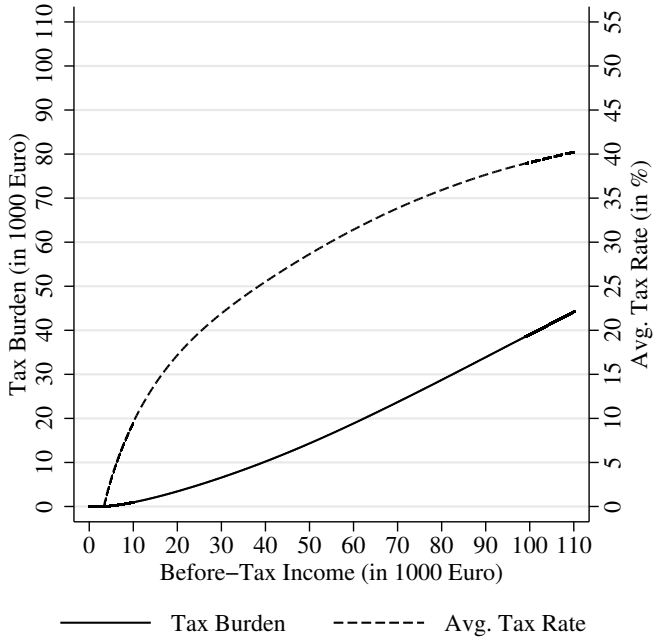
The tax code is based on the average income taxes over the sample period in 2008 €, which are available (in nominal terms) for each year on the website of the German Federal Ministry of Finance (`https://www.abgabenrechner.de/`). The tax code consists of three parts separated by two thresholds. First, annual incomes up to 3282€, the smallest income tax allowance in the years 1983 to 2006, are tax-exempted. Second, every € above 100,000 € is taxed linearly at a marginal rate of 52%. Third, every € between the two thresholds is taxed at an increasing marginal rate. The coefficients for this part are obtained by regressing the average tax burden over the sample period on a seventh order polynomial of taxable income, i.e. income less the tax allowance. The upper threshold of 100,000 € was chosen because for higher incomes the average marginal taxes does not change anymore. Figure C.1 and Table C.3 summarize the information on the progressivity of the tax code implemented in this paper.

Table C.2: Monthly Social Security Contributions

Insurance Type	**Contribution Rate (%)**	**Limit (€)**
Unemployment	3.52	4827.56
Pensions	10.29	4827.56
Health	7.28	3553.62
Long Term Care	0.40	3553.62

Source: German Federal Ministry of Labor and Social Affairs. Figures are averages over the years 1983 to 2006 expressed in 2008 € and represent the employee's contributions.

Figure C.1: Annual Tax Burden and Average Tax Rate



Source: German Federal Ministry of Finance, own calculations. Figures are averages over the years 1983 to 2006 expressed in 2008 €.

Table C.3: Annual Taxes

Taxable Income	**Tax Burden**
0 - 3282	0
3283 - 100000	$\sum_{i=1}^{7} \beta_i (y - 3282)^i$ β_1=.07415027 β_2=.00001249 β_3=-3.990e-10 β_4=9.011e-15 β_5=-1.143e-19 β_6=7.456e-25 β_7=-1.964e-30
100001 - ∞	$\sum_{i=1}^{7} \beta_i (1e5 - 3282)^i$+(y-1e5)$\times$0.52

Source: German Federal Ministry of Finance, own calculations. Figures are averages over the years 1983 to 2006 expressed in 2008 €.

Table C.4: Child Benefits

Number of Children	**Benefits**
1	93.99
2	210.23
3	379.78

Source: German Federal Ministry of Finance. Figures are averages over the years 1983 to 2006 expressed in 2008 €.

C.3 Child Care Fees

Table C.5: Monthly Per Child Fees - Regression Coefficients

	Subs.	**Non-Subs.**
Intercept	53.79	236.49
Full-time	50.20	177.52
Ages 0 to 2	21.90	—
Siblings in subsidized child care	−29.56	—
Household income[†]	0.02	—

Note: The coefficients for subsidized child care are obtained from a Tobit regression from all children in the selected sample enrolled in subsidized child care with censoring at 0 € and at 447.72 €, the lowest and highest observed monthly fee for subsidized child care. Due to the low usage of non-subsidized child care the coefficients for non-subsidized care are obtained from all children in the GSOEP in non-subsidized child care by an OLS regression. The information about fees that also allows to distinguish between subsidized and non-subsidized child care is only available in the years 1996, 2002 and 2005 and were transformed into 2008 €.

Table C.6: Monthly Per Child Fees - Predicted Values

		Subs.	Non-Subs.
Baseline fee			
Part-time		63	236
Ages 3 to 6.5			
No siblings			
Median household income†			
Extra Charges			
Full-time	(+)	46	177
Ages 0 to 2	(+)	19	—
Siblings in subsidized child care			
One further	(−)	27	—
Two further	(−)	45	—
Household income is twice the median	(+)	30	—

Note: The fees are expressed in 2008 € and are predicted values from the regressions reported in Table C.5.

† The median household income in the sample with children in subsidized child care amounts to 4583 € per month and is further deflated by the OECD (Oxford) equivalence scale to account for household size. A two parent, one child household is assumed for the baseline fees and in case of the sibling discount two and three children are used for the application of the equivalence scale.

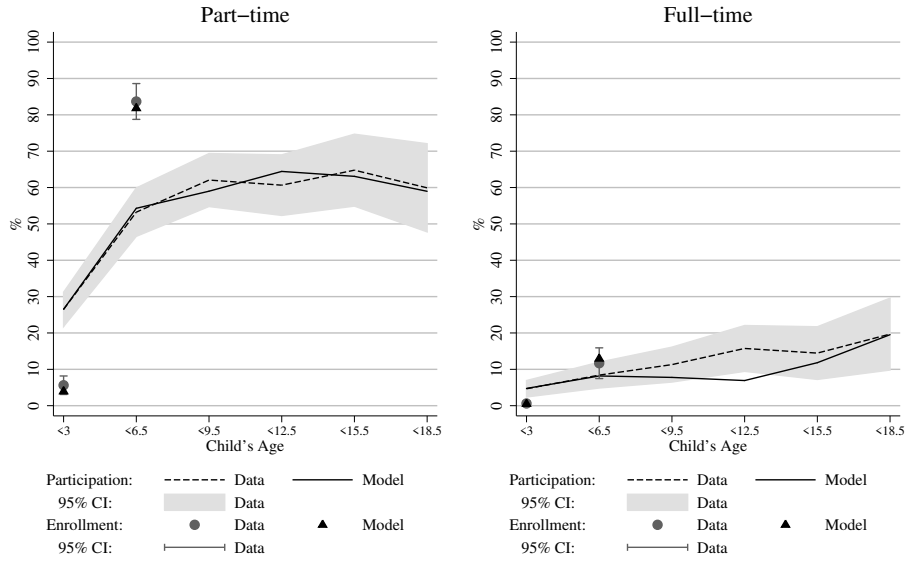
Non-subsidized child care is estimated to be three to four times as expensive as subsidized child care.This estimate seems very plausible as around 75% of the operating expenses per subsidized child care slot are covered by the subsidy, see Kolvenbach et al. (2004).

D Model Evaluation Appendix

In this section I discuss a set of non-targeted moments which were were only touched on in the presentation of stylized facts in Section 3.

The left panel of Figure D.1 shows that the part-time maternal labor force participation rate is predicted very well also for the non-targeted periods three to five. In contrast, the full-time maternal labor force participation rate in the data increases during periods three to four but decreases slightly in the model. This can be explained by the dominance of the participation-decreasing effect of the increasing husbands' income (see Figure 7) over the participation-increasing effect of the decreasing utility from spending time with the children. In the fifth period the latter effect dominates the former such that the full-time maternal labor force participation rate in the model increases and is very close to the data.

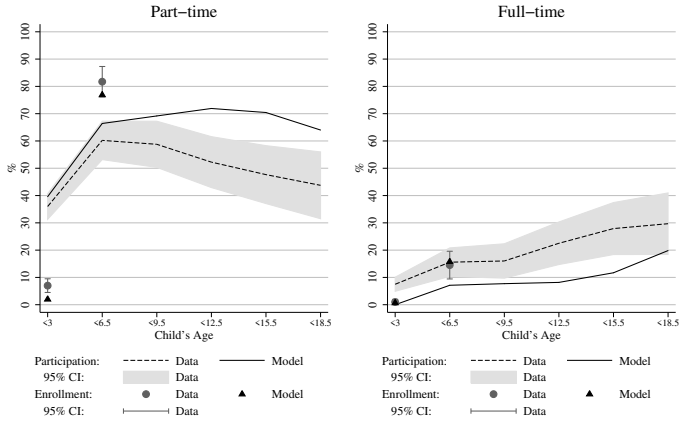
Figure D.1: Model Fit - Part- vs. Full-time Rates



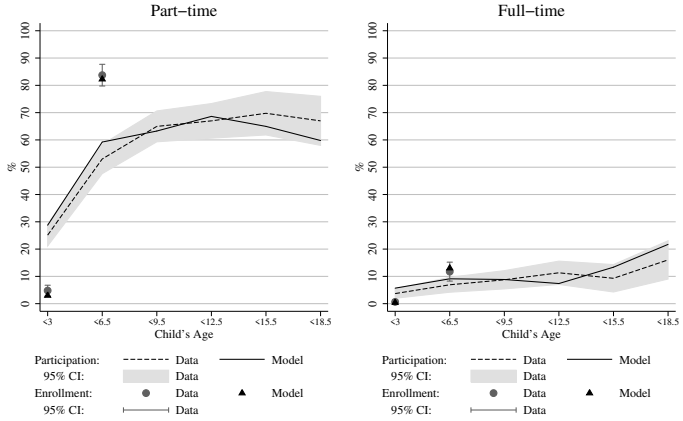
Recall that the average part- and full-time maternal labor force participation rate in periods one, two and six were used as targets. Figure D.2 documents the part- and full-time maternal labor force participation rates broken down by the number of children. The just described behavior of the full-time labor force participation rates during periods three to five is common to all parities. For females with one child part-time labor force participation is too high relative to the data, particularly once children enter school, whereas the opposite is true for the full-time labor force participation rate. For females with two children, which represent more than half of all females and

Figure D.2: Model Fit - Part- vs. Full-time Rates by the Number of Children

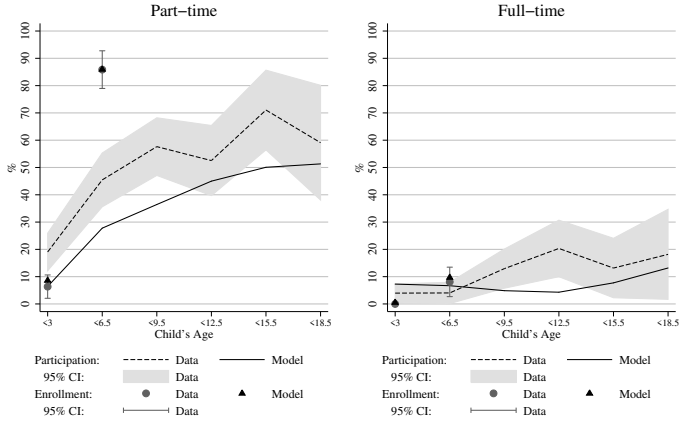
1 child



2 children



3 children

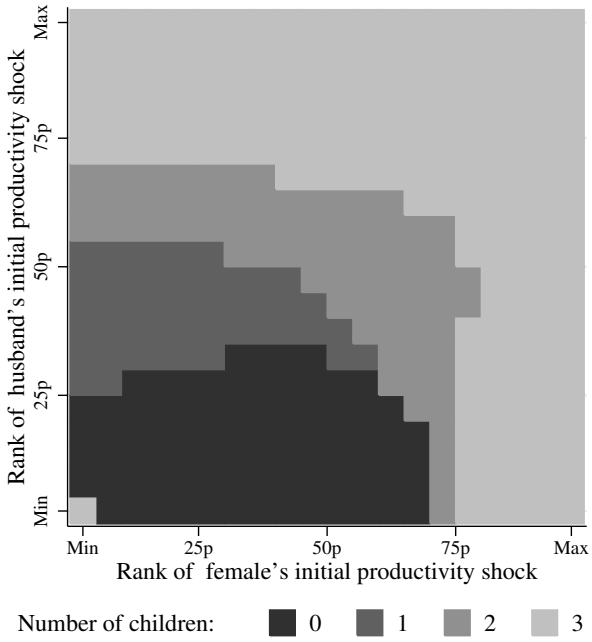


all mothers in the sample, both labor force participation rates are predicted fairly well and fall within the 95% confidence intervals. For females with three children both rates in the model are lower than the actual ones with the exception of the full-time labor force participation rate in the first two periods. The part- and full-time child care enrollment rates by the number of children are matched precisely. Although for mothers with one child the part-time child care enrollment rates are not within the 95% confidence intervals, the qualitative facts, i.e. a low (high) part-time child care enrollment rate for children aged zero to two (three to six and a half), are predicted correctly by the model.

The overprediction of part-time labor force participation of mothers with one child and the underprediction of labor force participation of mothers with three children is linked to the fertility choice. Differences in fertility outcomes stem from the heterogeneity of the initial productivity/income shocks of both spouses, see Figure D.3. Note that the probability of observing a certain combination of initial income shocks is not equally distributed but concentrated (symmetrically) around the center of the graph. Generally, fertility is increasing in the initial income shock of one spouse holding fixed the other spouse's initial income shock.[23] Jones et al. (Forthcoming) discuss the fertility-income relationship for various models. Similar to the result presented here, they show that in a static model with child care as a substitute for maternal time, fertility is increasing in household income. This relationship is responsible for the differences in the labor force participation rates between the model and data for females with one and three children. The former are on average (due to the persistence of the shock) of lower productivity types and therefore rather work part- than full-time. This force is stronger than the relatively low incomes of their husbands which in principle would provide an incentive for more females with one child to work full-time. The combination of low productivity females and husbands also explains the low part-time child care enrollment rate in the model relative to the data. Some of these females prefer to incur the utility loss of using non-paid child care over the consumption loss of using paid child care. In contrast, females with three children have a lower incentive to work part- and full-time because their husbands have a higher initial productivity (which is persistent over time) and thus a higher income on average, see Figure D.3. Only in the first two periods, where the husbands' incomes are relatively low (compared to later in life), more females with three children are working full-time in the model relatively to the data because they are

[23] Three exceptions break this monotonicity. In contrast to their "neighbors", couples with the lowest initial productivity shock combination choose three children because their income is that low that the income gain through the child benefits outweighs the decrease in the female's consumption share through the presence of the children. The two other exceptions stem from the interaction of the non-linear child care fees and benefits with the child-dependent equivalence scale in the budget constraint.

Figure D.3: Fertility and Income in the Model



themselves of a high productivity type.

Given the structure of the model employed in this paper, a direct comparison between the fertility-income relationship in the data and the model is not possible. As an approximation Table D.1 shows the coefficients from an OLS regression of the total number of children on an intercept and education dummies for the female and the husband. In the data, high education is defined as having at least a vocational degree plus the permission to attend college (Fachhochschule/Universität) or a college degree. In the model, high education is defined as having an above mean initial income shock and in the regression each spousal productivity combination is weighted according to the stationary distribution. The intercept in the model regression of 0.95 reflects the large fraction of low educated couples with zero children, compare Figure D.3.[24] In the data, low income couples have on average much more children which is reflected by the higher intercept (1.63). While the size of the education effects is not matched, the model replicates that the husband's education is a stronger predictor for fertility than the female's education by a similar magnitude in absolute terms ($\frac{0.20}{0.12} = 1.7$ vs. $\frac{1.07}{0.59} = 1.8$). However, in the model also the female's education raises the number of children while there is no statistically significant effect in the data.

[24]Note that the couples with the lowest initial productivity shock combination (who have three children) only enter with a weight of 0.000015%.

Table D.1: Fertility and Income in the Data and the Model

	Data	**Model**
Intercept	1.63^{***}	0.95^{***}
	(0.04)	(0.05)
High Educated Female	-0.12	0.59^{***}
	(0.07)	(0.06)
High Educated Husband	0.20^{***}	1.07^{***}
	(0.07)	(0.06)

Note: Standard errors are give in parentheses. $^{***}/^{**}/^{*}$ indicate significance at the 1%/5%/10% level. In the regression for the model the stationary distribution was used for weighting.