The Quantitative Role of Child Care for Fertility and Female Labor Force Participation

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Abstract

This paper documents facts about labor force participation and child care enrollment decisions of married females in West Germany. In line with the facts for a cross-section of OECD countries, a special emphasis is put on the level relationship between maternal labor force participation and child care enrollment. A calibrated life-cycle model is used to evaluate the quantitative impact of providing (subsidized) child care on maternal labor force participation and fertility.

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

JEL classification: J12, D91

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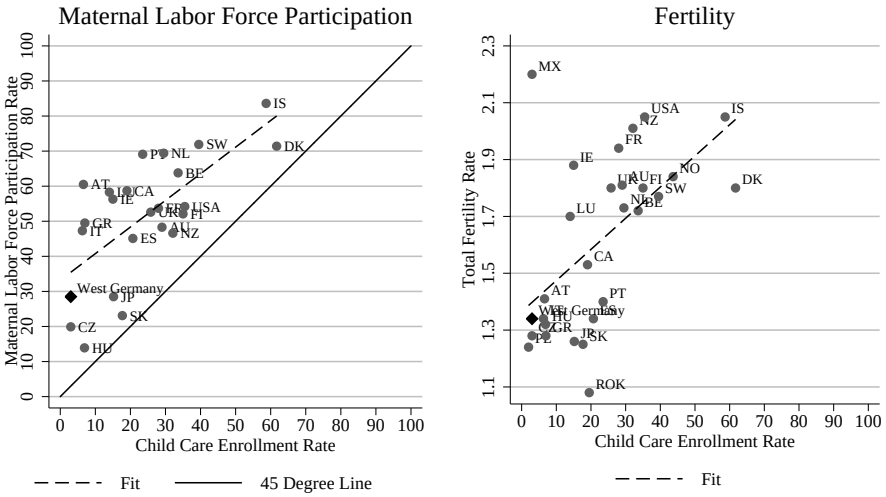
1 Introduction

> *"Member States should remove disincentives for female labour force participation and strive, in line with national patterns of provision, to provide childcare by 2010 to at least 90% of children between 3 years old and the mandatory school age and at least 33% of children under 3 years of age."*
>
> *European Council Barcelona - Conclusions of the Presidency* (2002)

According to the above quote, the lack of provision of child care is at least by EU politicians perceived as one of the main disincentives for female labor force participation. Indeed, the enrollment rate in child care of children below age three and the corresponding maternal labor force participation rate are significantly, positively correlated, see the left panel of Figure 1.

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



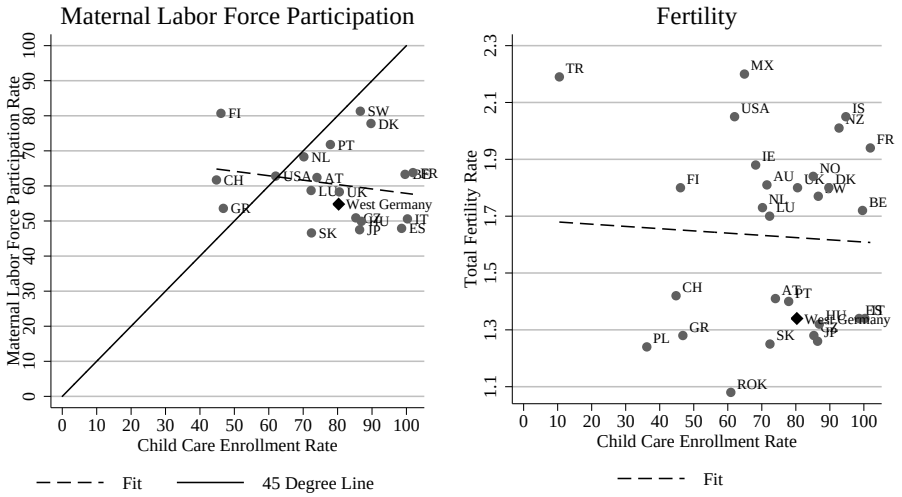
Source: OECD (2005), own calculations

As a matter of fact, the right panel of Figure 1 shows a significant positive correlation between the child care enrollment rate of children below age three and the total fertility rate – a further motivation for the interest in child care given the below replacement fertility rates in most European countries. In the light of the demographic change and the financing of the pay-as-you-go social security systems, both larger female labor force participation rates and higher fertility rates seem to be desirable.

While these facts seem supportive for the above stated quote, two concerns may be raised. First, despite the significant positive correlation for children below age three between the maternal labor force participation rate and child care enrollment rate, the latter exceeds the former by an order of magnitude.

Second, Figure 2 documents an oppositive view on child care for children aged three to five.

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



Source: OECD (2005), own calculations

While the positive correlation between the maternal labor force participation rate/total fertility rate and child care enrollment breaks down and becomes statistically insignificant for children aged three to five, the child care enrollment rate now even exceeds the participation rate for the majority of countries. This points to a very different role of child care in shaping decisions between the two age groups. In particular, paid child care is used heavily by non-working mothers (of children between age three and five) but also a substantial fraction of mothers (of children below age three) works without using any paid child care. These observations at least question the above quoted perception that the provision of child care is one of the main disincentives for female labor force participation. Furthermore, Figures 1 and 2 relate maternal labor force participation and child care enrollment but not the provision of child care.

The objective of this paper is to quantitatively assess the impact of the provision of child care on maternal labor force participation and fertility choices. To do so, I setup and calibrate a structural life-cycle model with endogenous fertility, labor supply and child care choices. The model features part- and full-time employment and is able to contrast the use of publicly provided child care, i.e. subsidized but potentially rationed, and non-subsidized and non-rationed market provided child care plus the usage of non-paid child care, e.g. provided by grandparents. The model is calibrated on West German data, as West Germany constitutes an interesting example due to its comparably low maternal labor force participation, child care enrollment and fertility rates representative for continental Europe.[1] In line with a large fraction of the economic literature on

[1] I focus on West Germany because of substantial differences in the provision of child care,

female labor supply, I focus in the empirical and quantitative analysis on females in stable, long-term relationships. While this might reduce the generality of the results, the analyzed group is from a policy perspective one of the most interesting ones. First, given the spousal income, they are the least likely to work. Second, females in stable, long-term relationships have above average fertility rates. In both cases, the response to changes in the provision of child care most likely constitutes a lower bound on responses of the population of females.

A number of recent papers investigates the quantitative importance of child care using structural models, all with the application to Germany. However, in contrast to this paper, the existing literature about life-cycle models with fertility choices and female labor force participation either does not model fertility jointly as a choice and/or requires females for each hour of work to buy one hour of child care, which is as shown in Figure 1 at odds with the data. The paper of Domeij and Klein (2009) is subject to both shortcomings although their model allows to point out some important optimal taxation considerations. Haan and Wrohlich (2009) estimate a structural, empirical micro model with endogenous fertility, but also require the strict substitution between female hours worked and usage of child care. Since most of the working West German mothers with children below age three do not use any paid child care at all, the policy implications of the results in Domeij and Klein (2009) and Haan and Wrohlich (2009) might be flawed by the inappropriate role attributed to paid child care. Wrohlich (2006) circumvents this problem by taking the option of non-paid child care explicitly into account, but does neither model fertility nor does she consider a life-cycle setting.

The results of conducting a set of counterfactual policy experiments, mimicking recently implemented or currently discussed policy reforms, can be summarized as follows: the quantitative impact of providing (subsidized) child care on female labor force participation and fertility is very small whereas financial support tailored towards mothers of young children is more effective in stimulating fertility without decreasing labor force participation in the long run.

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 the supply of paid child care, female labor force participation and child care usage in West Germany. I introduce the model in Section 4 and discuss the calibration and model fit in Section 5. In Sections 6 conduct a set of counterfactual policy experiments and Section 7 concludes.

2 Data

In this Section I introduce the data set the analysis of female labor force participation, child care and fertility in West Germany and briefly discuss the selection and construction of the underlying sample.

originating from the pre-unification period but persisting until today, the labor market and family structure between West and East Germany.

2.1 German Socio-Economic Panel (GSOEP)

The GSOEP is an annual household panel, comparable in scope to the American PSID. It is a representative longitudinal study of private households with the first survey having been conducted in 1984 for West Germany and in 1990 for East Germany. New samples were added in 1994, 1998, 2000, 2002 and 2006.[2] The variables I construct from the GSOEP include female cohabitation, female labor force participation and birth histories, child care usage, child care fees, and income profiles. The data are drawn from the 1984 to 2007 waves, and span the years 1983 to 2006 since the variables on labor force participation and income refer to the year prior to the interview.

2.2 Sample Selection

As in Francesconi (2002), only females living in a continuous relationship with the same partner are included in the sample since many economic theories of household production, female labor supply, and fertility are meant to describe behavior of this group only.[3] This might introduce a selection bias, if the unobservables affecting marriage stability are also correlated with the fertility and participation decisions.[4] In this paper, I use marriage interchangeably with cohabitation because the interest is less on the legal status but rather on living in a relationship in one household. Females with multiple relationships over the observation period enter the data set only with their most recent one and if it is still intact at the last interview. Among mothers, only those are included in the sample that have all children within the current marital spell, while for childless females the requirement is that they were already in that spell prior to age forty and thus had (at least theoretically) the possibility to give birth to a child. Furthermore, I only consider females that lived in West Germany throughout the whole observation period to ensure that all females in the sample faced the same economic environment.[5] Finally, given a trade-off between a sufficient sample size and homogenous sample of females with respect to birth years only females born between 1955 and 1975 are included. The number of individuals satisfying the respective selection criteria are shown in Table 17 in Appendix.

[2]Detailed information about the GSOEP are provided on the corresponding webpage `http://www.diw.de/english/soep/26636.html`.

[3]For a survey on fertility theories for married females see e.g. Jones et al. (2008). Recent contributions also model fertility, marriage and divorce jointly, e.g. Regalia and Rios-Rull (2001) or Greenwood et al. (2003).

[4]The direction of the sample selection bias with respect to labor force participation and fertility can go in either direction. For a detailed discussion, see Francesconi (2002) pp 347f.

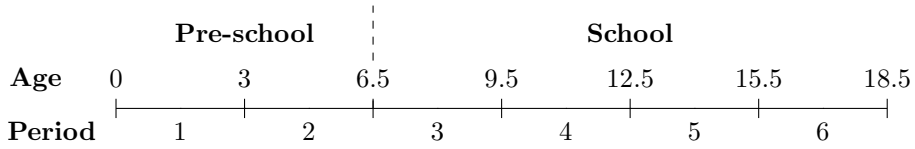
[5]Females are assigned to West Germany by their location in 1989 or, if this information is not available, by the sample region at their first interview.

2.3 Sample Construction

2.3.1 Period Definition

Female labor force participation profiles along children's age constitute the core of the analysis in this paper. Similarly to Apps and Rees (2005), my focus is less on the participation status in each month of a child's life but rather on the stages during a child's adolescence, see Figure 3.

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



The first two periods comprise the pre-schooling years with age six and a half as the mean age at school entry. The third period refers to grades one to three in elementary school (Grundschule), while the fourth period comprises fourth grade of elementary school plus grades five and six of secondary school (Förderstufe or Unterstufe). After the fifth period, teenagers can already graduate (Hauptschulabschluss) and start an apprenticeship or continue to attend school until they reach adulthood at the end of period six. All periods have a length of three years with the exception of period two which has a mean of three years.[6]

2.3.2 Labor Supply

For each period the female labor supply and child care enrollment status 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] Next, the mean over all months in a period is taken defining the period labor supply status. Values below 0.25 correspond to not working, values between 0.25 and 0.75 to part-time working, and values above 0.75 to full-time working. This assignment implies that a female working part-time in each month of the period and one not working in the first half of a period but full-time in the second half have the same period labor supply status, namely part-time working. As already mentioned before, this reflects how much a female has worked in total in certain stages during her children's adolescence.

[6] Details on the first two periods are given in Appendix A.1.1.

[7] The monthly labor force participation status is based on the retrospective information for the previous year at each interview months. I follow the convention in `http://www.diw.de/documents/dokumentenarchiv/17/60055/pgen.pdf` for the classification of part- and full-time work.

2.3.3 Child Care

In the introductory quote, the European Council instructed member states of the EU to meet certain targets of child care provision. I define publicly provided child care as follows. The GSOEP asks for two different categories of child care, namely daycare centers and nannies. Since, in contrast to nannies, 95% of all daycare centers receive public subsidies I use this category for publicly provided child care, henceforth called subsidized child care, whereas nannies are labeled as non-subsidized child care, reflecting a market arrangement. This categorization is in line with Wrohlich (2006) and Haan and Wrohlich (2009). Two limitations in the GSOEP are relevant for this paper. First, prior to 1995, the 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). The second limitation of the GSOEP relevant for this paper is that information on child care enrollment is only available for the interview date. In Appendix A.1.2 I describe how I impute the child care enrollment status for the remaining months of a year. The period child care enrollment status is then calculated in the same way as for labor supply.

One specific characteristic of subsidized child care, i.e. child care provided in daycare centers, is a limited number of available slots. Based on data from the German Statistical Office for every fourth year between 1986 and 2002, I compute the provision rate of subsidized part- and full-time slots per hundred children consistent with the definition used for the period labor force participation and child care enrollment status, see Appendix A.1.2.

2.3.4 Period Assignment

If a female has more than one child, the life periods of siblings only overlap perfectly for twins or triplets. Females observed the last time prior to the end of their fertile period might give birth to another child. Therefore, the analysis of females with one child (two/three children) will be based on the decisions of females after their first (second/third) birth until they are not observed anymore or give birth to a second (third/fourth) child. Hence, a female who gives birth to two children during the observation period contributes to facts about females with one child until the second child is born and to facts about females with two children afterwards. Moreover to avoid biased averages 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.

Recall that childless females are only included in the sample if they are observed

to reach at least age forty. I therefore assign the first three years of childless females after turning forty to the first period, the next three and half years to the second period and so forth.

2.4 Sample Size

Table 1 shows the number of observations for each period grouped by the number of children, e.g. 389 females with one child that is younger than three and 181 females with one child of age three to six and half are observed. Since there

Table 1: Distribution of Observations per Number of Children by Age

Age youngest child	**Number of children**				
	0	**1**	**2**	**3**	**4+**
$<$ **3**	68	400	458	126	39
$<$ **6.5**	38	186	332	99	27
$<$ **9.5**	14	131	274	85	30
$<$ **12.5**	0	111	212	59	15
$<$ **15.5**	0	86	129	38	8
$<$ **18.5**	0	64	106	22	8

Note: For childless females $<$ **3** corresponds to female ages 40 to 42, $<$ **6.5** to 43 and 46.5 and so forth. Since the first birth cohort of females included in the sample was born in 1945 and the last observations are from 2006, childless females could only be observed for three periods.

are not sufficient females with zero or four and more children, the analysis on labor force participation and child care enrollment in this paper will focus on females with one to three children only. The sample I use to calculate the fertility rate and distribution comprises all selected females who are at least of age 40 at their last interview, even if they only have incomplete periods and thus do not contribute to the set of stylized facts about labor supply and child care enrollment, and is restricted to females with zero to three children. Since the timing of birth is not part of the investigation in this paper, females not yet having completed their fertile period, assumed to end at the age of forty, are exlcuded. Eventually, there are 1112 females left over for the fertility analysis.

3 Stylized Facts

In this Section, I first present facts on the child care market which serve as exogenous inputs in my model. Afterwards, I present facts on female labor force participation and child care enrollment for West Germany from which a subset will be used as moments for the calibration of the model.

Table 2: Child Care Fees

		Monthly		Model Period	
		Subs.	**Non-Subs.**	**Subs.**	**Non-Subs.**
Baseline fee					
Part-time Ages 3 to 6.5 No siblings Median household income†		63	236	2278	8514
Markups					
Full-time	(+)	46	177	1661	6391
Ages 0 to 2	(+)	19	—	696	—
Siblings in subsidized child care					
One further	(−)	27	—	975	—
Two further	(−)	45	—	1632	—
Household income is twice the median	(+)	30	—	1112	—

Note: The fees are expressed in 2008 € and are predicted values from the regressions reported in Table 9.

† The median household income in the sample with children in subsidized child care amounts to 4583 € per month, i.e. 164993 € per period 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.

3.1 Child Care Market

Child Care Fees Table 2 shows the parental fees for subsidized and non-subsidized child care on a monthly basis, as reported in the GSOEP, and for the corresponding period measure (spanning three years) employed in the subsequent analysis. The per child parental fee for a subsidized part-time slot for children aged three to six and a half in West Germany amounts to 63€ per month. If the slot is full-time, the fee increases (46€) but does not double, i.e. full-time slots are even more subsidized than part-time slots. Additionally, there is a mark up of roughly 30% or 19€ for children aged zero to two. Finally, a discount of 27€ (45€) is granted if one (two) further sibling(s) enrolled in subsidized child care. Households with twice the median income face an increase in the fee of nearly 50% (30€). Non-subsidized child care is almost four times as expensive as subsidized child care which corroborate the plausibility of these estimates since around 75% of the actual costs per slot are covered by the subsidy, see Kolvenbach et al. (2004). There neither exists a significant markup for children younger than three nor a sibling discount.

Table 3: Provision Rates for Subsidized Child Care

	Ages	
	0 to 2	**3 to 6.5**
Part-time	4.3	71.5
Full-time	1.7	24.2
Total	6.1	95.6

Data Source: German Statistical Office, own calculations.

Subsidized Slot Provision Table 3 shows the provision rates of subsidized part- and full-time child care slots for the two age groups. The large gap between the two age groups originates from the initial governmental objective to provide affordable pre-school education for children from age three onwards rather than a means to enable mothers to work. Accordingly, for children aged zero to two hardly any subsidized child care is provided – only for 4.3 out of hundred a part-time and for 1.7 a full-time slot – whereas for nearly every child from age three to six and a half.

Although aggregate statistics on queuing for subsidized child care slots are not available, the supply of subsidized child care slots in Germany is usually considered to be fixed, at least in the short to medium run, rather than an equilibrium outcome equating demand for subsidized child care at the regulated, fixed prices, see Kreyenfeld et al. (2002). Wrohlich (2008) estimates the excess demand to be close to zero for children from age three onwards but far above zero for the younger age group.[8] Put differently, some females might face a constrained choice set when deciding on child care enrollment. This margin constitutes the potential of the government to increase the provision of subsidized child care.

[8]The numbers in Wrohlich (2008) are not directly comparable to those discussed in this paper due to the differences in the period length and the sample selection.

3.2 Female Labor Force Participation and Child Care Enrollment

In the following paragraphs I document child care enrollment and female labor force participation rates for West Germany. Due to the variable definitions employed here, time effects cannot really be controlled for and cohort effects are only small such that I abstract from them. In this section I document facts as averages over all mothers. Since the fraction of females with one, two and three children is not the same in each period, see Table 1, I weight the corresponding labor force participation and child care enrollment rates by the fraction of West German females in the sample with one, two and three children, conditional on having children, which are given in Table 11. This adjustment has only a small quantitative but no qualitative impact on the presented facts. Despite the differences in the selection of the sample and the construction of the variables, the documented patterns are similar to those in Wrohlich (2006) and Kreyenfeld (2001).[9]

Table 4: Subsidized and Non-Subsidized Child Care

	Part-time	**Full-time**	**Total**
Ages 0 to 2			
Provision Rate Subsidized	4.3	1.7	6.1
Enrollment Rate (Subs. and Non-Subs.)	5.6	0.6	6.2
Fraction Enrolled in Non-Subsidized Care	–	–	40.4
Ages 3 to 6.5			
Provision Rate Subsidized	71.5	24.2	95.6
Enrollment Rate (Subs. and Non-Subs.)	83.7	11.7	95.4
Fraction Enrolled in Non-Subsidized Care	–	–	0.8

Subsidized and Non-Subsidized Child Care Child care enrollment (6.2%) for children *aged zero to two* is slightly above the provision rate (6.1%) with part-time enrollment being predominant and larger than the number of subsidized slots. While this can be partly attributed to full-time slot being filled only part-time, non-subsidized child care is also an important source of paid child care in this age group. 40.4% of those enrolled in child care are enrolled in non-subsidized child care, either exclusively or in addition to subsidized child care.[10]

[9] Kreyenfeld (2001) looks all mothers independent of the relationship status from the 1997 Mikrozensus, a representative cross-section of the German population. Similar to my paper, Wrohlich (2006) focuses on females in relationships and uses the 2001 to 2003 waves from the GSOEP. In both studies, attention is restricted to mothers with children up to age ten.

[10] Recall that due changes in the survey only the total child care enrollment rate in subsidized and non-subsidized child care can be computed separately (cf. Section 2.3.3) and the fraction enrolled in non-subsidized child care condition on being enrolled in some child care.

The picture looks entirely different for children *aged three to six and a half.* Enrollment increases to over 95.4% and matches up very closely with the provision rate. Part-time child care is used much more than full-time care and again exceeds the supply of part-time slots. However, for this age group this is explained by the number of full-time slots being filled part-time as opposed to non-subsidized child care, which is negligible in absolute and relative terms.

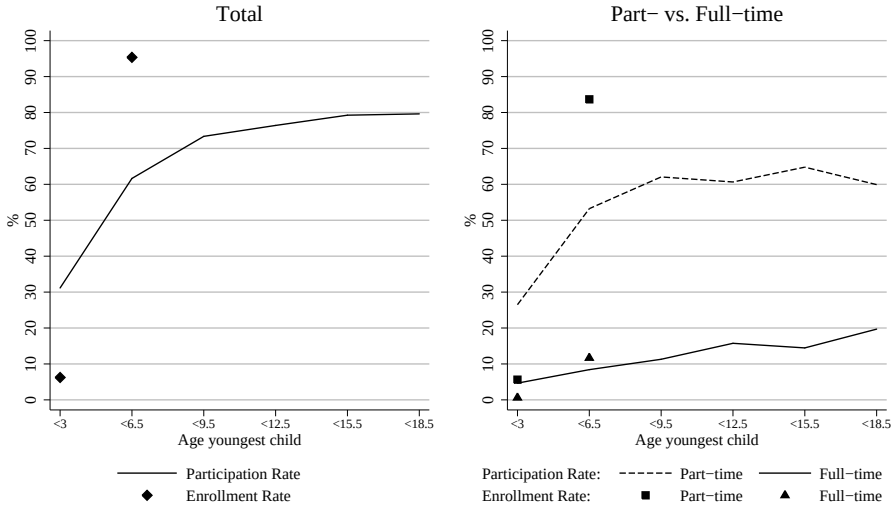
Table 5: Child Care Enrollment Rate
Conditional on Maternal Labor Force Participation Status

	Ages	
	0 to 2	**3 to 6.5**
At least part-time care		
Not Working	2.9	93.2
Part-time Working	11.8	96.6
Full-time Working	24.4	97.0
Full-time care		
Full-time Working	3.9	32.4

Child Care Enrollment by Maternal Labor Force Participation Table 5 shows the overall child care enrollment rate conditional on the maternal labor force participation status (upper panel) and the full-time child care enrollment rate of full-time working mothers (lower panel). This table highlights two of the facts discussed in the introduction for the cross-section of OECD countries. While children are of ages zero to two, only 11.8% of the part-time and 24.4% of the full-time working mothers use some paid child care, and for the latter group only 3.9% use full-time care. The remainder of working females, i.e. the vast majority, is not using any paid child care. Given the age of the children and since virtually all husbands are working full-time, these females necessarily use some form of non-paid child care, e.g. own parents (in law) or other family members and friends, to free up the time to work. In contrast, for children aged three to six and a half the enrollment rate is nearly independent of the maternal labor force participation status, even 93.2% of the non-working females use child care. However, with regard to full-time working females again only 32.4% use paid full-time child care and thus 67.6% use at least some non-paid child care.

Labor Supply and Child Care While the facts presented in the previous paragraph show the relative numbers of females not using child care and working and the relative numbers of females using child care but not working, the quantitative importance of these groups becomes obvious only when looking at the female participation rates. More than 30% of the females with a child of ages zero to two are working and still close to 40% of the females with a child of ages three to six and half are not working, cf. the left panel of Figure 4. Attempts

Figure 4: Labor Force Participation and Child Care Enrollment Rates



to quantify the role of child care for female labor force participation need to acknowledge the fact that a large fraction of females works without using paid child care but also uses paid child care without working.

The maternal labor force participation rate increases the strongest in the early periods of a child's life but levels off later in life at 80%. The right panel of Figure 4 provides the split of the overall participation and enrollment rates by part- and full-time. As for the enrollment rates, cf. Table 4, part-time participation dominates and explains the shape of the overall participation rate whereas full-time participation increases nearly linearly from 5% to 20% throughout a child's adolescence.

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. Subsidized child care is on the one hand around four times as cheap as non-subsidized child care, but on the other hand only provided for very few children aged zero to two whereas for nearly all children aged three to six and half.

2. Enrollment rates in child care match up with the provision rates while non-subsidized child care is only important for children aged zero to two.

3. Child care is on the one hand used by non-working females but on the other hand not used be working females.

4. The labor force participation rate grows strongly while children are of pre-school age and less afterwards.

In the next Section, I develop a life-cycle model that aims to capture this set of stylized facts for West Germany.

4 The Model

The model is based on the setup by Greenwood et al. (2003). While I abstract from marriage and divorce decisions and the implied equilibrium considerations discussed in their work, I extend the model by child care and a richer life-cycle structure.

4.1 Demographics

A female lives for six periods and is exogenously matched with a man at the beginning of her life. By then she chooses how many children to have and both the husband and children stay with her throughout her whole life. In case the female chooses to have more all children are born as multiples. This simplifying assumption is guided by one of the two objectives of the analysis: to quantify the importance of child care on the total number of children a female desires to have. The period length corresponds to three years reflecting the distinctive stages of a child's adolescence, compare Figure 3.[11]

4.2 Endowments

Each female and her husband are indexed by productivity levels ϵ and ϵ^* representing the stochastic part of each spouses' market wages (Asterisks refer to parameters for the husband. Both spouses are assigned initial productivity levels ($\epsilon,\ \epsilon^*$) in period one which follow an AR(1) process over time:

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

In the first two periods while the 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 time-dependent success probabilities.

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

4.3 Preferences

The female is assumed to be the household's sole decision maker and her per-period utility function consists of four additive parts reflecting the utility from her share of consumption, her leisure, the number of children and a measure of child quality:[12]

$$u_t = \frac{(\psi(n)c_t)^{1-\gamma_0} - 1}{1-\gamma_0} + \delta_1 \frac{(1-l_t-m_t)^{1-\gamma_1} - 1}{1-\gamma_1} + \delta_2 \frac{(1+n)^{1-\gamma_2} - 1}{1-\gamma_2} + \mathbf{Q}_t. \tag{2}$$

4.3.1 Consumption

Household consumption c_t is transformed into the consumption realized by an adult, the female's share, using the OECD equivalence scale (Oxford scale):

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

with n being the number of children in the household. The budget constraint is given by:

$$c_t = \tau\left[y_t(l_t, x_t, \epsilon_t), y_t^*(t, \epsilon_t^*)\right] - p_{cc}\left[n, t, cc_{s,t}, cc_{ns,t}, y_t, y_t^*\right] + T\left[n, t, l_t\right]. \tag{4}$$

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 (in line with the all husbands are assumed to work full-time and thus accumulate full-time experience) and a stochastic component represented by the husband's current period productivity shock (ϵ^*). In contrast, the female's income depends on her labor supply (l_t), accumulated experience through past labor force participation

$$x_t = x_{t-1} + l_{t-1}, \tag{5}$$

and her current period productivity shock (ϵ_t^f).

Child care fees p_{cc} are related to the number of (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 T conditional on the time period (t) and choices (n, l_t).

The functional forms for the gross incomes y and y^*, the tax schedule τ, the child care pricing function p_{cc} and transfers T are specified further below in Section 5.1.

4.3.2 Leisure

Each female is endowed with one unit of non-sleeping time which is reduced by labor force supply (l_t), and maternal time investment (m_t) in her children.

[12] Greenwood et al. (2003) interact the utility from having children with child quality. Similar to one of the specifications in Jones et al. (2008) I use separability which allows me to pin down the parameters by moments more clearly.

4.3.3 Children

Children enter the utility function directly in form of a durable consumption good.

4.3.4 Child quality

I model a reduced form measure of child quality $\mathbf{Q}_t$ consisting of the time a mother spends with her children (m_t), non-paid child care, i.e. time neither spend with the mother nor in paid child care ($1 - m_t - cc_{s,t} - cc_{ns,t}$) and a fixed cost of having children (ζ):

$$\mathbf{Q}_t = \mathbf{I}_{\{n>0\}} \left(\delta_3 \xi(t) m_3^{\gamma} - \phi(t) \left(1 - m_t - cc_{s,t} - cc_{ns,t}\right)^{\phi_3} - \zeta \right). \tag{6}$$

Child quality matters only if a female has indeed children in which case the indicator function $\mathbf{I}_{\{n>0\}}$ takes the value one and zero otherwise. Ignoring the fixed costs ζ which I discuss in detail further below, this formulation has two possible interpretations. First, it could reflect the quality time mothers enjoy when being with their children. However, if they do not spend time with their children, someone else has to take care of them, which could happen either through paid child care or non-paid child care. While paid child care reduces the available resources for consumption, non-paid child care decreases utility, e.g. because of the effort to convince the grandparents to take care of the grandchildren. Second, it could reflect child quality in the sense of the children's human capital measured relative to the omitted category of paid child care. Maternal time spent with the children increases their human capital, while the negative impact of non-paid child care could reflect that e.g. care by grandparents because of different attitudes concerning education might be harmful. In the following analysis I will stick to the first interpretation. It is important to stress that this setup does not imply that for each unit of labor supply one unit of paid child care has to be used because females can also use non-paid child care. This assumption is crucial for being able to match the fact that not all working females use paid child care.

Similar to the setup by Hotz and Miller (1988), I assume that the utility mothers receive from spending time with their children might decline geometrically over time, i.e. as the children age, with the parameter $\xi_1 > 0$ and is linearly transformed to fall in the interval $[\xi_2, 1]$ with $\xi_2 \in [0, 1]$:[13]

$$\xi(t) = \xi_2 + \frac{t^{-\xi_1} - T^{-\xi_1}}{1 - T^{-\xi_1}}(1 - \xi_2) \text{ for } t = 1, \ldots, T \text{ and } T = 6. \tag{7}$$

The contribution of non-paid child care has to enter negatively, otherwise costly paid child care would simply not be used. As the utility of time spent with the children, I allow the impact of non-paid child care on child quality to be

[13] In Hotz and Miller (1988), this is not a choice but a fixed time cost.

age-dependent, i.e.

$$\phi(t) = \begin{cases} \phi_1 & \text{for } t = 1 \\ \phi_2 & \text{for } t = 2 \\ 0 & \text{for } t > 2 \end{cases} \tag{8}$$
$$= \phi_1^{\mathbf{I}_{\{t=1\}}} \phi_2^{\mathbf{I}_{\{t=2\}}} \mathbf{I}_{\{t \leq 2\}},$$

where $\mathbf{I}_{\{cond\}}$ is the indicator function that takes the value of one when *cond* is true and zero otherwise. With the focus of the analysis in this paper lying on pre-school child care I do not model child care once children enter school and as a consequence do not consider the impact of non-paid child care anymore. I assume that every female can use as much non-paid child care as she desires. It might be argued that some females have access to non-paid child care and others not, e.g. because some live closer and other further away from the own parents or parents in law who are the most likely provider of non-paid child care. This information is available for three years (1991, 1996, 2001) in the GSOEP for five categories: living in same house, same neighborhood, same city, within 1h driving distance, further away/non-existent. Surprisingly, the participation rates for females with children aged zero to two, and aged three to six and a half, are essentially independent from this distance measure, see Table 20 in Appendix B. Although this is no evidence in favor of homogenous access to or costs of non-paid child care, it is at least not a rejection of this assumption.

Finally, the parameter ζ is deducted from the child quality measure for a technical reason. Since ζ is fixed, conditional on having children ζ neither affects the choice of maternal time investment nor of child care usage but only the $n = 0$ vs. $n > 0$ decision. The negative fixed cost of having children counteracts the large utility increase females experience from having the first child through the benefit of spending time with the children (although the net effect might be lower in periods one and two if non-paid child care is used) and the fact that the difference in the utility derived from the pure presence of children ($\delta_2,\ \gamma_2$) is the largest for the $n = 0$ vs. $n = 1$. In economic terms ζ essentially rescales the utility from spending time with children.

4.4 Choice Variables

All choices are assumed to be discrete. Labor supply l 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 work would correspond to four and full-time work to eight hours. Similarly, subsidized cc_s and non-subsidized child care cc_{ns} can take on three values:

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

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

$$a_t = \begin{cases} 0 & \text{no access to subsidized child care} \\ \frac{1}{4} & \text{access to a part-time subsidized child care slots} \\ \frac{1}{2} & \text{access to a part-time subsidized child care slots} \end{cases} \quad \forall\ t = 1, 2 \tag{11}$$

such that

$$cc_{s,t} \leq a_t \ \forall\ t = 1, 2. \tag{12}$$

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 to

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

which could be interpreted such that child care facilities are only open during the first half of the day, i.e. 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

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

However, a mother cannot spend time with her children while these are in child care or she is working. Once children are of school age, $cc_{s,t}$ is replaced by the time spend in mandatory, costless school s_t:

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

4.5 Dynamic Problem

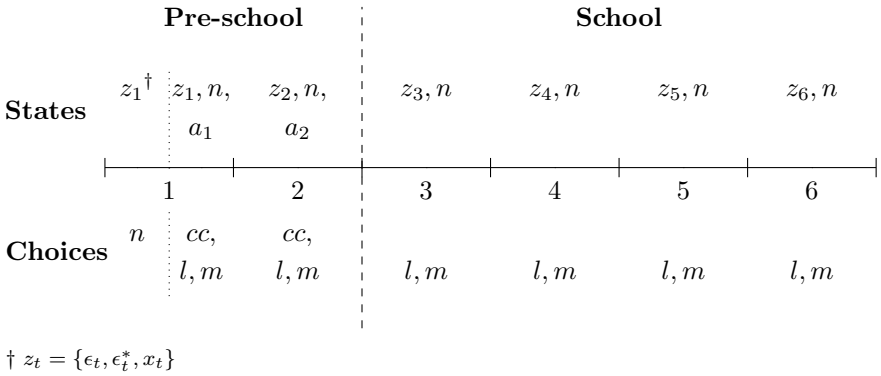
Figure 5 presents the timing of events during a female's life which is defined by the stages of her children's adolescence, compare also Figure 3. The term z_t combines the productivity states of both spouses ($\epsilon_t,\ \epsilon_t^*$) and the female's experience level (x_t, with $x_1 = 0$). The first period is split up in two stages with different state and decision variables. In the first stage, the initial productivity levels 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:

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

Once the optimal number of children (n) is chosen, n becomes a state variable since the children stay with the mother throughout her entire life. After access to subsidized child care is determined by a 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:

$$\begin{aligned} V(1, \epsilon_1, \epsilon_1^*, x_1, n, a_1) = & \max_{m, l, cc_s \leq a_1, cc_{ns}} u_t + \beta E_{\epsilon, \epsilon^*, a_2} V(2, \epsilon_2, \epsilon_2^*, x_2, n, a_2) \\ & \text{subject to (4), (5), (13) and (15).} \end{aligned} \tag{17}$$

Figure 5: Life Cycle



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

u_t is given by Equation (2) and β is the discount factor. At the beginning of period two, the new productivity levels ($\epsilon_t,\ \epsilon_t^*$) 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. The value function in period two is

$$V(2, \epsilon_2, \epsilon_2^*, x_2, n, a_2) = \max_{m,l,cc_s \leq a_2, cc_{ns}} u_t + \beta E_{\epsilon,\epsilon^*} V(3, \epsilon_3, \epsilon_3^*, x_3, n, 0) \quad \text{subject to (4), (5), (13) and (15).} \tag{18}$$

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

$$V(t, \epsilon_t, \epsilon_t^*, x_t, n, 0) = \max_{m,l} u_t + \beta E_{\epsilon,\epsilon^*} V(t+1, \epsilon_{t+1}, \epsilon_{t+1}^*, x_{t+1}, n, 0) \ \forall\ 3 \leq t \leq 5 \quad \text{subject to (4), (5) and (15).} \tag{19}$$

In the last period, the female only maximizes the current-period utility:

$$V(6, \epsilon_6, \epsilon_6^*, x_6, n, 0) = \max_{m,l} u_t \text{ subject to (4) and (15).} \tag{20}$$

4.6 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 has been working 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.[14] By construction, part- and full-time working mothers work at their "pre-birth"

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

wage 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 their offered wage in the second period is given by $y_2\left(l_2, 0, \max\{\epsilon_1, \epsilon_2\}\right)$ and the third period productivity level is 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

Before turning to the calibration of the preference parameters and discussing the corresponding data moments, I present the functional forms for the so far unspecified elements of the budget constraint.

5.1 Elements of the budget constraint

5.1.1 Income

Husbands In line with the data, all husbands are assumed to be working 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):

$$\ln Y_t^* = \eta_0^* + \eta_1^*(t-1) + \eta_2^*(t-1)^2 + \epsilon_t^*, \tag{21}$$

with $y_t^* = e^{Y_t^*}$. Equation (21) as well as the persistence parameter ρ^* of the income shock ϵ_t^* (Equation (1)) can be estimated directly from the data. The period income is defined as the total 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 13^{th} and 14^{th} salary, vacation and Christmas pay or any further boni received during the period.

Females The gross full-time income Y_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:

$$\ln Y_t = \eta_0 + \eta_1\tilde{x}_t + \eta_2\tilde{x}_t^2 + \epsilon_t, \tag{22}$$

with $y(l_t = 1, x_t, \epsilon_t) = \frac{1}{2}e^{Y_t}$ for part-time and $y(l_t = 2, x_t, \epsilon_t) = e^{Y_t}$ for full-time working females.

While for the husbands the wage equations (21) 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 wage process as their husbands but take into account that they are on average 2.9 years younger and introduce a gender gap in wages originating from gender differences in education and occupational choices and potentially a discriminatory component.

The age difference of nearly three years corresponds to one model period. I shift the income process for husbands by one period to obtain that of females, as a female that 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

$$\begin{aligned} \ln Y_t(\tilde{x}_t = t-1) &= \ln Y^*_{t-1} \\ &= \eta^*_0 + \eta^*_1(\underbrace{t-1}_{\tilde{x}_t} - 1) + \eta^*_2(\underbrace{t-1}_{\tilde{x}_t} - 1)^2 + \epsilon_t \end{aligned} \tag{23}$$

Equation (23) can then be reformulated to obtain the coefficients of the female income process:

$$\ln Y_t = \underbrace{\eta^*_0 - \eta^*_1 + \eta^*_2}_{\eta_0} + \underbrace{[\eta^*_1 - 2\eta^*_2]}_{\eta_1}\tilde{x}_t + \underbrace{\eta^*_2}_{\eta_2}\tilde{x}^2_t + \epsilon_t \tag{24}$$

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 wages of both sexes prior to the first birth, the gender wage gap in mean income not driven by the age difference can be estimated and added to the log of the gross income:[15]

$$\eta_0 = \eta^*_0 - \eta^*_1 + \eta^*_2 + \Delta_{gender}. \tag{25}$$

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 6 and Figure 6 summarize the estimation results on the income process. It is worthwhile to mention that the difference between η_0 and η^*_0 without the gender wage gap is -0.058. Not controlling for age would increase the pre-birth gender wage gap by -0.069. Thus, using the same experience profile for husbands and females but shifting it by one period as done in Equation (23) and Equation (24) provides an accurate estimate of the pre-birth gender income difference due to the age difference of spouses.

For the numerical solution of the model, the AR(1) process for the productivity shock (Equation (1)) is discretized using the method proposed by Tauchen (1986) into 20 states. The initial productivity levels are assigned according to the corresponding stationary distribution.

5.1.2 Tax Code

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

Progressivity The tax code is based on the average income taxes over the sample period in 2008 €, which are available (in nominal terms) for each

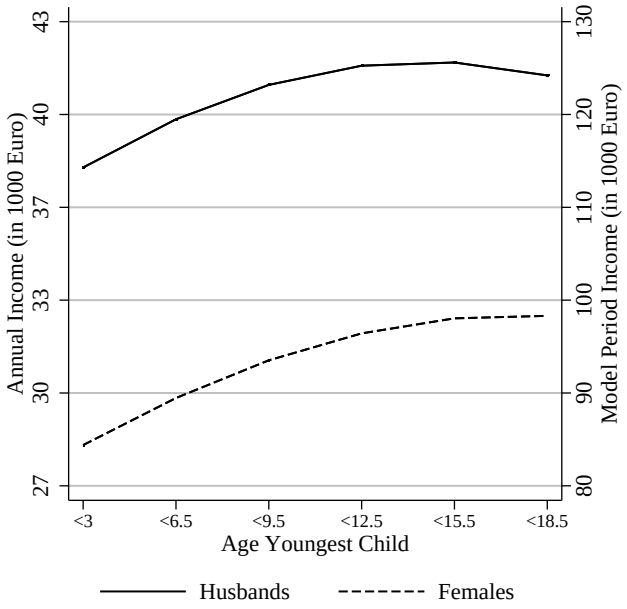
[15] By then 75% of the females are working full-time such that selection into full-time employment is less of a problem.

Table 6: Income Process

	West
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: η_0 is calculated as in Equation (25) and η_1, η_2 as in Equation (24).

Figure 6: Income Profiles (in 1000€)



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 income up to 3282€, the smallest income tax allowance in the years 1983 to 2006 is 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, associated with a R^2 of 1.00. The upper threshold of 100,000€ was chosen because for higher incomes the average marginal taxes does not change anymore. Figure 7 and Table 7 summarize the information on the progressivity of the tax code implemented in this paper on and annual basis and for the model period of three year length.

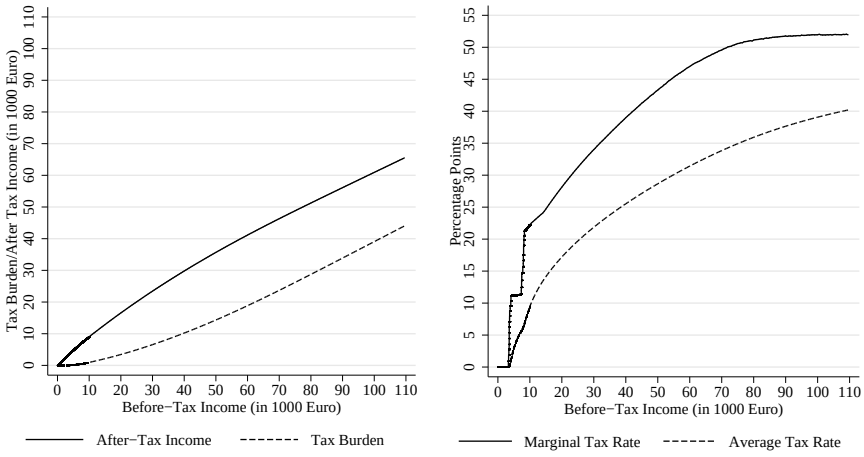
Table 7: Annual Taxes

Frequency	**Taxable Income (y)**	**Tax Burden**
Annual	0 - 3282	0
Model Period	0 - 9846	0
Annual	3283 - 100000	$\sum_{i=1}^{7} \beta_i (y - 3282)^i$
Model Period	9847 - 100000	$\sum_{i=1}^{7} \beta_i (y - 9846)^i$
		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
Annual	100001 - ∞	$\sum_{i=1}^{7} \beta_i (1e5 - 3282)^i$+(y-1e5)×0.52
Model Period	300001 - ∞	$\sum_{i=1}^{7} \beta_i (3e5 - 9846)^i$+(y-3e5)×0.52

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

Joint Taxation Married couples are taxed jointly. The sum of the spouses' incomes is divided by two, the tax burden is calculated according to the tax code and doubled afterwards. Because of the progressivity of the tax system, the joint net income is larger compared to individual taxation as long as one spouse earns more than the other and at least one income remains below 100,000€. Joint taxation is only feasible for legally married partners. Although my sample contains cohabitating but not legally married partners I apply joint taxation for all couples.

Figure 7: Annual Taxes and Tax Rates



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

Mandatory social security contributions Employees, excluding civil servants, have to make mandatory contributions to the pension system, unemployment, long-term care and public health insurance which accrue proportionally up to certain income threshold. Any income above the threshold is not subject to the contribution anymore. Table 8 shows the average monthly and model period thresholds and contribution rates for each type of insurance over the years 1983 to 2006 in 2008€.

Table 8: Social Security Contributions

Insurance Type	**Contribution Rate** (%)	**Contribution Limit**	
		Monthly	**Model Period**
Unemployment	3.46	4849.86	174594.81
Pensions	10.28	4849.86	174594.81
Health	7.27	3557.66	128075.93
Long Term Care	0.41	3557.66	128075.93

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.

Implementation The income tax and mandatory social security contributions refer to annual and monthly values whereas the model periods correspond to three years. I therefore divide the incomes in the model by three to obtain annual values, calculate after-tax income under using the tax code defined above

under joint taxation, deduct annual social security contributions and multiply the resulting value by three to return to the three year period values.

5.1.3 Child care fees

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

Subsidized child care 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 highest observed monthly fee for subsidized child care with the following set of regressors: an intercept, a full-time dummy, a dummy for ages 0 to 2, number of further siblings enrolled in subsidized child care, and household income which is defined 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.

Non-subsidized child care The per-child fees for non-subsidized child care are the predicted values from an OLS-regression with the constant and full-time dummy as the only statistically significant explanatory variables

The coefficients for both regressions are shown in Table 9 for monthly fees and the corresponding values the model period fees.

Table 9: Per child fees - Regression Coefficients

	Monthly		**Model Period**	
	Subsidized	**Non-Subs.**	**Subsidized**	**Non-Subs.**
Intercept	53.79	236.49	1936.38	8513.70
Full-time	50.20	177.52	1807.38	6390.82
Ages 0 to 2	21.90	—	788.22	—
Siblings in subsidized child care	-29.56	—	-1064.28	—
Household income†	0.02	—	0.02	—
$\hat{\sigma}$	58.05	—	2089.97	—

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. 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 €.

5.1.4 Transfers

The transfers include child benefits which are paid each period depending on the total number of children, see Table 10. Finally, based on the description

Table 10: Child Benefits

Number of Children	Total Benefits Monthly	Total Benefits Model Period
1	93.99	3383.55
2	210.23	7568.17
3	379.78	13672.19

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

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 paid during the first six months after a child is born if the mother does not work.

5.2 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 Table 3.

5.3 Data Targets

With the exception of the discount factor β, which is chosen to reflect a 4% yearly interest rate as in Kydland and Prescott (1982) ($\beta = \left(\frac{1}{1.04}\right)^3$), all 13 preference parameters are calibrated by matching 13 targets. Most parameters are particularly connected to a data category and I will discuss in this context which parameter has the strongest impact on a given moment if possible.

Fertility The maximum number of children is restricted to three. ζ, the fixed costs of having a positive number of children, matches the fraction of females without children, δ_2 and γ_2 the fraction of females with one and two children. Table 11 shows the empirical fertility distribution which is adjusted for the fact that around 3.5% of of all couples are unable to get children at all, see Robert-Koch-Institut and Statistisches-Bundesamt (2004).

Labor Force Participation I target the average (over all mothers) part- and full-time labor force participation rate in periods one, two and six. The parameters δ_3, ξ_0 and ξ_1 all govern the utility of spending time with children and are used to match the part-time participation rates. In period one neither ξ_0 nor ξ_1 has a direct impact on the utility of spending time with children and hence δ_3 is set to match the part-time participation period in period one. The part-time participation in period six is matched by ξ_1 which sets the utility level of time spent with children in the last period. ξ_0 influences how fast the utility level time spent with the children decreases and the chosen functional form implies the largest decrease between period one and two. Accordingly ξ_0 is set to match

Table 11: Fertility Distribution

Children	
Number	**Fraction**
0	10.7
1	21.0
2	50.4
3	17.8

Source: GSOEP, own calculations.

the part-time participation rate in period two. Since the relative share of women working full-time conditional on working varies over time, the remaining three parameters governing the time allocation of the mother, i.e. leisure (δ_1 and γ_1) and the curvature of time spent with children (γ_3), are set to match the full-time participation rate in the corresponding periods.

Furthermore, I target the difference in the part-time participation rate between females with one and two children in period one. The parameter γ_0 has a strong influence on this moment because it relates the budget constraint and hence the effect of female labor force participation via the income with the number of children through the equivalence scale adjustment.

Child Care Enrollment I target the part-time child care enrollment rate in periods one and two, as well as the full-time child care enrollment rate in period two. The parameters ϕ_1 and ϕ_2 give the weight on the disutility of using non-paid child care, and are thus used to match the part-time child care enrollment rate for each period. Finally, I match the full-time child care enrollment rate in period two via ϕ_3. I do not match the full-time child care enrollment rate in period one. Since the conditional full-time child care enrollment rate, i.e. the fraction of children enrolled in full-time child care conditional on being in enrolled child care, is very similar for both periods (9.7% in period one and 12.2% in period two), a successful match of the part- and full-time child care enrollment in period two should imply a successful match of full-time child care enrollment in period one conditional on matching part-time child care enrollment in period one.

Table 12 summarizes the data targets and the set of calibrated parameters. Since no closed form solution of the corresponding model moments is available, I simulate 100000 individuals with the initial income shock being drawn from the stationary distribution of the income shock.

5.4 Results

Table 13 shows the data moments along with the simulated model moments for the calibrated model version.

Table 14 shows the calibrated values for the preference parameters sorted by the

Table 12: Data targets and parameters

Target	**Parameter**
Fertility	
Fraction of females	
without children	ζ
with one and two children	δ_2, γ_2
Labor Force Participation Rate	
Part-time	
$t = 1$	δ_3
$t = 2$	ξ_0
$t = 6$	ξ_1
$t = 1$; $\Delta_{\{n=1\}-\{n=2\}}$	γ_0
Full-time	
$t = 1, 2, 6$	δ_1, γ_1, γ_3
Child Care Enrollment Rate	
Part-time	
$t = 1$	ϕ_1
$t = 2$	ϕ_2
Full-time	
$t = 2$	ϕ_3

Note: Labor force participation and child care enrollment rates are averages over all mothers.

Table 13: Targeted data and model moments

Target	**Data**	**Model**	**Difference**
Fertility			
Fraction of females			
with out children	10.7	10.1	0.6
with one child	21.0	20.0	1.1
with two children	50.4	51.2	-0.8
Labor Force Participation Rate			
Part-time			
$t = 1$	26.5	26.2	0.3
$t = 2$	53.2	53.6	-0.4
$t = 6$	60.0	56.8	3.1
$t = 1;\ \Delta_{\{n=1\}-\{n=2\}}$	10.9	11.5	-0.6
Full-time			
$t = 1$	4.7	5.1	-0.5
$t = 2$	8.4	8.7	-0.3
$t = 6$	19.7	16.5	3.1
Child Care Enrollment Rate			
Part-time			
$t = 1$	5.6	5.1	0.5
$t = 2$	83.7	81.8	1.8
Full-time			
$t = 2$	11.6	12.9	-1.3

calibration targets and with reference to the corresponding part in the utility function. While not all parameters, in particular the utility weights δ_i $i = 1, 2, 3$,

Table 14: Preference parameters

Fertility				
Number of children	$\delta_2 = 1.13$	$\gamma_2 = 1.39$		
Fixed cost of children	$\zeta = 0.60$			
Labor Force Participation				
Consumption	$\gamma_0 = 2.00$			
Leisure	$\delta_1 = 0.35$	$\gamma_1 = 1.92$		
Maternal time	$\delta_3 = 2.20$	$\gamma_3 = 0.46$	$\xi_0 = 0.03$	$\xi_1 = 0.46$
Child Care Enrollment				
Non-paid child care	$\phi_1 = 0.49$	$\phi_2 = 0.45$	$\phi_3 = 2.40$	

do not have a concrete interpretation, a few comments can be made. First, as already discussed the fixed costs of having children $\zeta = 0.6$ rescale the level of utility from spending time with children which only affects the decision of having vs. not having children. The parameter values for the utility from spending time time with children and ζ imply that for a female spending at least one unit of time ($m_t = \frac{1}{4}$) with her children $\mathbf{Q}_t$ is always positive, with the exception of the last period ($\mathbf{Q}_6 = -0.06$), even if in the first two periods no paid child care at all is used. Second, the curvature of consumption $\gamma_0 = 2.00$ is in the range of usually cited values. The utility of maternal time in the last period is ($\xi_0 = 0.46$) slightly less than half of the value in the first period and decreases at a very modest speed over rate ($\xi_1 = 0.03$). Finally, using non-paid child care for children aged three to six and a half is associated with a lower utility cost than for children aged zero to two ($\phi_2 = 0.45$ vs. $\phi_1 = 0.49$).

5.5 Model Fit

Let me now turn to a set of data moments that have not been targeted. Table 15 shows some of the statistics presented in Tables 4 and 5. Both the fraction of children enrolled in non-subsidized child care conditional on being enrolled in child care and the child care enrollment rates conditional on the maternal labor force status are very close to the actual figures, although any other outcome could have been consistent with matching the overall employment and enrollment rates well.

Table 15: Model Fit

	Ages 0 to 2		Ages 3 to 6.5	
Fraction Enrolled in Non-Subs. Care	40.4 [14.0 ; 66.8]	31.4	0.8 [0.0 ; 2.0]	0.1
Conditional Child Care Enrollment Rate				
At least part-time care				
Not Working	2.9 [0.6 ; 5.1]	3.6	93.2 [88.0 ; 98.6]	92.2
Part-time Working	11.8 [5.4 ; 18.7]	7.2	96.6 [94.1 ; 99.0]	96.3
Full-time Working	24.4 [5.9 ; 47.9]	25.3	97.0 [91.6 ; 100.0]	96.7
Full-time care				
Full-time Working	3.9 [0.0 ; 11.2]	3.1	32.4 [16.8 ; 47.5]	27.1

Note: 95% confidence intervals for the data moments are given in brackets and were obtained from 1000 bootstrap replication.

Figure 8: Participation and enrollment

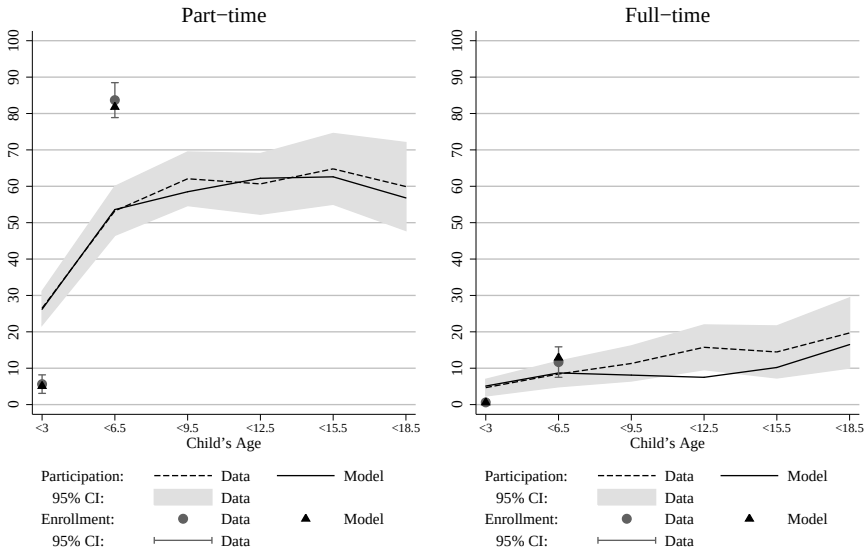
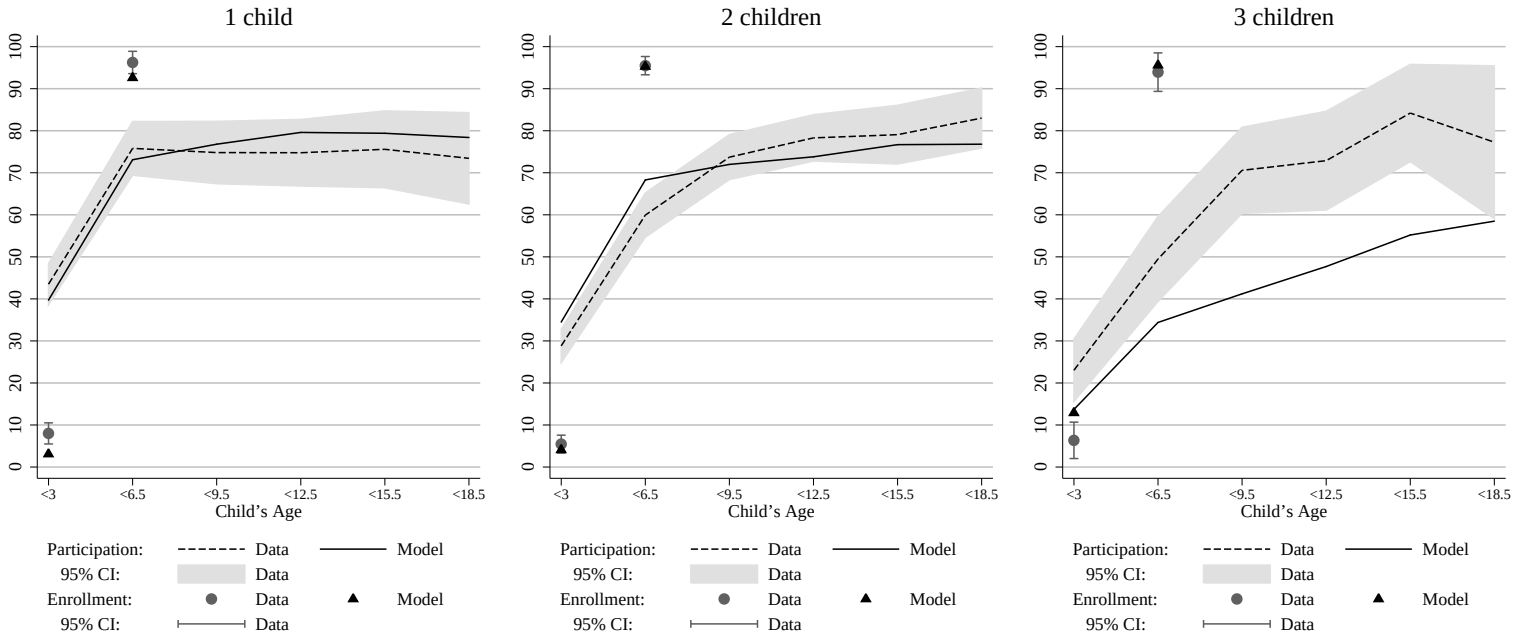


Figure 8 shows the part- and full-time participation profiles as the children age. Recall that all moments in periods one, two and six were used as targets. There is one exception, namely full-time child care enrollment for children aged zero to two which is nevertheless matched precisely. The profile of the part-time participation rate is replicated fairly well, whereas for full-time participation the increase during period three and four (above age six and half until age 15) is not.

Figure 9: Participation and enrollment rates by number of children



In the calibration, average participation and enrollment rates, i.e. the average over all mothers, were targeted. Another set of overidentifying restrictions is thus given by the participation and enrollment rates by the number of children, shown in Figure 9. For mothers with one child the participation rate is predicted, fairly well whereas enrollment rates fall slightly short. The facts for mothers with two children are replicated closely although the participation rates in period one and two are overpredicted. The worst fit is obtained for females with three children with a substantial underprediction of participation. Figure 10 provides the split by part- and full-time rates.

The overall participation pattern for females with one child is matched fairly well. However, while part-time participation is consistently overpredicted the opposite is true for full-time participation. Both part- and full-time participation are predicted precisely for mothers with two children, although they are overpredicted in period one and two. The worse match for females with three children comes both from an underprediction of part- and full-time participation, with an exception of periods one and two.

6 Policy experiments

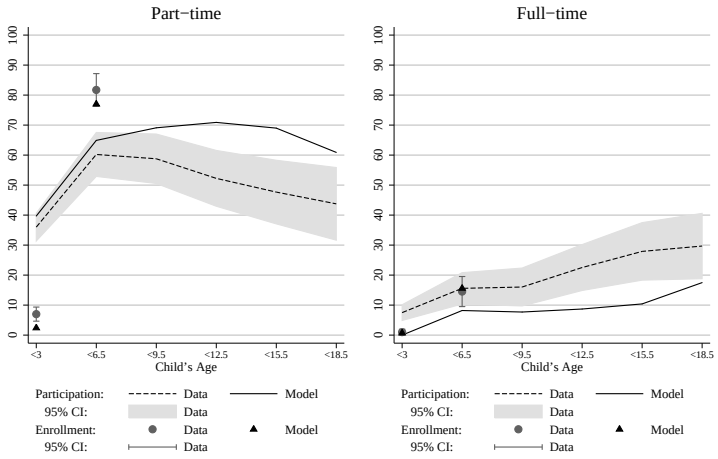
In this section, I conduct and compare three counterfactual policy experiments. First, since January 2007 females can receive for up to twelve months after birth a monthly maternity leave benefit of 67% of their pre-birth monthly net income or 1800€ – whatever is less. In this experiment, I replace the initial maternity leave benefit of 2414.19 € granted to all females with children aged zero to two either not or part-time working with the new policy. Second, I assume that every part-time working female has access to subsidized part-time child care and every full-time working female has access to subsidized child care full-time care. Rationing only occurs for non-working females and part-time working females with respect to full-time care for which I leave the success probabilities of the slot lottery unchanged. The third experiment mimics a political initiative by the Bavarian conservative party (CSU), who argue the subsidy on child care discriminates females who prefer to stay at home taking care of their children themselves. After this proposal, non-working mothers who do not use subsidized child care while their children are of age one and two receive a monthly subsidy of 150€ per child.

Table 16 compares the effects of the three reforms to the baseline model outcome. The larger transfers conditional on not working full-time by the *'07 Leave Benefits* reform naturally decreases the full-time participation rate for children aged zero to six while the part-time participation rate is left unchanged. Overall, it is however the case that the extra money drives full-time working women into part-time and part-time working women out of the labor force. The part-time participation rate itself increases by roughly 5% points in all remaining periods and the full-time participation by less than that. The fertility rate increases by 0.1 children per female through a shift from zero to one and one to two children.

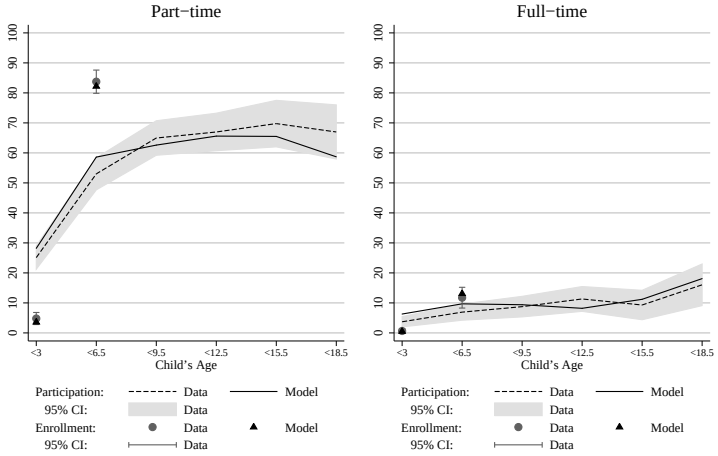
Rationing access to child care by the labor force participation status increases part-time and full-time employment for mothers of children aged zero to two. However, the increase is only modest compared to the increase in the enrollment

Figure 10: Part- and full-time enrollment and participation

1 child



2 children



3 children

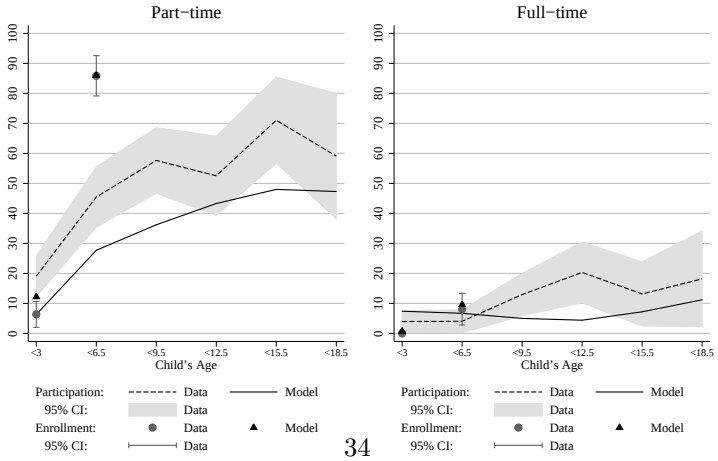


Table 16: Counterfactual Policy Experiments

	Baseline	'07 Leave Benefits	Conditional Rationing	Cash Subsidy
Ages 0 to 2				
Part-time				
Participation	26.2	26.1	30.4	7.6
Enrollment	5.1	8.4	32.4	2.5
Full-time				
Participation	5.1	0.0	7.7	5.1
Enrollment	0.6	0.7	8.1	0.3
Ages 3 to 6.5				
Part-time				
Participation	53.6	58.4	51.2	54.0
Enrollment	81.8	78.7	75.7	83.0
Full-time				
Participation	8.7	8.3	11.8	10.2
Enrollment	12.9	17.2	21.8	11.3
Ages 7 to 18.5 (Avg.)				
Part-time participation	60.0	65.7	60.5	59.8
Full-time participation	10.6	7.9	10.7	11.5
Fertility Rate	1.78	1.89	1.79	2.04

rate. Hence, working mothers substitute non-paid with paid child care and for the vast majority of non-working mothers the rationing of child care is not responsible for their decision to stay out of the labor force. Only for a small fraction of non-working women abolishing the rationing of child care induces them to start working. It is worthwhile mentioning that this reform which is close to the actual implemented one by the federal government would result in an enrollment rate close to the target stated in the introductory quote from the European Council. The full-time participation rate of mothers with children aged three to six and a half increases slightly, mainly at the expense of a lower part-time participation rate. In the remaining periods, and with respect to fertility, there is hardly any response.

The final experiment subsidizes non-working mothers who do not use child care while their children are of ages zero to two. The reform is very effective in reducing the corresponding maternal labor force participation rate. The positive effect is that it has no long-lasting impact in further periods, full-time participation increases even slightly. Among all policy experiments, subsidizing non-working mothers who do not use child care while their children are of ages zero to two has the largest impact on fertility with an increase of 0.26 children per female.

From these results, one can conclude that the provision of subsidized child care has only very modest effects on maternal labor force participation and fertility. In contrast, monetary incentives raise fertility strongly, essentially without a negative long-lasting impact on labor force participation.

7 Conclusion

In this paper, I documented facts about labor force participation and child care enrollment decisions of married females in West Germany. In line with the facts of a cross-section of OECD countries, I emphasize the level relationship between maternal labor force participation and child care enrollment. While for children aged zero to two, the labor force participation rate is by a magnitude larger than the child care enrollment rate and the opposite is the case for children aged three to six and a half. I setup a structural life-cycle model with endogenous fertility, labor supply and child care choices that is calibrated to match these facts and also provides a good description of data moments not targeted. A set of counterfactual policy experiments indicates that the quantitative impact of providing (subsidized) child care on labor force participation and fertility is very small whereas financial support is more effective in stimulating fertility without decreasing labor force participation in the long run. Since the analysis focuses on females in long-term relationships, future research should attempt to enrich the model by marriage and divorce decision in order to generalize the results.

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A Data

Table 17: Sample Selection

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 relationships	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 1984-2006.

A.1 Sample Construction

A.1.1 Period Definition

Ages 0 to 2 I exclude the month of birth and the subsequent two months to account for the mandatory maternity leave which outlaws females to work in the first eight weeks after the child is born. Depending on when the child is born within a month this implies an exclusion of the first eight to 13 weeks of a child's life. Thus, it is guaranteed that only the months in which it is legally allowed to work contribute.[16] Hence, by construction this period has a duration of 2.75 years.

Ages 3 to 6.5 The second period lasts from the month in which the child turns three until school entry. According to a cut-off rule, which is very similar across all German states, children who are at least six in July of a given year have to enter mandatory schooling. There are exceptions permitting a child to

[16] Excluding only the month in which a child is born and the next month would correspond to the first five to nine weeks.

enter school one year earlier or later. Because of some peculiarities in the timing of the survey the age at school entry cannot always be determined exactly and has to be constructed. I therefore assume that for all children the cut-off date determines school entry but allow children to enter school earlier if this is known from the survey. Even if the exact entry age would be known, the length of the period is heterogenous among children because school starts only once a year. The mean duration in the data is 3.5 years.

A.1.2 Child Care

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, the oldest cohort in a daycare center usually leaves the daycare center together at the same time of the year, i.e. 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 of a year is a good predictor for the status in the second half 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. In the following the detailed imputation procedure will be described. The child care enrollment status in the interview month is assumed to be the same in all other months of a half year. The second half of a year and the first half of the next year have the same status in case no new information is available. To make that point more clearly, 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. Finally, in all other cases the last known child care enrollment status is used until one of the two described situation occurs. Although this reasoning applies more to child care provided in daycare centers, I use the same imputation rule for child care provided by nannies.

Subsidized Child Care Slot Provsion The slot provision rates are calculated from the data provided by German Statistical Office (Statistik der Jugendhilfe, various years). They are only available for every fourth year between 1986 and 2002. Table 19 shows the annual averages over the years 1983 to 2006, the period for which the monthly labor supply status from the GSOEP is available. These averages are constructed for the two age groups zero to two, and three to six and 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 slot 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 and a period is regarded as a unified entity. 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. Therefore I assume that a female can apply once per year for a slot. If she gets a slot, she can send her child there until it reaches age three and has to apply again for a slot or goes to school. Put differently, 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 18.

Table 18: Access to Subsidized Child Care

Access in Year			**Period Access**		**History**
1	**2**	**3**	**Mean**	**Status**	**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 with 0.5 and 1. The mean over the whole period - the three years - would be given in column 4 in Table 18 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 state 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 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 19 presents the annual, i.e. observed, slot provision rates and the period provision rates after the transformation. E.g. while there are 62.3 part-time and 14.6 full-time slots per 100 children aged three to six and 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 71.8% and 23.7% 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.

Table 19: Annual and Period Provision Rates of Subsidized Child Care Slots

	West		**East**	
	Annual	Period	Annual	Period
Ages 0 to 2				
Part-time	0.5	4.3	1.2	38.8
	$\Rightarrow$		$\Rightarrow$	
Full-time	1.7	1.7	40.6	41.1
Ages 3 to 6.5				
Part-time	62.3	71.8	1.8	2.4
	$\Rightarrow$		$\Rightarrow$	
Full-time	14.6	23.7	95.9	97.6

B Model

Table 20: Minimum distance to one of the own parents or parents in law

	Ages 0 to 2	**Ages 3 to 6.5**
Same house	35.6 [25.7 ; 45.5]	60.8 [50.2 ; 71.4]
Same neigbourhood	38.7 [30.3 ; 47.1]	64.2 [55.4 ; 72.9]
Same city	31.5 [23.5 ; 39.5]	63.3 [54.4 ; 72.2]
Within 1h driving distance	36.1 [28.1 ; 44.1]	59.8 [51.4 ; 68.3]
Farther away	26.5 [16.0 ; 37.0]	66.0 [52.7 ; 79.3]

Source: GSOEP, 1991, 1996 and 2001.

Note: 95% confidence intervals are given in brackets and were obtained from 1000 bootstrap replication.