Discussion Paper No. 14-068

Completed Fertility Effects of Family Policy Measures: Evidence from a Life-Cycle Model

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Abstract

We estimate a structural life-cycle model of fertility and female labour supply and use it to evaluate the effects of a number of key family policy measures based on data for Germany. Parental leave benefits, child benefits and subsidized childcare are found to have substantial fertility effects. Without these measures, completed fertility is estimated to be lower by 6%, 7%, and 10%, respectively. Income tax splitting, which is fiscally expensive, reduces female labour supply but has a negligible effect on fertility.

JEL classification: C25; C53; J13; J22

Keywords: Fertility; female labour supply; family policy; dynamic programming

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1 Introduction

Although spending on family policy measures is quite considerable in many countries, relatively little is known about the effects of these measures, in particular with respect to long-run fertility outcomes.[1] Quasi-experimental studies on the effects of family policies on fertility focus on the short-run effects (e.g. Cygan-Rehm, 2014; Raute, 2014). Likewise, the structural models of Haan and Wrohlich (2011) and Stichnoth (2014) assume a one-year decision horizon and therefore cannot analyze the effects on completed fertility.

In this paper, we develop a structural *life-cycle* model that allows us to quantify the effects of parental leave benefits and three other key family policy measures (subsidized childcare, child benefits, income tax splitting) on *completed* fertility. The model is estimated using data from the German Socio-Economic Panel (SOEP); the simulation of disposable incomes is based on a detailed representation of the tax-transfer system and models the cost and availability of childcare based on new data from the SOEP extension FiD ("Familien in Deutschland").

Francesconi (2002) develops a dynamic model with endogenous fertility for the US. While he focuses on women who are always married, we include all women and model marriage as an exogenous stochastic process. Moreover, we consider not only the number, but also the age of children, allow for stochastic fertility, model disposable income as opposed to gross earnings and incorporate demand restrictions on the labour market by allowing for (exogenous) job offer and break-up rates. Adda et al. (2011) allow for occupation-specific wage-experience profiles and endogenize the initial occupation decision. However, they study women who go through the German system of apprenticeship training, while we also include women with tertiary education, a group that is important in the discussion about (low) fertility. Importantly, Adda et al. focus on the decomposition of the career costs of children and less on the evaluation of specific policies. The model by Slonimczyk

[1] In Germany, the country on which we focus here, spending on four key measures (parental leave benefits, subsidized childcare, child benefits, income tax splitting) alone totals around 70 billion euros per year (BMFSFJ, 2008).

and Yurko (2014) is also closely related to ours; they study the effects of the maternity capital policy in Russia.

2 The Model

We develop a dynamic discrete choice model of women's fertility and employment choices from their mid-20s (when education is typically completed) until the end of the fertile phase. We assume a finite horizon of $T = 20$ discrete periods, each of which corresponds to one year.

Women decide optimally in each period given their expectations about all future periods. Fertility is stochastic in the model: the probability of becoming pregnant within one year when trying to conceive depends on age; in addition, we allow for permanent infertility as an absorbing state. We also take into account that women cannot always transit between the employment states (not employed, part-time, full-time): whether a transition is possible depends on state-specific job offer rates. Moreover, a woman may lose her current job, with exogenous break-up rate.

Women anticipate that a reduction in their labour supply leads to a loss of work experience and hence of future earnings opportunities. This drives the dynamics of the model and the interaction between fertility and employment choices. In addition, fertility has an impact on the formation and dissolution of couples, as the exogenous stochastic (Markov) processes through which these are modelled depend (among other things) on the number of children.

Let $\boldsymbol{x}_{it}$ denote the vector of (discretized) state variables for woman i in period t. The elements of the vector are the female employment status, the years of work experience (0,1,4,12), the number of children (0,1,2,3) and the age of the youngest child (0,1,3,10), as well as indicators for permanent infertility and for the presence of a partner.

Given the state variables and her expectations about future periods, the woman chooses a vector of actions $\boldsymbol{a}_{it}$: her desired employment state and whether she tries to conceive; there are thus six possible choices.

She solves the dynamic programming problem given by

$$V_{it}\left(\boldsymbol{x}_{it},\boldsymbol{\theta}\right)=\max_{\{a_{is}\}_t^T}\left\{\sum_{s=t}^{T}\beta^{s-t}\mathbb{E}_t\Big[u(\boldsymbol{x}_{is},\boldsymbol{\theta})|\boldsymbol{a}_{it}\Big]\right\}. \tag{1}$$

Consumption equals disposable income in each period; the latter is simulated using a fairly detailed representation of the German tax-transfer system (see the Online Appendix for details).

The instantaneous utility function is assumed to be linear in its parameters $\boldsymbol{\theta}$. β is the one-period discount factor. The expectation is with respect to the state transition probabilities $\Pr_t(\boldsymbol{x}_{i,t+s}|\boldsymbol{x}_{it},\boldsymbol{a}_{it})$, which depend on the current state $\boldsymbol{x}_{it}$ and on the action $\boldsymbol{a}_{it}$ and act as a constraint on the maximization problem.

A key component of the model is the accumulation of work experience. Each additional year of full-time work is assumed to increase experience by one unit, while each year of part-time work leads to an increase of 0.5 units. If a woman does not work, her work experience remains constant. Wages increase with accumulated experience. As a result, a career break after child birth is not only costly in terms of foregone current earnings, but also affects future wage offers negatively. We assume that the logarithm of hourly wages is a deterministic function of experience and experience squared.

For every parametrization $\boldsymbol{\theta}$, the dynamic programming problem is solved by backwards induction. We take into account that there are utility components of each option that are observed by the woman, but not by the econometrician. We assume these to be iid extreme value. With this assumption, the policy function in our model is a vector of six logistic choice probabilities.

3 Data and Estimation

We use the 1995–2010 waves of the German Socio-Economic Panel (SOEP)[2] to estimate the parameters of the exogenous stochastic processes (household formation and separation, wage-experience profile).[3] The age-specific fecundity rates (i.e., the probability of giving birth within one year of unprotected sexual intercourse) and the probability of being permanently infertile are calibrated based on data from the Fertility Sourcebook (Khatamee and Rosenthal, 2002). We set the discount factor β to 0.98, a typical value in the literature (e.g. Attanasio et al., 2008; Blundell et al., 2013). The annual job break-up rate is set to 0.1. Concerning transition between employment states, we assume that a woman who worked full-time in the previous period can keep her full-time job if she wants to, unless she becomes involuntarily unemployed. By contrast, a woman who worked part-time and decides to move to a full-time job will only be successful with a probability of 70%.

The 18 parameters of the utility function are estimated based on 44 cross-sectional moments from the SOEP wave of 2010. The moments are based on the joint distribution of the employment state and the number of children at four different ages (26, 32, 39, 45). We consider women aged 25 to 29 and use the dynamic model to simulate trajectories over 21 periods (including the initial period), i.e. until the end of their fertile years at ages 45 to 49.[4] The stochastic elements are introduced by drawing from the distributions for the exogenous stochastic processes and from the vector of choice probabilities.

The objective function is the sum of squared differences between the sample moments

[2]The SOEP, which started in 1984, is a longitudinal survey of private households, with a rich set of information on personal and household characteristics. See Wagner et al. (2007) for a detailed description.

[3]Results available from the authors upon request.

[4]We group several birth cohorts to increase the sample size. As expected given their young age (mean: 27, std.dev.: 1.4), relatively few of the 392 women (33%) are married in the initial period, and 60% do not have children (22% have one child, 14% have two children, and 5% have more than two children). 45% of the children are below the age of three, 44% are between three and six, and 11% are older than six. 30% of the women are not employed when we initially observe them, 24% work part-time and 46% work full-time. They have on average 3.1 years of work experience; the mean wage offer is 11.5 euros per hour.

and the moments generated by the model. As we have closed-form expressions for the choice probabilities, we can derive exact expressions for the model moments.

The estimated utility parameters and the deviations between observed and simulated moments are documented in the Online Appendix. The model fits the sample moments closely, with the exception of the share of women working part-time with one child at ages 38 and 45, which we found more difficult to reproduce.

Our baseline simulation predicts that women aged 25 to 29 will have on average 1.87 children at the end of their fertile phase. 13% of women will remain childless, and 15%, 44% and 28% of women will give birth to one, two, and more than two children, respectively. As shown in the Online Appendix, the simulation predicts a strongly negative relationship between the number of children and the number of years spent in full-time work.

4 Policy Experiments

Table 1 shows the results for our counterfactual policy experiments. Each row of the table is from a separate experiment in which we switch off the corresponding measure and keep the remaining rules of the 2012 tax-transfer-system in place. The interactions within the system are taken into account. For instance, abolishing child benefits does not lead to a one-to-one income reduction as some households may become eligible for social assistance.

The model predicts that abolishing parental leave benefits, child benefits or subsidized childcare would reduce completed fertility by 6%, 7%, and 10%, respectively, compared with the baseline simulation. Income tax splitting, which is fiscally expensive, reduces female labour supply but has a negligible effect on fertility.

Table 1: Main results

		Employment (years)		
	Completed fertility	Not employed	Part-time	Full-time
Income tax splitting	-0.01	-0.10	-0.04	0.14
	(0.004)	(0.02)	(0.01)	(0.02)
Child benefits	-0.14	-0.22	-0.04	0.26
	(0.02)	(0.03)	(0.05)	(0.07)
Parental leave benefits	-0.12	-0.25	-0.12	0.37
	(0.02)	(0.06)	(0.05)	(0.09)
Subsidized childcare	-0.20	-0.08	-0.54	0.62
	(0.04)	(0.13)	(0.09)	(0.18)

Source: Own simulations based on SOEP 2010 and the tax-transfer system of 2012. T=21 periods, each corresponding to one year. The simulation sample consists of 50 clones of each of the 392 women in the original sample. The table shows absolute changes with respect to the baseline scenario. Each line corresponds to a different scenario. Standard errors in parentheses based on 250 bootstrap runs.

5 Conclusion

Based on a structural life-cycle model of fertility and female labour supply, this paper has estimated the effects of key family policy measures on completed fertility in Germany. For some of the measures, such as parental leave benefits, these are the first estimates of a long-run nature, as existing quasi-experimental studies focus on the short run and cannot distinguish between timing effects and effects on completed fertility.

Future research should refine the estimates by using (administrative) data on complete employment biographies and by allowing for unobserved heterogeneity in preferences and ability as well as for a more complex relationship between work experience and wages.

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A Appendix

A.1 Simulation of childcare costs and disposable income

We do not allow for savings, so consumption is equal to disposable income. The latter is simulated based on a model of the German tax-transfer system. The starting point of the simulation model is gross labour earnings. For the woman, these earnings depend on her hourly wage and on whether she works full time or part time. We assume that full-time work corresponds to 40 hours per week, while part-time work is taken to be 20 hours per week. If a husband is present, his earnings also enter the simulation of disposable household income. We assume that the male partner works full time and has gross earnings of 3749 euros per month, which corresponds to median earnings in 2010. Social security contributions are deducted from each partner's gross earnings.

Taxable income is obtained from gross earnings after deducting certain standard allowances. Income tax is computed by plugging taxable income into a tax function. Note that married couples in Germany can file a joint income tax declaration and benefit from income tax splitting, i.e., the tax function is applied to the mean of both spouses' taxable income, and the tax payment is then doubled. As the income tax scheme is progressive, this tends to make households better off than a system of individual taxation unless both partners have exactly the same taxable income. By making both spouses' marginal tax rate equal, income tax splitting creates work disincentives for the secondary earner, in most cases the woman. The disincentives are particularly strong at a threshold of 400 euros per month, below which earnings are exempt from income tax and employee's social security contributions.

Households may be entitled to a number of benefits and transfer payments. These usually depend on household income, on the number and age of the children in the household, and on the labour market states. For instance, certain transfers such as parental leave benefits are conditional on working less than 30 hours per week, ruling out full-time employment. Likewise, payments from unemployment insurance (ALG I) can only be received if a person is registered as unemployed. Social assistance (ALG II) payments depend on the level of earnings, the number of persons in the household and the cost of rent and heating, which we base on 2010 averages (by household size) published by the German Federal Ministry of Labour.

A transfer that is of special interest in the context of family policy is parental leave benefits. In 2007, Germany reformed its system of parental leave benefits. The previous means-tested child-rearing benefit ("Erziehungsgeld") was replaced by "Elterngeld", which depends on (individual) earnings in the year before childbirth. In most cases, the replacement rate is 67%. The benefit is capped at 1800 euros per month, but nevertheless represents a substantial transfer, especially compared to the previous child-rearing benefit. To receive the benefit, at least one of the parents has to reduce working hours below a threshold of 30 hours per week. The benefit is paid for a maximum of twelve months.[5]

Child benefits and child tax allowance can be received for up to 25 years (and even longer in a few exceptional cases that we neglect here, such as when the child is handicapped). Since 2010, child benefits have amounted to 184 euros per month for the first two children, 190 euros for the third child and 215 euros for additional children. Alternatively, households can deduct a tax allowance of 7008 euros per child from their annual taxable income, which is advantageous for households with a high income.

Another factor that is relevant when modelling fertility and employment decisions is the cost and availability of childcare. Public childcare has long been in short supply in Germany, in particular for children aged below 3. We assume that the amount of external childcare required is a function of parents' employment status. More precisely, we make it dependent on $\min\{h_m, h_f\}$, where h are weekly hours of work, and m and f index the male and female partner. If the minimum is 0, no external childcare is needed.

[5] If both partners reduce their working time during at least two months, the benefit can be extended to 14 months. We neglect this possibility here as our model assumes that the husband works full-time.

If the minimum is 20 or 40 hours, parents need to organize the corresponding amount of childcare for all children up to the age of 6. Assuming a fixed relationship between parental working hours and childcare reduces the choice variables in the models, and provides a reasonable approximation to observed patterns of childcare use.

For each household, we compute expected childcare costs for each choice alternative using data from the 2010 SOEP extension "Families in Germany" (FiD, "Familien in Deutschland"), which has detailed information on childcare use and costs. With a certain probability, the household is "rationed", i.e., cannot find a subsidized childcare slot. In the data set, parents are asked why they do not send their child to public childcare, and we define them to be rationed if they answer that they could not get a place, that the distance was too great or that the opening hours do not correspond to their needs. We estimate the rationing probability as a function of the region and the age of the child, and then impute the probabilities to the SOEP households. As Table A.1 shows, the probability of not finding an adequate slot in public childcare is higher in West Germany and for younger children. Following Müller et al. (2013), we assume that parents who cannot find a subsidized childcare slot have to rely on privately organized childcare, at a rate of 6.40 euros per hour.

Table A.1: Probability of not having access to public childcare

	Age 0-2	Age 3-6
East	10.2%	2.3%
West	15.8%	4.3%
Total	14.8%	4.0%

Source: Own calculations based on FiD 2010. Children aged 6 or below. N=4517. Households are classified as not having access to public childcare if parents report that their child is not in public childcare because they could not find a place, because the distance would be too great, or because the opening hours do not correspond to their needs.

Parents who do have access to public childcare pay a (heavily subsidized) monthly fee, which depends on household income, the age of the child, the region, whether siblings are already in childcare, and whether the child is in part-time or full-time care. Note that for some parents (e.g., with low income or in specific regions), parental fees can be zero.

Estimation results (from Tobit models) are shown in Table A.2.

Table A.2: Parental fees for public childcare: estimation results

	Part-time care		Full-time care	
Age < 3	56.2***	(14.1)	64.8***	(5.8)
Number of siblings in childcare	-21.9***	(4.1)	-28.4***	(4.4)
Net household income (1000 euros/month)	23.2***	(3.1)	17.0***	(3.8)
Single parent	-23.6**	(9.4)	-32.0***	(10.5)
Intercept	39.7**	(16.4)	149.1***	(24.3)
Dummies for Federal State	Yes		Yes	
Number of observations	972		906	
Of which left-censored	222		171	
Pseudo R^2	0.05		0.03	

Source: Own calculations based on FiD 2010. Dependent variable: self-reported parental fees per month. Results from Tobit models. Children aged 6 or below. Asymptotic standard errors (clustered at the household level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1

A.2 Additional tables and figures

Table A.3: Job offer rates

	Employment in $t+1$								
	Choice: NE			Choice: PT			Choice: FT		
Employment in t	Not employed	Part-time	Full-time	Not employed	Part-time	Full-time	Not employed	Part-time	Full-time
Not employed	1	0	0	0.3	0.7	0	0.3	0	0.7
Part-time	1	0	0	0.1	0.9	0	0.1	0.9×0.3	0.9×0.7
Full-time	1	0	0	0.1	0.9×0.7	0.9×0.3	0.1	0	0.9

Source: Own representation.

Table A.4: Sample moments targeted in the estimation

	Age 26			Age 32		
	Not employed	Part-time	Full-time	Not employed	Part-time	Full-time
No children	6.6	12.3	37.4	2.4	3.6	19.2
One child	8.5	5.7	7.8	8.6	10.0	10.2
Two children	8.8	5.9	1.7	13.8	16.8	4.6
More than two children	4.0	0.9	0.4	5.0	5.2	0.6
	Age 38			**Age 45**		
	Not employed	Part-time	Full-time	Not employed	Part-time	Full-time
No children	0.8	3.0	12.7	2.0	2.8	10.8
One child	6.1	11.7	9.8	3.5	9.1	8.9
Two children	8.0	23.0	8.1	7.3	20.4	15.8
More than two children	6.9	7.3	2.6	5.2	10.1	4.1

Source: Own calculations based on SOEP 2010. All values in percent.

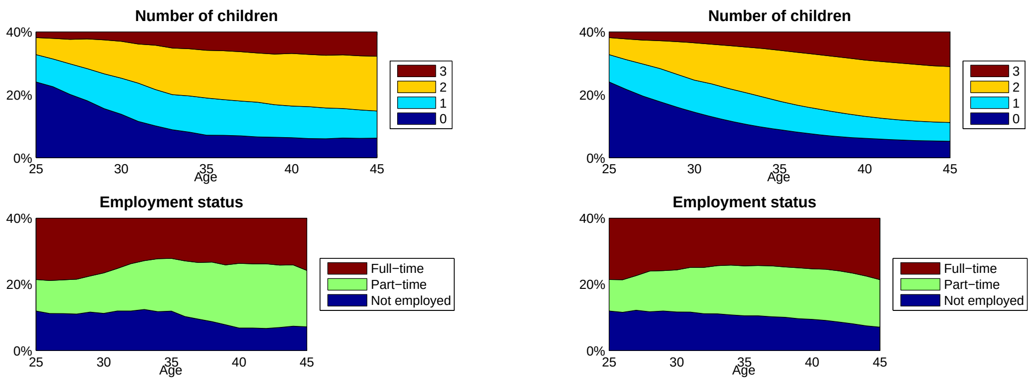
Table A.5: Deviations between sample moments and simulated moments

	Age 26			Age 32		
	Not employed	Part-time	Full-time	Not employed	Part-time	Full-time
No children	0.2	-1.2	-1.7	1.1	1.3	-0.4
One child	0.1	0.6	1.7	-0.7	-0.9	-0.3
Two children	-0.6	0.8	-0.2	-1.4	0.3	0.6
More than two children	1.1	-0.5	-0.3	-0.5	-0.4	1.3

	Age 38			Age 45		
	Not employed	Part-time	Full-time	Not employed	Part-time	Full-time
No children	1.1	-0.5	-1.8	-0.7	-1.5	-2.0
One child	-1.4	-5.8	-1.0	-1.1	-6.7	0.8
Two children	3.6	0.1	2.8	-0.4	1.6	0.6
More than two children	0.5	0.2	2.4	1.7	0.9	6.8

Source: Own simulations based on SOEP 2010. The simulation sample consists of 50 clones of each of the 392 women in the original sample. All values are in percentage points. Each entry corresponds to the simulated moment minus the observed moment.

Figure A.1: Model fit



(a) Data (b) Model

Source: Own calculations/simulations based on SOEP 2010. The simulation sample consists of 50 clones of each of the 392 women in the original sample.

Table A.6: Estimated utility parameters

	Coefficient (Std.err.)
Disposable income	1 (.)
One child	-378.0 (51.7)
Two children	-1382.1 (153.0)
More than two children	-2881.4 (164.2)
Partner * children > 0	294.4 (127.9)
Part-time	-78.9 (24.9)
Not employed	-688.7 (152.1)
Part-time * one child	-1881.1 (99.7)
Part-time * two children	827.2 (92.2)
Part-time * more than two children	782.4 (100.7)
Part-time * age youngest child < 3	-2111.3 (133.6)
Part-time * age youngest child $\in [3, 10)$	2813.0 (103.0)
Part-time * age youngest child ≥ 10	-663.9 (97.7)
Not employed * one child	-464.9 (94.2)
Not employed * two children	515.1 (144.2)
Not employed * more than two children	1720.0 (196.3)
Not employed * age youngest child < 3	1114.8 (145.3)
Not employed * age youngest child $\in [3, 10)$	1562.0 (235.6)
Not employed * age youngest child ≥ 10	-6203.4 (100.1)

Source: SOEP 2010. N=392. Standard deviations from 250 bootstrap runs shown in parentheses, using the point estimates for the original sample as the starting value in each case. Disposable income is divided by the number of adults in the households. The coefficient on disposable income is normalized to 1.

Table A.7: Baseline simulation

	Share	Children per woman	Employment (years) Not employed	Part-time	Full-time
Without children	13.1%	0	2.65	3.74	14.62
	(0.99)		(0.05)	(0.50)	(0.51)
One child	14.9%	1	5.83	5.93	9.24
	(0.88)		(0.47)	(0.32)	(0.50)
Two children	44.1%	2	6.83	10.07	4.11
	(1.78)		(0.42)	(0.38)	(0.24)
More than two children	27.9%	3	9.32	7.71	3.98
	(1.75)		(0.52)	(0.56)	(0.51)
Total	100%	1.87	5.42	7.32	8.26
		(0.03)	(0.18)	(0.22)	(0.22)

Source: Own simulations based on SOEP 2010 and the tax-transfer system of 2012. T=21 periods, each corresponding to one year. The simulation sample consists of 50 clones of each of the 392 women in the original sample. Standard errors in parentheses based on 250 bootstrap runs.