Employment and Fertility – A Comparison of the Family Survey 2000 and the Pairfam Panel

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Abstract. The major objective of this work is the analysis of the relationship of employment and fertility in Germany, also regarding causality. Based on Germany's current panel analysis of intimate relationships and family dynamics (pairfam), Cox's proportional hazards model is used to investigate the influence of labor force participation of women on the transition into motherhood. The obtained results serve as validation of an earlier study presented in Schröder and Brüderl [25], where the effect of employment on the fertility is analyzed for women based on the data of the West-German Family Survey 2000, using a proportional hazards model with a piecewise constant baseline hazard. In general, the estimated effects for the Cox model based on the pairfam data are surprisingly consistent with the results from Schröder and Brüderl [25], whereas indirect causality test results disagree.
Keywords: Pairfam, Employment, Fertility, Event data analysis, Cox's proportional hazards model.

1 Introduction

Today, there exist already several empirical studies in the literature, which clearly indicate that there is evidence for an influence of female labor force participation on the fertility. In this context, Schröder and Brüderl [25] mention several works which use event data analysis for different western industrial nations to show that employed women have a lower transition rate for delivering a (further) child than non-working women, see e.g. Felmlee [11] and Budig [6] for the US or Liefbroer and Corijn [23] for Flanders and the Netherlands. Apart from a few studies such as Kohlmann and Kopp [17], Kreyenfeld [18], Dornseiff and Sackmann [10], Lauer and Weber [20] or Kreyenfeld [19], which partly have a different analytical focus or exhibit some methodical problems, the work of Schröder and Brüderl [25] is the first study that explicitly analyzes if and to what extent there is a relationship between the labor force participation of women and their fertility in Germany, based on the West-German Family Survey 2000. This study is replicated and validated here for the territory of the reunified Germany based on Germany's current panel analysis of intimate relationships and family dynamics (pairfam), release 4.0 (Nauck et al. [24]). A detailed description of the study can be found in Huinink et al. [15]. So the main focus in this work is the analysis of the influence of labor force participation of women on the transition into motherhood. Besides, like Schröder and Brüderl [25] we also investigate the causality of a possible (negative) effect of employment on the fertility, using a similar indirect causality test as proposed there. Note that our analyses are also restricted on transitions of childless women into motherhood, i.e. women delivering their first child.

The rest of the article is structured as follows. The most important sociological theories concerning employment and fertility are shortly summarized in Section 2. In Section 3 we discuss

some theoretical aspects concerning the causality of a potential negative effect of female labor force participation on the fertility and propose a suitable indirect causality test. The data, the used methods and the results are presented in Section 4, before we finally conclude in Section 5.

2 Sociological theories concerning employment and fertility

Though lively discussed in media and social sciences, according to Schröder and Brüderl [25] only few theoretical approaches concerning the explicit mechanisms of employment and fertility exist. Schröder and Brüderl [25] provide a compact summary of the existing sociological theories and hypothesis in this context. Among the most important and relevant theories are the following two:

The hypothesis of incompatibility of roles: the roles of a woman as mother on the one hand and as employee on the other hand are generally incompatible, as simultaneous childcare and labor force partition would either reduce the productivity of the job performance or the quality of childcare.

The hypothesis of substitution: both of these roles are linked with certain rewards or incentives of e.g. emotional, social or financial kind; furthermore, the rewards that go along with one role can partially be substituted by those of the other role.

However, the gist of both theories does not directly explain why labor force participation thus necessarily has a negative effect on the fertility, because according to Schröder and Brüderl [25] employed women could simply give up their role as employee by the time they want to have children. At this point another theory has to be mentioned, which plays a major role in this context.

The economic theory of fertility: this theory is embedded in the well-known rational choice framework for understanding and modeling social and economic behavior. Here, the main idea is that couples are regarded as consumers, who take their decision with regard to the number of children they want to have after an extensive cost-benefit-assessment. Among the most famous protectionists of the economic theory of fertility are Leibenstein and Becker.

Leibenstein [21] considers children to implicate three different types of benefit: a consume benefit, as children are a general enrichment for parents, bringing affection and personal gratification to them; an income benefit, arising from the productive activities of the children; and finally, an insurance benefit, as children care and assist their parents in their old ages. At the same time, children cause direct (food, clothes, education etc.) and indirect costs (the raising of children goes along with a huge expenditure of time, strongly limiting the engagement of the parents in other activities) for their parents. While nowadays the last two types of benefit became more or less obsolete, at least in western industrial nations, where child labor is illegal since many decades and the requirement of insurance is transferred as far as possible to responsible institutions (compare Huinink and Konietzka [16]), the consume benefit has remained rather consistent and can already be achieved by a small number of children, according to Leibenstein [21]. At the same time, with increasing economic wealth, the costs of children have generally increased. Consequently, by the theory of Leibenstein the number of children is decreasing with increasing economic wealth.

A similar approach is presented in Becker [3], where children are regarded as consumer products, offering psychological benefit to their parents. Both the quantity and quality of children are included, the quality of children covering several characteristics such as education, health or future income. For Becker quantity and quality of children can (at least partly) be substituted, creating an incentive for parents to invest into the quality of their children, i.e. to spend more efforts on care and education, rather than to realize a higher number of children. On the other hand, similar to

Leibenstein's indirect costs of children, Becker associates the costs that arise by the time spent for children. The idea is that child education is highly time-consuming and hence competes with other activities, e.g. employment. The time used for education could instead be used for employment, and the corresponding loss of earnings generates the so-called opportunity costs. This aspect is especially relevant for an employed woman. As soon as she stops working, even if only temporarily, her opportunity costs increase. Besides, the higher the wage rate the higher the opportunity costs (see Huinink and Konietzka [16]). Finally, as for Becker quantity and quality of children are more or less exchangeable, an employed women can realize her psychological benefit by investing in the quality of a child instead of deciding to get another child. Accordingly, with more and more women being employed and increasing income levels, also Becker's theory indicates a general decline in the number of children in developed nations. For more information about the economic theory of fertility, see also Hotz et al. [14]. A useful introduction and summary regarding important highlights of the attempts to develop an "economic" theory of human fertility are found in Leibenstein [22].

Several models exist, which consider the connection between the decision of women with respect to labor force participation and a demand for children, see e.g. Willis [28]. In most of these models the decisions relating to fertility and time allocation depend on basic economic variables such as man's income and woman's wage rate. As in these models the decisions relating to the number of children and to the time that a woman spends for labor force participation are usually ultimately determined at the beginning of the marriage, these models are called *static life time models*.

As pointed out by Schröder and Brüderl [25], so-called *dynamic life cycle models* are more realistic, where the whole life time is divided into periods and then for each period the time is determined that a woman spends for child education and employment (or leisure time, depending on the model) together with the corresponding fertility decision. The major assumption in these models is that the previous employment history and the current work effort have an influence on the income. Consequently, employed women are able to achieve higher wage rates than non-working women and hence, these models expect a causal negative effect of employment on the fertility.

As already stated in the introduction, in fact several studies exist that confirm this hypothesis. In particular, Schröder and Brüderl [25] have found that practically all studies that base on event data analysis and investigate the influence of female labor force participation and fertility in western industrial nations have found such a negative effect, which is independent from the country and from the parity of the child. Apparently, the existing empirical studies confirm the theoretical considerations presented in this section. However, in spite of the results of existing studies, following Schröder and Brüderl [25] one has to be careful when making statements with regard to causality of this negative effect and a more sophisticated analysis seems necessary, see next section.

3 Causality

In this section we discuss some theoretical aspects concerning the causality of the negative effect of female labor force participation on the fertility. According to Schröder and Brüderl [25], one cannot directly conclude from the results of the presented existing studies that the effect is causal, i.e. the reason for the probability of birth being lower for employed women than for non-working women is in fact their labor force participation. If so, reversely, this would require that the decisions related to the labor force participation are made independent from the fertility decisions. But Schröder and Brüderl [25] point out that it is also conceivable that fertility decisions may have an influence on the labor force participation. Some studies have tried to account for this problem by considering

suitable control indicators for the fertility and employment intentions, see e.g. Budig [6] or Cramer [9], but unfortunately the operationalization of these variables is quite imprecise. However, in most analyses the fertility intentions are not controlled at all. Otherwise, the results of two studies for Sweden (Hoem and Hoem [13]) and Great-Britain (Wright et al. [29]) indicate that fertility decisions also influence the labor force participation. Hence, Schröder and Brüderl [25] conclude that the relationship between employment and labor force participation is in fact quite complex. In this context they also graphically illustrate how, beside the employment status, also attitudes, moral concepts and long-term plans on the one hand, but also opportunities and restrictions on the other hand could have effects on the fertility.

But for the present analysis the relationship between fertility decisions and the preceding employment status is of most interest. In this context, one problem is that the exact time of a fertility decision cannot be observed and usually birth is used as a simple indicator. Hence, neither the influence of the preceding employment status on the fertility decision nor a possible influence of a fertility decision on the subsequent employment period can be analyzed in a reasonable way. For this reason, Schröder and Brüderl [25] also mention that it is possible that the effect of the current labor force participation on the fertility, to which most of the studies mentioned in Section 1 refer, in fact is an effect of the anticipated fertility on the employment status. Furthermore, they point out that for an optimal analysis of the influence of the employment status on the fertility a data set would be required, which contains the fertility intentions as a time-dependent covariate with the same temporal preciseness as the employment variable. For this purpose a panel with rather short interview intervals would be required. Unfortunately, such data are currently not available, neither for our analysis nor in Schröder and Brüderl [25].

Another important aspect in this context is the problem of so-called *unobserved heterogeneity*, also known as self-selection or spurious correlation. Even if the fertility intentions could be observed at any time and an effect of the preceding employment status on the fertility would be discovered, statements concerning the causality of this effect can only be made, if one can control for all factors which may have an influence on both the employment status and the fertility decision. If instead some of these factors are unobservable, then the relationship between fertility and labor force participation is (at least partly) a spurious correlation, i.e. non-working women would possibly be more likely to get children than employed women anyway (also without a causal effect of the employment status on the fertility), simply because they differ with respect to some unobserved factors relevant for the fertility decision. Hence, the effect of the employment status on the fertility would (at least partly) reflect this unobserved heterogeneity[1], compare Schröder and Brüderl [25].

Regarding these theoretical considerations, a major task is now to find a suitable method, which allows to empirically test the causality of the employment effect. Ideally, panel data containing the fertility intentions as a time-dependent covariate with the same temporal preciseness as the employment variable would be available, but as mentioned above such data are not (yet) on hand. Hence, Schröder and Brüderl [25] propose two indirect[2] causality tests.

[1] Possible candidates for such unobserved factors are the family, employment and career orientation or the fertility intentions. In this context Schröder and Brüderl [25] mention several research results, which indicate that such unobserved factors might be relevant. For example, Stolzenberg and Waite [26] found a negative relationship between (long-term) fertility intentions and employment plans and Cramer [9] and Budig [6] show that fertility intentions actually have an effect on the fertility.

[2] Schröder and Brüderl [25] call these tests *indirect*, because they base on additional assumptions, which cannot be checked on the basis of their data. Nevertheless, the tests are quite transparent, compare e.g. Brüderl et al. [5] or Beck and Hartmann [2] for similar test applications.

The first test assumes that women have different family orientations and can be divided into different (observable) groups according to their family orientation. It analyzes the progress of the effect of employment on the fertility over the cohorts and is based on the assumption that the differences with regard to family orientation between employed on non-working women have increased over the cohorts[3]. However, in the following analysis we abstain from performing this test for two reasons. First, pairfam's youngest cohort covers people born in the years 1971-1973, so even women from the youngest cohort already benefit from modern opportunities and working time organization models increasing the compatibility of family and work, such as e.g. public financial support, part-time work, trust-based working etc., when they reach their reproductive age. Second, in total pairfam contains only three different cohorts and people from the third cohort (1991-1993) are still in their teens at the time of the third interview wave (2010/2011). So, our data basis contains basically women belonging to only two different cohorts and hence, the corresponding indirect causality test would not be very meaningful.

With their second indirect causality test Schröder and Brüderl [25] want to check if the effect of the current employment status on the fertility in fact results from a reverse effect of an anticipated fertility decision on the employment status. The idea is that if some women would determine their employment status due to a preceding fertility decision, then one could expect among the group of women, who change from employment to unemployment and vice versa, a high percentage of such women. For this reason women are divided into the following four different groups: (a) mainly employed, (b) mainly non-working, (c) changers from employment to unemployment and (d) changers from unemployment to employment. For women belonging to group (c) one would expect very high transition rates for the transition into motherhood, while on the contrary for women belonging to group (d), very low transition rates are expected. Finally, for the other two groups (a) and (b) one would expect moderate transition rates lying in between. If instead only the current employment status causally affects the transition rate into motherhood, one would expect that the transition rate of currently employed women is much lower than the one of currently non-working women, independent of the former employment history. Following Schröder and Brüderl [25], we hope that if we regard a survival model with a single categorical covariate for these four groups, this allows us some conclusions about the causality of the effect of employment on the fertility or whether the effect in fact results from a reverse effect of an anticipated fertility decision on the employment status. We present the results of the corresponding indirect causality test in Section 4.

4 Data, methods and results

In this section we first illustrate the data and shortly comment on operationalization. Furthermore, we explain the used methods and finally present the results.

[3] The idea behind this assumption is that while in the 1950s and 1960s the bigger part of the female population was extensively restricting their labor force participation when getting their children, nowadays women have many possibilities and alternatives to combine their professional career with their family life, with the consequence that today only women with a very strong child-orientation are supposed to decide themselves against labor force participation. Hence, an increasing effect of employment over the cohorts would indicate self-selection as described in Section 3.

4.1 Data

Germany's current panel analysis of intimate relationships and family dynamics (pairfam, release 4.0; Nauck et al. [24]), started in 2008 and contains about 12.000 randomly chosen respondents, belonging to the birth cohorts 1971-73, 1981-83 and 1991-93. Pairfam follows the cohort approach, i.e. the main focus is on anchor persons of certain birth cohorts, who provide in yearly conducted interviews detailed information, orientations and attitudes (mainly concerning the family situation) of themselves and their partners. A detailed description of the study is found in Huinink et al. [15].

Here, for a sub sample of 2289 women the retention time (in days) until the birth of the first child is considered as the dependent variable, starting at their 14th birthdays. In order to ensure that the independent time-varying covariates are temporally preceding the events, the duration until conception (and not birth) is considered, i.e. the time of event is determined by subtracting 7.5 months from the date of birth, which is when women usually notice pregnancy. For each woman the employment status is given as a time-varying categorical covariate with eight categories, compare Table 3. Note that due to gaps in the women's employment histories a category called "no info" is introduced. As in the study of Schröder and Brüderl [25], for women who belong to this category for longer than 24 months it is set to "unemployed". Besides, several other time-varying and time-constant control variables are considered. Tables 2-4 give an overview of all considered variables together with their proportions in the sample. An extraction of the data set is shown in Table 1.

Id	start	stop	birth	employment	education level	relationship status	cohort	# siblings	education level of parents
111000	0	730	0	school	apprenticeship	single	1	1	traineeship
111000	730	1434	0	no info	apprenticeship	single	1	1	traineeship
111000	1434	1891	0	no info	apprenticeship	cohab	1	1	traineeship
111000	1891	1939	1	full-time	apprenticeship	cohab	1	1	traineeship
907000	0	365	0	school	secondary education	single	2	0	traineeship
907000	365	2438	0	no info	secondary education	single	2	0	traineeship
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

Table 1: Structure of the data

For the indirect causality test we extract a second, smaller data set, *event.data.test*, with the employment status as the only covariate of interest. Observations in the categories "school", "education" or "no info" are dropped. As in Schröder and Brüderl [25], we construct the time-varying covariate *employ.test* with four categories: (a) mainly employed, (b) mainly non-working, (c) changers from employment to unemployment, (d) changers from unemployment to employment. Each category is computed proportionally on the preceding intervals (threshold: $> 50\%$) and also accounts for the current employment status. E.g., if a woman has been employed for more than 50 % of her employment biography and is currently unemployed, then she is currently in status (c).

One can observe that most of the variables have similar proportions compared to the West-German Family Survey 2000 , with the major difference that for the variable *employment status* we found higher proportions in the categories "school" and "no info" and consequently lower proportions in the categories "full-time employed", "part-time employed" and "education", see Table 3.

4.2 Methods

In the following we use a semi-parametric approach, which is suitable for the estimation of the influence of specific covariates on the survival time of certain statistical objects. The most common

	proportion
Birth cohort	
1971-1973	0.49
1981-1983	0.41
1991-1993	0.10
# siblings	
no siblings	0.20
one sibling	0.44
two siblings	0.21
three or more siblings	0.14
Education level of parents	
university with PhD	0.015
university without PhD	0.095
A levels	0.003
college of higher education	0.138
apprenticeship	0.103
traineeship	0.440
general secondary education	0.005
secondary education	0.024
no graduation	0.007
other graduation	0.001
no info	0.169
Number of women	2,289
Number of events	1,371

Table 2: Distribution of the time-constant covariates in the sample

	# days	proportion
Employment status		
full-time employed	3,089,174	0.274
self-employed	85,560	0.007
part-time employed	252,396	0.022
marginally employed	107,087	0.009
education	165,165	0.015
school	2,634,246	0.233
unempl./job-seeking/housewife	216,639	0.019
no info	4,737,190	0.420
Education level		
university with PhD	483,529	0.043
university without PhD	1,669,741	0.148
A levels	396,253	0.035
college of higher education	1,764,788	0.156
apprenticeship	2,226,048	0.197
traineeship	4,004,395	0.355
general secondary education	298,837	0.026
secondary education	299,438	0.027
no graduation	45,206	0.004
no info	99,222	0.009
Relationship status		
single	5,471,726	0.485
partner	3,310,963	0.293
cohabitation	1,904,906	0.169
married	599,862	0.053
Number of women	2,289	
Number of events	1,371	
Number of days	11,287,457	

Table 3: Distribution of the time-varying covariates in the sample

	# days	proportion
Combination employment history/current employment status		
continuously unemployed	150,340	0.040 (0.013)
change from employed to unemployed	66,299	0.018 (0.006)
change from unemployed to employed	85,717	0.023 (0.008)
continuously employed	3,448,500	0.919 (0.306)
Number of women	1,705	
Number of events	863	
Number of days	3,750,856	

Table 4: Distribution of the four groups that are considered in the indirect causality test; in brackets: proportion with respect to the main data set

class of models used in the literature is the class of hazard rate models, in particular the so-called proportional hazards rate (PH-)model. This model belongs to the class of semi-parametric regression models, as for the baseline hazard function no specific form needs to be assumed.

The influence of explanatory variables is modeled parametrically, assuming that these covariates directly influence an individual's hazard rate. The hazard rate has the following well-known form:

$$\lambda(t, \mathbf{x}) = \lambda_0(t) \exp(\mathbf{x}^t \boldsymbol{\beta}) = \lambda_0(t) \exp(x_1 \beta_1) \cdot \ldots \cdot \exp(x_p \beta_p),$$

with baseline-hazard $\lambda_0(t)$ and linear predictor $\mathbf{x}^t\boldsymbol{\beta}$ (usually containing no intercept β_0, as it is already covered by $\lambda_0(t)$). The hazard rate is defined as follows:

$$\lambda(t, \mathbf{x}) = \lim_{\Delta t \to 0} \frac{P(t \leq T < t + \Delta t | T \geq t, \mathbf{x})}{\Delta t},$$

representing the instantaneous risk of a transition at time t (here: a transition into motherhood), given that the transition did not yet occur. Characteristic property is the proportionality of the hazard rates: for two arbitrary individuals with corresponding vectors of covariates $\mathbf{x}_i, \mathbf{x}_j$ we get

$$\frac{\lambda(t, \mathbf{x}_i)}{\lambda(t, \mathbf{x}_j)} = \frac{\lambda_0(t) \exp(\mathbf{x}_i^t \boldsymbol{\beta})}{\lambda_0(t) \exp(\mathbf{x}_j^t \boldsymbol{\beta})} = \exp((\mathbf{x}_i - \mathbf{x}_j)^t \boldsymbol{\beta}),$$

i.e. the proportion of the hazard rates of woman i and j at time t is not depending on time, but solely on their covariate realizations; major objective is the estimation of the covariate effects $\boldsymbol{\beta}$.

4.3 Results

In the following we consider two rather similar PH-models, the famous Cox-model (Cox [7]) and the so-called piece-wise constant (PWC-)model (e.g. Blossfeld et al. [4]). In the PWC-model the basic assumption is that the baseline hazard can change on predefined intervals, but remains constant within these intervals. In contrast, the Cox-model uses the so-called Nelson-Aalen estimator (Aalen [1]) for the baseline hazard. The corresponding cumulative baseline hazard functions are illustrated in Figure 1, showing that the PWC cumulative hazard is coarser, but has the same general course as the Cox estimate. Exemplarily, a Cox model incorporating all covariates from Section 4.1 can be fitted in R using the package `survival` (Therneau and Grambsch [27]) by the call:

```
>cox.obj <- coxph(Surv(start,stop,birth) ~ employment + education + relationship
+ siblings + edu.parents + cohort + cluster(id), data=event.data, method="breslow"),
```

presuming that all categorical covariates are already transformed into factors[4]. Similarly, a PWC-model can be fitted using the `phreg` function from the R package `eha`. Figure 1 also shows the effect of the *employment status* on the cumulative baseline hazard functions for both approaches: women, who are still at school (blue), have the lowest transition rate into motherhood, whereas women in the reference category (represented by the baseline hazard; black), i.e. who are unemployed, job-seeking or housewives have the highest transition rate. As the Cox estimates are smoother, exhibit no big jumps and hence more adequately model the data structure, in the following we focus on the Cox model when comparing our results with those obtained in Schröder and Brüderl [25].

Figure 2 shows the estimated fixed effects and 95%-confidence intervals corresponding to the German Family Survey 2000 (Schröder and Brüderl [25]; dashed lines) and the pairfam data (solid lines). As not all covariates exhibit exactly the same categories for both studies, only the effects of

[4] The `cluster(id)` term in the formula implies that robust variance estimators are used. The `method` argument specifies the method for tie handling.

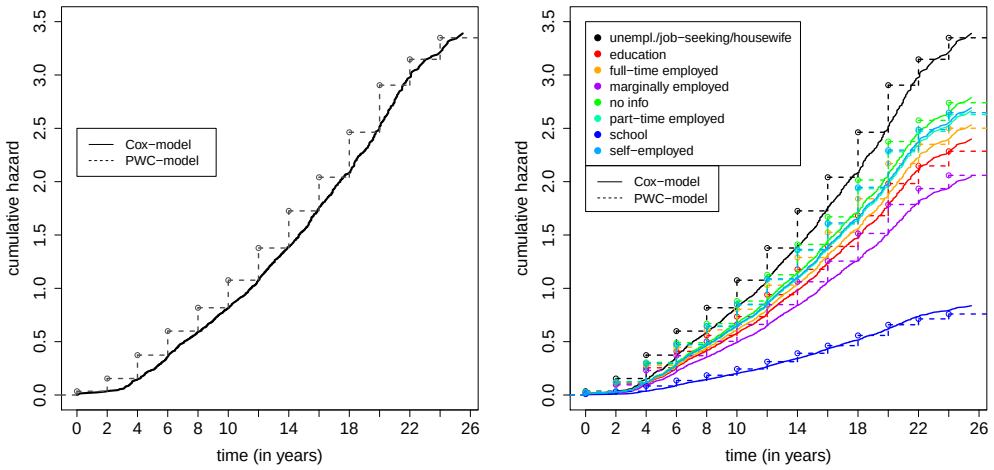

Fig. 1: Left: comparison of the cumulative baseline hazard functions, PWC- and Cox-model; right: effect of the *employment status* on the cumulative baseline hazard functions, PWC- and Cox-model

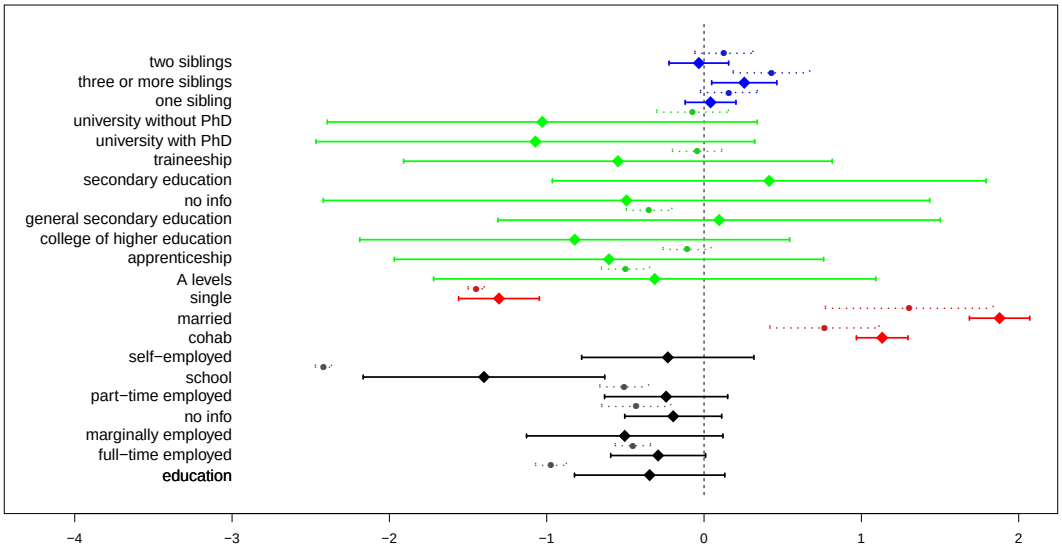

Fig. 2: Comparison of the fixed effects corresponding to the German Family Survey 2000 data (Schröder and Brüderl [25]; dashed lines) and the pairfam data (solid lines)

those covariates are shown where a comparison is (at least approximately) possible. Note that the effects of the *parents' education level* are not shown here, as in the pairfam study it is measured in more detailed levels compared to the German family survey. First, it turns out that the estimated effects for the Cox model based on pairfam are surprisingly consistent with those from Schröder and Brüderl [25]. Second, standard errors and confidence intervals are larger for the pairfam data, which is partly due to the used special variance-robustness method. All estimated (exponential) regression coefficients together with standard errors are presented in Table 6 in the Appendix.

In detail, we get the following results. Similar to Schröder and Brüderl [25], we find a strong negative, significant effect when women still go to school. Besides, the categories "part-time employed" and especially "full-time employed" have negative effects on the transition into motherhood compared to unemployed women, the first effect being close to significance and the latter being significant. Hence, our results confirm a negative effect of female labor force participation on the fertility for whole Germany. Later, we focus on the investigation of the causality of this effect.

With respect to the other control variables we find that the degree of institutionalization of the relationship shows the expected effects: married women have the highest transition rate into motherhood, followed by (unmarried) women who live together with their partner and women who live (apart) together with a partner; single women have the lowest transition rates. While the birth cohort has no influence on the hazard rate, women who grow up with many siblings have significantly higher transition rates. Besides, it is seen that in comparison to the reference category "no graduation" higher educational levels, except for the two types of secondary education, have negative effects, with similar trends as in Schröder and Brüderl [25], though without being significant. Similar tendencies, but with significance, are observed for the *parents' level of education* see Table 6. Next, we consider several goodness-of-fit criteria for the fitted model.

Goodness-of-fit

First, we check the proportional hazards (PH-)assumption for the hazard function. Grambsch and Therneau [12] propose a test on the validity of the PH-assumption against the alternative of time-varying coefficients. While Table 6 in the Appendix shows that the global test rejects the PH-assumption, also tests for single covariates should be considered, in particular those corresponding to key variables. A closer examination of the single tests shows that for the variables *education level* and *relationship status* the PH-assumption is generally violated ($\alpha = 0.05$), as for at least one category the null hypothesis is significantly rejected. In contrast, for the variables *employment status*, *cohort*, *number of siblings* and *parents' education level* the PH-assumption is not rejected.

The model's overall performance can be graphically assessed by investigating the Cox-Snell residuals (Cox and Snell [8]), i.e. by comparing empirical and theoretical cumulative hazard functions of the residuals. If the true underlying model is close to the specified one, the estimated cumulative hazard rate of the Cox-Snell residuals is close to the bisecting line, which is generally fulfilled here, see Figure 3 in the Appendix. Besides, similar to the residuals of an ordinary least-squares-estimator in linear regression, the Cox-deviance residuals can be regarded, separately for each covariate. They should vary symmetrically around zero and are also suitable to detect outliers. Figure 4 in the Appendix shows the Cox-deviance residuals, exemplarily for the covariates *employment status* and *relationship status*, which manifest a slight negative trend, i.e. survival times are slightly over-estimated by the model. Consequently, some model assumptions might be violated. Nevertheless, all in all the fitted model seems appropriate and provides an adequate fit.

Indirect causality test

To check if the effect of the current employment status on the fertility in fact results from a reverse effect of an anticipated fertility decision on the employment status, we fit the following model:

```
>cox.obj2 <- coxph(Surv(start,stop,birth) ~ employ.test + cluster(id),
data=event.data.test, method="breslow"),
```

which is based on the smaller data set *event.data.test* and on the constructed time-varying covariate *employ.test*, introduced in Section 4.1. Even though the fitted effects in Table 5 show the same trend as in Schröder and Brüderl [25], they are far from significance. Hence, our test does not directly indicate that the estimated negative effect of female labor force participation is not causal.

	$exp(\beta)_{SB}$	$exp(\beta)_{pairfam}$
Combination employment history/current employment status		
continuously unemployed	1	1
change from employment to unemployment	1.822∗∗∗	1.014
changers from unemployment to employment	0.449∗	0.653
continuously employed	0.862	0.776
individuals	2,093	1,705
number of events	1,447	863

Table 5: Comparison of the indirect causality test results for the German Family Survey 2000 data (Schröder and Brüderl [25]; $exp(\beta)_{SB}$) and the pairfam data ($exp(\beta)_{pairfam}$)

5 Conclusion

In this work the relationship of employment and fertility in reunified Germany is analyzed on basis of the pairfam data, also regarding causality. We find that the estimated effects for a Cox proportional hazards model based on the pairfam data are surprisingly consistent with the results of an earlier study from Schröder and Brüderl [25], which is based on the West-German Family Survey 2000. However, a corresponding indirect causality test cannot confirm the opposite direction, namely that self-selection in terms of anticipated fertility decisions also affects employment. We conclude that with respect to causality a more sophisticated analysis seems necessary.

Acknowledgment: This article uses data from the German family panel pairfam, coordinated by Josef Brüderl, Johannes Huinink, Bernhard Nauck, and Sabine Walper. Pairfam is funded as long-term project by the German Research Foundation (DFG).

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Appendix: Estimation, goodness-of-fit and PH-test results

	$\exp(\beta)$	$\text{se}(\beta)$	ρ	χ^2	$P(\cdot > \chi^2)$
Employment status (Ref.: unempl./job-seeking/housewife)					
education	0.708	0.244	0.006	0.045	.832
full-time employed	0.747$^{\bullet}$	0.154	0.046	3.572	.059
marginally employed	0.604	0.318	0.006	0.051	.822
no info	0.882	0.157	0.037	2.444	.118
part-time employed	0.786	0.200	0.024	1.031	.310
school	0.247***	0.392	-0.014	0.292	.589
self-employed	0.794	0.279	0.048	3.679	.055
Cohort (Ref.: cohort 1)					
cohort 2	1.049	0.065	0.006	0.059	.809
cohort 3	0.884	0.348	0.016	0.392	.531
Relationship status (Ref.: partner)					
cohabitation	3.103***	0.084	0.008	0.125	.724
married	6.543***	0.098	-0.085	14.208	$< .001$
single	0.272***	0.131	-0.042	3.027	.082
Education level (Ref.: no graduation)					
A levels	0.730	0.717	0.040	9.826	.002
apprenticeship	0.546	0.696	0.040	10.362	.001
college of higher education	0.440	0.697	0.045	13.069	$< .001$
general secondary education	1.100	0.717	0.034	7.321	.007
no info	0.611	0.983	0.014	0.802	.370
secondary education	1.513	0.703	0.034	7.425	.006
traineeship	0.579	0.695	0.038	9.284	.002
university with PhD	0.342	0.711	0.046	13.158	$< .001$
university without PhD	0.358	0.697	0.049	15.783	$< .001$
# siblings (Ref.: no siblings)					
one sibling	1.042	0.082	0.045	0.09	7.68e-01
two siblings	0.967	0.097	0.036	2.59	1.08e-01
three or more siblings	1.291*	0.106	-0.004	0.03	8.54e-01
Education level parents (Ref.: no graduation)					
A levels	0.430	0.516	-0.018	0.345	.557
apprenticeship	0.492*	0.296	-0.056	3.557	.059
college of higher education	0.526*	0.293	-0.052	3.084	.079
general secondary education	1.156	0.553	-0.007	0.068	.795
no info	0.725	0.291	-0.076	6.448	.112
secondary education	0.578	0.343	-0.045	3.104	.078
traineeship	0.573$^{\bullet}$	0.286	-0.070	5.385	.020
other	0.134***	0.330	0.013	0.185	.667
university with PhD	0.429*	0.395	-0.043	2.347	.125
university without PhD	0.603$^{\bullet}$	0.298	-0.054	3.202	.074
Global test				158.451	$< .001$

Table 6: Estimated (exponential) regression coefficients together with robust standard errors (left) and test on the PH-assumption (right) for the Cox-model on the pairfam-data
$^{\bullet}$ p<0.1; * p<0.05; ** p<0.01; *** p<0.001.

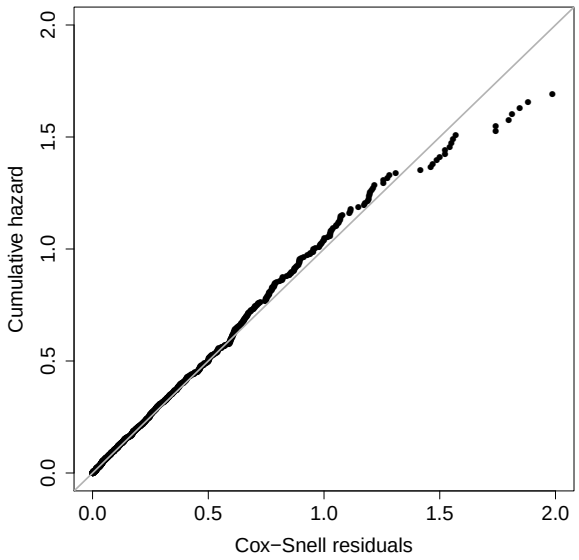

Fig. 3: Cox-Snell residuals for the Cox-model

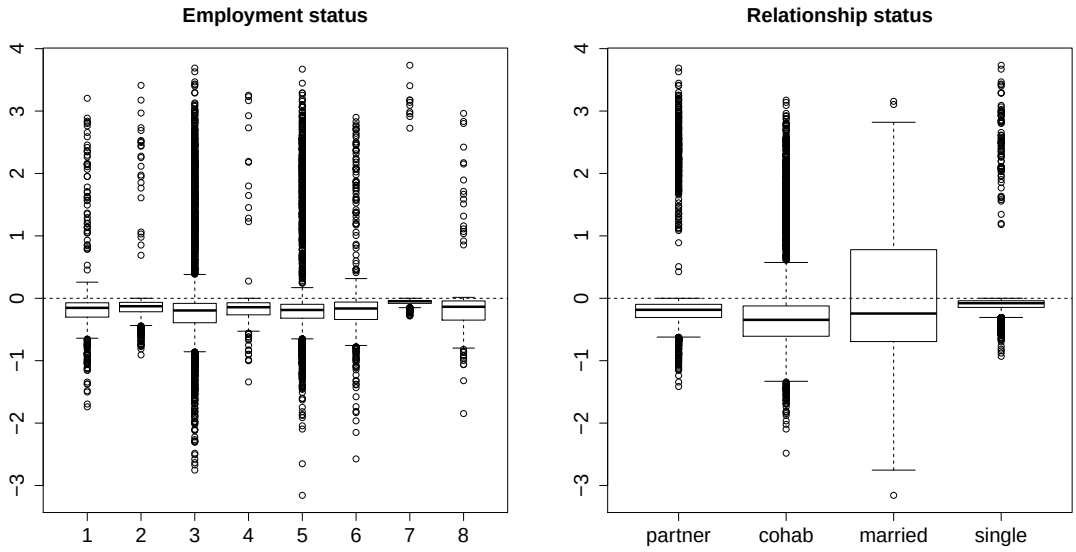

Fig. 4: Cox-deviance residuals for the Cox-model