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Racing Against the Biological Clock? Childbearing and Sterility Among Men and Women in Second Unions in France

Une course contre la montre? Fécondité et stérilité des hommes et des femmes en seconde union en France

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Abstract In developed countries, rising rates of union disruption have induced an increase in the share of people experiencing several fertile partnerships during their fertile life-span. However, from the large-scale 1999 French Family Survey, in the 1939–1954 birth cohorts it appears that completed fertility of repartnered men is slightly higher than that of never-separated men while repartnered women have fertility levels similar to those who remain in a first intact partnership. Following this observation, this article aims to study whether people, and especially women, have enough time to have children in the context of second union before they become limited by the "biological clock". Using a cure model, we find that once age-related sterility is controlled for, the decrease in risk of having children with age is not visible anymore up to age 40. This offers some evidence that people in their second partnership, especially women, are constrained in their childbearing by the decline in fecundity with age. Additionally, childless women seem to respond proactively to the decline in fecundity with age by accelerating childbearing.

Keywords Fertility · Late fertility · Childbearing · Sterility · Fecundity · Couples · Partnership · Separation · Repartnering · Remarriage · Stepfamily

Résumé Dans les pays développés, la proportion de personnes connaissant plusieurs histoires conjugales durant leur période de vie féconde a cru avec la hausse des taux de divorce et de séparation. Cependant, l'enquête française à grande échelle Histoire Familiale 1999 (EHF) montre que, pour les générations 1939–1954,

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la descendance finale des hommes qui se sont remis en couple est légèrement supérieure à celle des hommes dont la première union est intacte, tandis que la descendance des femmes qui reforment une union est similaire à celle des femmes qui restent dans leur premier couple. Cette observation nous a conduit à étudier si les personnes qui se remettent en couple, et en particulier les femmes, disposent de suffisamment de temps pendant leur deuxième union pour avoir des enfants dans le temps imparti par l'horloge biologique. Basés sur des modèles avec une fraction non à risque (Cure models), nos résultats montrent que la fécondité ne diminue plus avec l'âge dans les secondes unions une fois tenu compte de la baisse de la fertilité avec l'âge (estimée sur données historiques). Il semble donc que les personnes se remettant en couple, en particulier les femmes, soient limitées dans leur choix de fécondité par la baisse de la fertilité avec l'âge. En outre, les femmes sans enfant semblent lutter contre cette baisse en accélérant leur calendrier de procréation à l'approche de la fin de vie féconde.

Mots-clés Fécondité · Fécondité tardive · Stérilité · Fécondabilité · Couple · Séparation · Remise en couple · Remariage · Famille recomposée

1 Introduction

In the last decades, the fertility process has been affected by the general postponement of the steps leading to family formation (Sobotka and Toulemon 2008; Billari et al. 2006). The mean age at first birth has increased sharply—around 3 years in most European countries since the seventies. In the demographic literature, considerable attention has been paid to a potential link between the postponement of first union formation and first birth, and the fertility decrease observed in several European countries. In particular, in the early 2000s, postponement was seen as a possible reason for the prolonged situation of low fertility (Kohler et al. 2002), but the recent upturn in period fertility that has followed the slowdown in postponement signals that it only had a transient effect on aggregate fertility levels (Goldstein et al. 2009). However, at the individual level, this delay may still lead more couples to remain involuntary childless since fecundity decreases with age (Beets 1996; Billari et al. 2007; te Velde et al. 2012)—or at least it may lead the partners to have less children than they would have had if entering a partnership and having their first child earlier. Notably, some evidence has been found that women who have their first child at later age have fewer children than women who become mother at younger ages (Billari et al. 2000; Billari and Borgoni 2005; Kohler et al. 2001).

Another possible restriction to childbearing has been emerging more recently with the growing frequency of union break-up and multiple partnership trajectories. Even if fathers and mothers who actually form a second partnership manage to have about as many children, if not more, as those who remain in a stable partnership (Thomson et al. 2012), overall people who have ever separated have a lower completed family size than people who have never separated (Jansen et al. 2009). Since partners entering second and subsequent partnerships are on average older than people forming a first couple, and are therefore more exposed to biological

constraints to fecundity, some of them might see their fertility limited by their more advanced age at repartnering.

The investigation of the "births in later unions" issue notably calls for a knowledge of fecundity matters. Child desire at these ages seems constrained by fecundity problems (Menken 1985; Trussell and Wilson 1985). Indeed, fecundity declines sharply with age, especially for women (Leridon 2008): 10 % of couples are already sterile when the woman is 30 years old, 17 % when she is 35, and 29 % at age 40. Late partnership involves "having less time at one's disposal before reaching the biological limits of fertility" (Kreyenfeld 2002). Though it has been shown, on women without obvious signs of sterility, that those in their early 30s can have a first child without significant fecundability loss compared with younger woman (McDonald et al. 2011), such a "time squeeze" could be an incentive for conceiving children quicker in later unions.

Do people forming a second or higher-order partnership have enough time to have children, and is there a contrast between men and women? This question links together a demographic and epidemiological broader question about whether people try to overcome increasing sterility with age. The aim of this article is to test whether people respond proactively to their higher risk of sterility at later age by having their children quicker, taking second unions as a framework. As fecundity decline by age is slower for men than for women, we ask also how far such behavior differs between men and women.

After some empirical and theoretical considerations, we model the timing of child birth since second partnership formation by age using the French "Family History Survey" (1999),[1] having taken account of the progressive rise of sterility with age.

2 Empirical and Theoretical Considerations

In a context where repartnering as well as births in a subsequent partnership become increasingly common, second unions form an ideal framework to test whether people are confronted with and react to biological constraints. We present here an overview of second or higher unions' fertility in France. A discussion on the determinants of fertility in second unions follows, describing the specific incentives and constraints couples face when entering a second or higher-order union, with special attention to the role of sterility in this childbearing process.

2.1 Second (or Higher-Order) Unions in France

Fertility in second and higher-order unions constitutes a good framework for analyzing possible adaptive behavior to biological constraints. First, the empirical literature shows that the desire for children remains substantial in second unions and even in stepfamilies (Thomson et al. 2002; Toulemon and Knudsen 2006; Vikat et al. 1999), up to high-reproductive ages. Second, studies on late fertility (Billari et al. 2007; Prioux 2005; Bessin et al. 2005) often choose a fixed and arbitrary age

[1] For more details, see Mazuy and Toulemon (2001).

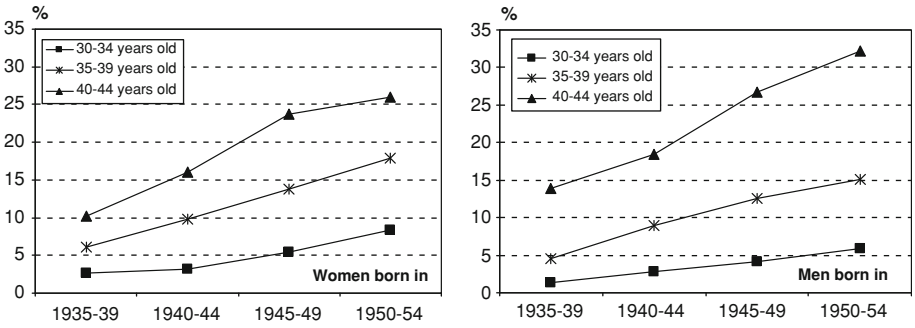

Fig. 1 Percentage of births that occur in a second and subsequent union over all births, by birth cohort of parents and age at birth; all birth orders; women and men; France. *Sample* Women and men born in 1935–1954. *Source*: Family History Survey (FHS), Insee, 1999

(35 or 40 years old) from which fertility is observed, and do not accurately take into account the duration already spent in the union. However, union duration can vary widely at that age, and strongly influences the risk of transition to a (further) birth. Second or subsequent unions provide a more homogenous population for testing the effect of biological clock on fertility timing.

Additionally, studying births in this framework might help us to better understand the dynamics of fertility after a separation has occurred, and especially the difference between men and women. We give thereafter a brief description of the growing frequency of complex family paths and of their outcomes in terms of fertility for men and women in France.

Among people who have children at an advanced age, births occurring in second or subsequent unions are increasingly common. Figure 1 (see the data section for the description of the FHS) shows the percentage of all children who are born in a second or higher-order union according to parental age at birth in various generations. Between the cohort of men and women born at the end of the 1930s and those born at the beginning of the 1950s, the proportion of children born in a second or subsequent union has increased for all parental ages at birth. The proportion is particularly high at older ages: of men born in 1950–1954, one-third who became fathers at ages 40–44 were in a second union, compared with only 14 % in the cohorts born 15 years earlier. The proportion also rises for women: in the most recent birth cohorts one quarter of all births to mothers in this age group occurred in a second or higher-order partnership, against one in ten in the 1935–1939 birth cohorts. Also, for men and women whose child was born between ages 35 and 39, the proportion of children born in second or subsequent unions is about three times higher in the most recent cohorts than in the earliest ones. All in all, more and more births at ages 35+ are to parents in a second or higher-order partnership, and this trend is likely to be going up with the growing likelihood of first union dissolution. However, births in higher-order unions are possibly limited by biological constraints, and we are interested in knowing to what extent.

Figure 2 shows the age distribution of first and of higher-order partnering before age 45 and the proportion of unions that will be fertile. Second unions are clearly

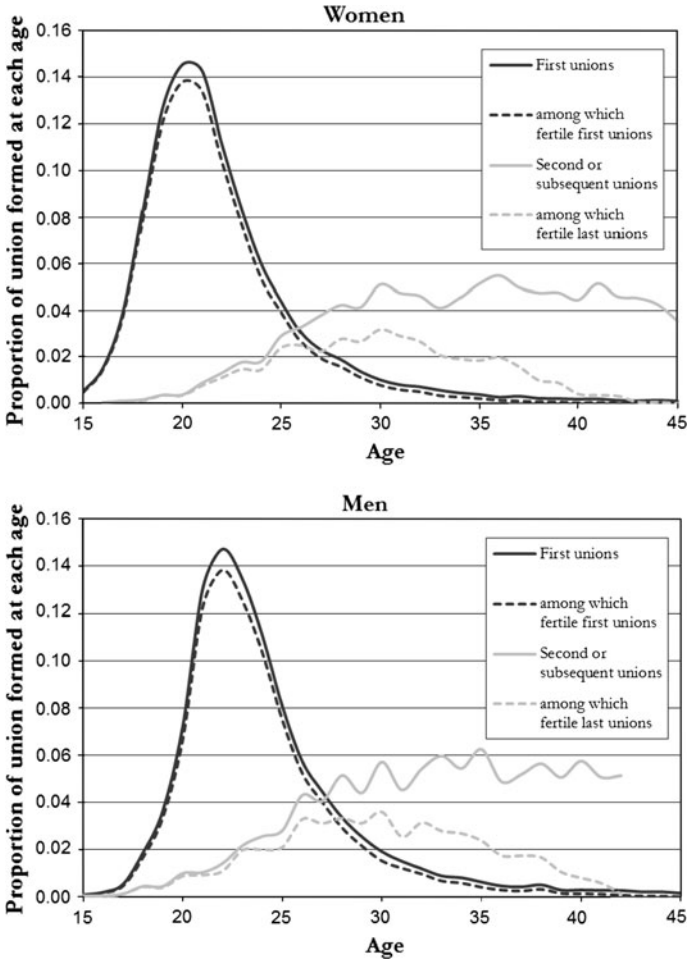

Fig. 2 Percent-distribution of first unions and of second or subsequent unions by age at union formation, and subgroup of them that will be fertile; women and men; France. *Sample* Women and men aged 45–60 in 1999 (at the end of their reproductive spell). *Source* Family History Survey (FHS), Insee, 1999

formed at an older age than first unions, and their age variance is much larger. Among cohorts aged 45–60 in 1999, the mean age at second or subsequent union formation is around 35 for men and women, while the age at first union was 22 for women and 24 for men. As a consequence, even if recent medical progress may help older couples to have children, biological limits are more likely to be already reached when people in a second or subsequent union decide to have children. From Fig. 2 we can also deduce that among women who enter their second or higher-order partnership at age 30, 62 % will subsequently have children (percent of fertile unions among unions formed at age 30, i.e., ratio between the doted light curve and the plain light curve). If the new partnership started at age 35, the percentage of fertile unions decreases to 36 %, and it falls to 9 % at age 40. For men, the

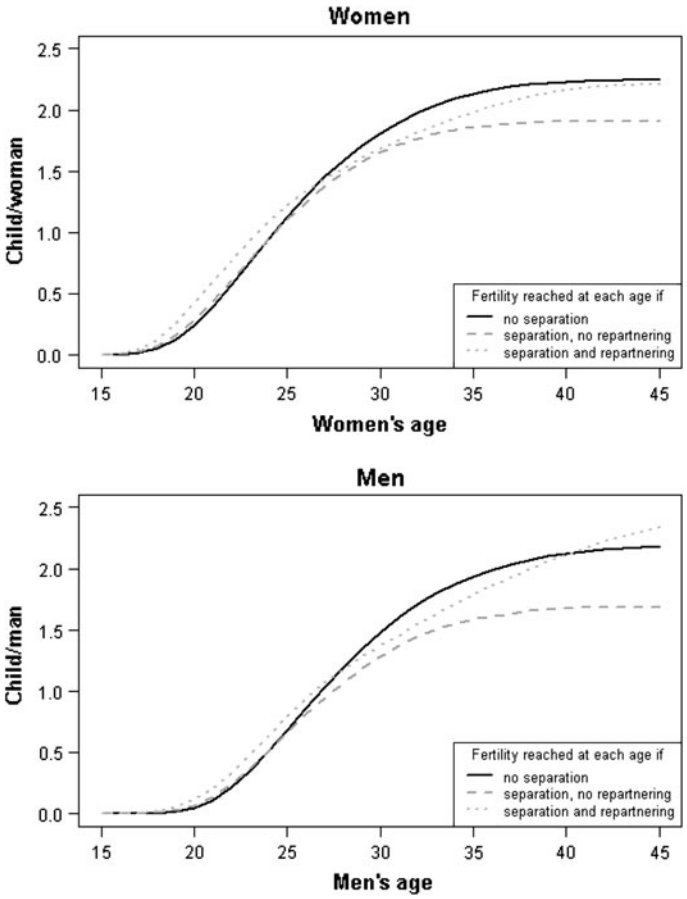

Fig. 3 Total cumulative fertility of women and men by age and partnership history; France. *Sample* Women and men aged 45–60 in 1999 (at the end of their reproductive spell). *Source* Family History Survey (FHS), Insee, 1999

proportion of fertile unions remains higher at later ages of union formation, and men who enter a second partnership at age 40 still have a 33 % chance of having children with the second partner. Thus, the probability that a second union will be fertile is highly dependent on the age at union formation (see also Thomson et al. 2012), and more particularly on the woman's age. This is especially true for women aged 35–45 and accurately raises the question of gender-specific biological constraints.

Figure 3 illustrates gender differences in fertility depending on the family path by showing the total cumulative fertility curves of the 1939–1954 birth cohorts by partnership history. Among people who did not separate, completed fertility flattens after age 37 for women and after 40 for men. Fertility of both separated women and men slows down earlier, but those who repartner before age 45 tend to make up for their lower number of children. However, the magnitude of fertility catch-up differs by gender. Whereas the cumulative fertility of men who repartner reaches and slightly exceeds from age 40 that of non-separated men (eventually 2.32 children on average

against 2.2 for never-separated men), women who repartner do almost not make up for the difference (2.17 against 2.25 for never separated at age 45). Again, these observed gender differences raise the question of the role biological constraints may play on fertility in second partnerships.

2.2 Incentives and Constraints to Childbearing

Deciding on having a/another child depends on various components (Régnier-Loilier and Solaz 2010) such as parity, partnership duration, fecundity, economic situation, social norms about family size and age at parenthood, physical constraints, etc. For instance, people may decide to have a child earlier because they might not want to exceed an ideal age for paternity and maternity fixed by social and cultural timetables (Settersten and Hägestag 1996), because they are concerned by becoming "too-old parents". They may also anticipate health problems other than sterility as they grow older, and want to have children when they are still in a good shape. Newly repartnered men and women are also exposed to these different factors, and have the additional double interest, for our research purpose, to have high age constraints associated with a substantial fertility desire.

It has been shown that there is a strong desire for having a shared child in stepfamilies. This first shared birth signals the couple's commitment to remain together in order to rear the child whether partners have pre-union children or not (Thomson et al. 2002; Vikat et al. 1999). Indeed, at similar age and parity, people who just enter a union are more likely to desire a child than those who have been in a union for a long time (Buber and Fürnkranz-Prskawetz 2000; Toulemon and Knudsen 2006; Griffith et al. 1985).

On the other hand, a major difference with first unions is that those entering second or subsequent unions often have children from a previous partnership. Looking at stepfamilies and second unions, it has been found that already having children generally reduces chances of childbearing, especially if both partners already have children (Thomson et al. 2002; Toulemon and Knudsen 2006; Beaujouan 2011). It is thus possible that some people who already have children will not necessarily try to have more in a second union, and thus will not be confronted with the sterility constraints.

Yet, in the situation of a new union and willing to have children, some people may speed up having children in anticipation of fecundity problems. To explore whether couples in second unions adapt their childbearing behavior to decreasing fecundity with age, we observe fertility by age once the effects of age-related sterility have been isolated. Intuitively, this relates to understanding what their fertility behavior would be in absence of fecundity problems. We also give special attention to the parental status of each partner, as possible markers of a difference in desire for children in the new union.

2.3 Sterility

Beyond social and psychological factors, sterility, defined as the state of being permanently unable to reproduce, very strongly limits fertility from age 35/40

(Prioux 2005). Though infecundity is also often unknown, several factors have been reported that seem to affect the individual likelihood of being infecund (Kamel 2010) such as the age of both partners, past diseases (such as sexually transmitted infections), diet during childhood, some personal habits, and other sex-specific and combined male and female factors (Menken et al. 1986; Gnoth et al. 2005; Kamel 2010). As empirical data on all of these factors, except for age, is not generally available, an alternative method of identifying an individual's fecundity is adopted here, using the stochastic average risk of being sterile estimated by the frequencies of sterile couples by age of the woman.

A central feature of our approach is that we take account of the progressive onset of sterility as men and women age (Leridon 2002). Since we model risks of first birth in a given union, the definition of sterility chosen is the permanent incapacity to give a live birth. It includes couples who have never been able to conceive after a period of unprotected intercourse, couples who manage to conceive but then miscarry, and couples who have a stillborn baby (Leridon 2010). This broad definition of fecundity—also referred to as "effective fecundability" (Sheps and Menken 1973; Leridon 1977)[2]—fits our purposes since we want to take into account all the physical problems that may impede a couple for having a live birth.

Women's age is generally considered as the main observable determinant of couple's sterility, but as men's fecundability also decreases with age though in a lesser extent, the sterility of the couple also depends on male's age (de la Rochebrochard and Thonneau 2003). Epidemiological studies of the man's role in couple infecundity show that even though both ages are important, the effect of age on male fecundity is generally weaker and men become sterile at a later age than women (de la Rochebrochard 2001; Goldman and Montgomery 1990).[3] There is currently no sterility equation that takes both partners' ages simultaneously into account, which could limit the accuracy of the couple's sterility control. However, even when estimated as a function of female's age only, couple's sterility also partly depends on male's age, since both partners ages are closely interrelated (Menken and Larsen 1986).

3 Data and Method

3.1 Data

To carry out a study of second (or higher-order) unions, a large database is necessary so as to have sufficient numbers of partnerships for analysis. Our results are therefore based on a large survey called Family History Survey (FHS, "Enquête sur les Histoires Familiales" Ined-Insee, 1999) conducted in France in 1999 and linked to the General Population Census. It encompasses 380,000 individuals (1 %

[2] Sheps and Menken (1973) already presented some equations of effective fecundability (pp. 224–225), and Leridon (1977) gave a general definition of effective fecundability (chapter 2).

[3] Goldman and Montgomery's estimations are based on polygamous households in different countries of Africa. Their results differ by country, but male age is never a strong determinant with respect to female age.

of the census) aged 18 and over. The questionnaire includes questions on first and last partnership and on childbearing history. Detailed information on own children is available for each union, and whether the spouse/partner already had at least one child at union formation. However, our data are at an individual level and not at a couple level, and within a couple we do not dispose of symmetrical information for both partners. The large sample size makes this survey the only one currently suitable in France for analyzing relatively infrequent events such as childbearing in second and subsequent unions. A union is defined as a partnership with at least 6 months of cohabitation. Unfortunately, the survey does not distinguish between second and subsequent unions: information is available only on the first union and on the most recent union. For this reason, we retain the most recent union declared which is not a first union, and it is referred to in the text as "second or subsequent union" or "second or higher-order union", but also sometimes as "second union". In 1999, around 14 % of people had experienced at least two unions. Very few couples experience more than two unions in the cohorts studied. Calculated with a more precise but smaller survey (French GGS, INED-INSEE 2005), 80 % for men and 87 % for women of second and higher-order union are second unions. Of course, there may be more under-reporting of unions in the FHS self-administered questionnaires (Mazuy and Toulemon 2001), but it seems that people tend to "forget" more infertile unions than fertile ones.

3.2 Sample

The sample used for our analysis is composed of all women and men with at least one union dissolved by separation, divorce, or partner's death, who are in a second or higher-order union and are still of childbearing age (45 and under) at the time of second union formation. In total, 23,296 respondents (15,021 women and 8,275 men) who completed the questionnaire meet these criteria and are included in the analysis sample. Table 1 describes the sample and the covariates used in the model. In this sample, the mean age at the break-up of first partnership is around 30 years for men and 28 years for women. There were 60 % of men and 56 % of women that were married in their first union. The mean age of entry into second or subsequent union is 34 years for men and 32 years for women; 64 % of men and 62 % of women entering a second union are childless. Parity is calculated at the beginning of the second or subsequent union and includes all births at this moment: births that occur before or during the first union and between the end of the first and of the last union. The situation in which the woman is a lone parent is three times more frequent than the reverse situation in which only the man is parent. We note additionally that men in second or higher-order unions form a couple with women 4 years younger on average, whereas women find a partner only one and a half years older on average.

3.3 Taking Account of the Sterility Constraint

Age-specific fecundability is estimated using an equation stating the proportion definitely sterile by age (i.e., no more able to give a live birth). This type of

Table 1 Description of the sample used in the fertility timing models (mean (SD) for continuous covariates or frequencies (percent) for categorical covariates); women and men; France

	Women	Men
Respondent's age* (mean age)	32.4	34.2
Cohabitation versus marriage* (%)	71.8	73.2
Previous children at union formation (%)		
Both partners already have children	27.7	26.1
Only man has previous children	34.1	31.8
Only woman has previous children—*ref*	10.3	9.8
Neither has previous children (%)	27.9	32.3
Partner's age at union formation (continuous, mean age)	33.0 (8.2)	29.1 (7.1)
Partner's age at union formation (categorical, %)		
Partner under 35	61.8	78.3
Partner 36–40—*ref*	17	12.9
Partner >40	21.1	8.8
Education (%)		
No diploma	14.5	11.3
Low—*ref*	48.6	51.7
Medium	15	13.7
High	21.9	23.4
Duration between union 1 and 2 (mean no. of years)	3.4 (3.9)	3.0 (3.5)
Widowhood versus other type of separation (%)	2.2	1.2
Union cohort (%)		
Before 1970	10.3	6.9
1970–1979—*ref*	10.1	10.7
1980–1989	26.9	28.9
1990–1999	52.8	53.6
Duration between union and first child** (mean no. of years)	2.6 (2.9)	2.6 (3.0)
Event: having a first child	7,344 (49 %)	4,178 (50 %)
Event: having a second child**	2,876 (39 %)	1,828 (44 %)
Sample size	15,021	8,275

Source Family History Survey (FHS), Insee, 1999

* Time-varying covariates, calculated at union formation

** In the model for second child (7,344 women, 4,178 men). All the other distributions are given for the model for first birth in second or higher-order union

estimation is generally based on population with natural fertility (Trussell and Wilson 1985), i.e., who do not use contraception. We choose to use the equation of couples' effective sterility derived by Leridon (2002) from historical data. Leridon's method is to model the proportion sterile by age among newly wedded couples in the 17th century in France. This estimation refers to all conceptions, including those ending in a spontaneous abortion or a stillbirth. As stated before, our purpose is to take into account all the physical problems that may impede a couple for having a

live birth. Out of a set of estimations of effective sterility by several scientists, this one is the lowest after age 35 (Leridon 2008): if we can show an acceleration of childbearing in age when controlling for a low sterility scenario, by default the result will be accurate for any higher sterility scenario.

The primary sterility equation for a couple is given by the following equation (with age being the woman's age):

$$ster\,(age) = 0.370\,\exp(0.109\,age)$$

Disregarding the woman's parity, the probability for a couple of being fecund is given by $P_{fert}(age) = 1 - ster(age)/100$ where age is the woman's current age. To illustrate, we can calculate the fecund life expectancy for a couple using this equation: it amounts to 14 years at woman's age 30, 10 years at age 35, and 6 at age 40.

In the models, we estimate the risk of having children in a second or subsequent union of men and women, controlling for fecundity (which is exactly the same as controlling for sterility, since it is its reverse). The estimation of the couple's fecundity based on woman's age is used in both the female and male models. To introduce the sterility equation into the male model, partner's age was thus necessary. The date of birth was missing for around 8 % of the partners, so we imputed it using a multiple imputation procedure. Under the assumption of a monotone missing pattern for the "partner's date of birth", we use a regression method for multiple imputations, with the respondent's date of birth and age at the beginning of the last union as control covariates.

If the woman already gave birth, her risk of sterility is lower (Toulemon 2006). Therefore, we additionally estimate the probability of having a first child in a second union by using a more precise fecundity equation that depends on whether the woman in the couple already had children or not, and on last child's age.[4] From Leridon's initial curves of primary sterility, Toulemon (2006) has calculated additional curves that model the probability of being sterile by age of the last child. The older the last child, the more the sterility curve converges towards the primary sterility curve (Fig. 4).

Deduced from Toulemon's sterility equations, the equation for the probability of being fecund at a given age, depending on the age of the woman at birth of her last child, is the following:

$$P_{fert}(age,\, agebirth) = \frac{1 - ster(age)/100}{1 - ster\,(agebirth)/100}$$

where *age* is the current age and *agebirth* is the age of the mother at birth of the last child. If the woman is still childless, *ster*(*agebirth*) is set equal to zero, recouping the original equation.

This equation is introduced into our model to capture the effect of a couple's decreasing fecundity with the woman's age and with age of the last childbirth. Both variables are time-varying in the model.

[4] Whenever referring to "first birth" in a second or higher-order union, this has to be considered independently from the person's parity at the start of the union, as they can already have children from a previous union: it is a union-specific first birth.

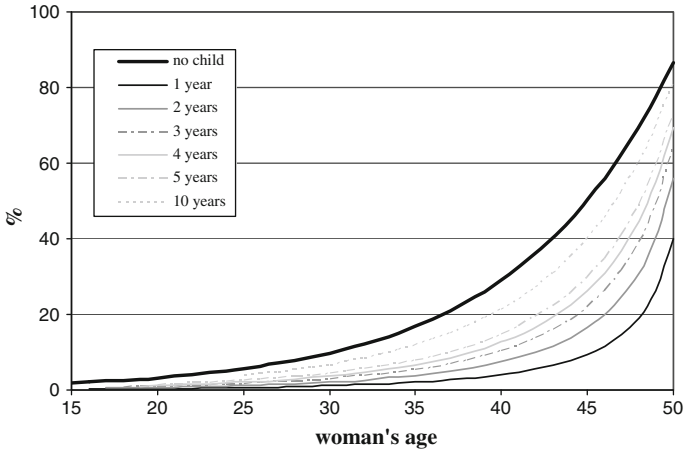

Fig. 4 Percentage of couples sterile by age of the woman and by age of her last child (if any). *Source* Toulemon's calculations (Toulemon 2006, Figs. 1 and 2) based on Leridon's primary sterility equation (Leridon 2002)

Estimations of sterility calculated on a population that did not use contraceptive methods or only ineffective natural ones, are open to criticism. One may argue that effective natural contraception may exist by reducing sexual intercourse during fecund periods. If so, our sterility control could be over-estimated. Nevertheless, as these estimations are based on recently married people, they may have less reason to delay parenthood at this time than later. Having a child was socially expected and Henry (1972), using historical data (1720–1829) from the South of France, showed that birth control remained very moderate during the 15 first years of marriage. Furthermore, Weinstein et al. (1990) showed that, after age 30 or 35, declining fecundity plays the dominant role, compared to coital frequency, in explaining live births. Over-estimation of sterility would then be very limited at later ages, and thus in second unions. An additional precaution has been taken by purposely choosing an estimation of late sterility in the lower range.

We examine the risk of childbearing at each age, relative to the preceding age, after controlling for sterility: the residual effect of age indicates the fictitious fertility we would observe if sterility did not increase with age.[5] After controlling for socio-demographic covariates and increasing sterility, a risk that increases with age implies that people tend to accelerate childbearing when approaching fecundity limits; if it is constant, that suggests that the fertility decline with age is mostly explained by the biological constraints; and if lower, we infer that people tend to slow down transition to childbearing with age. These results are of course confined to second unions in France.

[5] The simultaneous introduction of variables that depend on age does not create interactions, since it comes to the same than introducing a linear combination of functions of age.

3.4 Model

For estimating the risk and the timing of having children in a second or subsequent union, one can use a classical duration model, whether continuous (like the Cox model) or discrete time models. The main limitation of these models if that they implicitly assume that any person in a second or higher-order union is at risk of having a child. If we suppose that one part of the population is for some reason not at risk of having children in the new union, it is better to make the estimations using cure models. Cure models are a specific type of survival analysis model where it is assumed that part of the population will never experience the event. Various cure models exist (see Lambert 2007 for a detailed description). Initially used in epidemiological and biostatistical studies, cure models have been adopted recently in demographic research (Gray et al. 2009; Rosina 2006; McDonald and Rosina 2001).

We have chosen Jenkins' specification which adapts mixture cure models to discrete-time data (Jenkins 2001). Based on a discrete-time survival model, this model[6] offers the possibility to take out of the risk set the proportion of persons who will not be at risk of experiencing the event, and to examine the fertility behavior and its determinants for the others. Applying this kind of model is a way of taking into account unobserved heterogeneity by splitting the subjects in two sub-populations.[7] Here, the population remaining at risk at each age is the proportion who still has a chance of having children, that is to say the "non-cured" subjects.

To start with, we model the risk of a first conception (referred to more widely as risk of first birth) in a second or higher-order union. Women might be childless or already mothers at the start of this partnership and they are exposed to the risk from the entry into the partnership until the survey or the separation (censoring events), or until the conception. Births from women pregnant at the beginning of the new partnership are counted as events in our models. Afterwards, we model the risk of second conception in these same partnerships, but only women who have had a child in their second or subsequent partnership are concerned, and they become at risk from that time until the censoring events. In our specification, the usual likelihood of a model is decomposed using the cure probability c. Failure or events (i.e., conception which drives to a live birth) occurs within the "non-cured" population, and "cured" people plus "non-cured" people getting out of risk are censored. c being the cure probability, for an individual i at time t, the contribution to the log likelihood is given by:

$$\ln L_i = d_i \ln[(1-c)h_{it}S_{it-1}] + (1-d_i)\ln[c + (1-c)S_{it}]$$

where $S_{it} = \prod_{j=1}^{t} 1 - h_{ij}$ is the discrete-time survival function and d_i is a censoring indicator (1 in case of failure, 0 otherwise). The discrete-time hazard is assumed to take the form of a complementary loglog function:

[6] The model is specified under the command spcurv in Stata software.

[7] In economics, cure models might be called "split population" models.

$$h_{it} = 1 - \exp[-\exp(I_{it})]$$

where $I_{it} = f(t) + b'X_{it} \cdot X_{it}$ are the covariates (time-varying or not) and $f(t) = \log(t)$is the specification of the duration. b' can be considered as a "hazard ratio".

This model supposes that people taken out of the risk set are not a selective group. We adopt this assumption since the hypothesis that any person—at a given age and parity—is at risk of being infecund whatever their other demographical characteristics appears realistic. With this specification, the parameter calculated is one of the covariates that concern people remaining at risk, i.e., supposedly still fecund ("uncured group"). By introducing an additional control for sterility risk, we reinforce the accuracy of the control by age, so the interpretation of the other variables should be more precise.

To make sure that the child was conceived within the second or higher-order union, we model the risk of conception ending in a live-birth, but we will often refer broadly to "having a child". The model contains three time-varying covariates: our variable of interest that is the age, as a succession of categorical variables, the fecundity probability (that depends on the age of the woman), and a control variable for the marital status of the union (cohabitation or marriage). While the respondent's age is time-varying, the partner's age at the beginning of the new union is fixed. The following variables are also introduced: type of first union termination (separation or widowhood), educational level, union cohort, interval (in years) between the end of the first union and the new partnership, and a variable combining children from the individual and from the partner.

4 Results

4.1 First Child Timing

We draw two distinct models for men and women on the timing of a first birth in a second or subsequent union from the time of entry into union, and introduce in each regression some partner characteristics and other covariates as described previously. Table 2 details the results for women and men before and after control for fecundity (the complementary variable of sterility probability due to aging). Age-specific log-hazard ratios are depicted in separate graphs (Figs. 5, 6, 7) for a better visualization. In our models, the proportion of the "cured" population (couples not at risk of having any more children in second union) is around 14 %, i.e., exp(−1.91) for women. The probability is stable whether fecundity control is introduced or not. For men, this population equals 13 % but decreases to 9 % when we take into account couple's fecundity, i.e., one part of the inability to have children was captured by biological constraints.[8]

[8] Overall, our estimation by split population models does not differ much from the estimation by a complementary loglog discrete time model.

Table 2 Estimates of the cure model, risk of *first birth* during a second or subsequent union, since union formation; before and after control for sterility; women and men of any parity at union formation; France

Variable	Women				Men			
	Before control		After control		Before control		After control	
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Duration (log)	−0.49***	0.024	−0.48***	0.024	−0.44***	0.030	−0.34***	0.031
Age (ref = 32–33)								
Age ≤ 23	−0.04	0.063	−0.66***	0.152	−0.58***	0.126	−0.67***	0.126
Age = 24–25	0.12*	0.055	−0.41**	0.131	−0.33***	0.088	−0.41***	0.088
Age = 26–27	0.12*	0.051	−0.32**	0.110	−0.18*	0.070	−0.23**	0.070
Age = 28–29	0.19***	0.047	−0.13	0.086	−0.16*	0.063	−0.2**	0.063
Age = 30–31	0.2***	0.046	0.02	0.061	−0.08	0.059	−0.1†	0.059
Age = 34–35	−0.21***	0.051	0.02	0.071	−0.11†	0.061	−0.09	0.061
Age = 36–37	−0.54***	0.057	−0.03	0.126	−0.19**	0.065	−0.14*	0.065
Age = 38–39	−0.97***	0.068	−0.12	0.201	−0.34***	0.072	−0.25***	0.072
Age = 40–41	−1.56***	0.085	−0.27	0.298	−0.51***	0.079	−0.36***	0.079
Age = 42–43	−2.59***	0.132	−0.76†	0.426	−0.76***	0.089	−0.54***	0.089
Age ≥ 44	−3.82***	0.337	−1.46*	0.624	−1.38***	0.151	−1.14***	0.151
Fecundity (probability not to be sterile)			0.07***	0.016			0.05***	0.004
Partner's age (ref = 36–40)								
Partner under 35	0.04	0.043	0.04	0.043	0.75***	0.074	−0.05	0.090
Partner >40	−0.34***	0.057	−0.34***	0.057	−1.26***	0.160	−0.16	0.171
Cohabitation (vs. marriage)	−0.81***	0.031	−0.81***	0.031	−0.88***	0.038	−0.86***	0.037
Previous children (ref = only woman)								
Both partners already have children	−0.58***	0.042	−0.58***	0.042	−0.59***	0.077	−0.57***	0.074
Only man has previous children	−0.17**	0.050	−0.18**	0.050	−0.05	0.069	−0.2**	0.067
None has previous children	−0.17***	0.035	−0.17***	0.035	−0.11	0.068	−0.23**	0.066
Education (ref = low)								
No diploma	0.25***	0.042	0.24***	0.042	0.21***	0.057	0.18**	0.056
Medium	−0.1*	0.040	−0.1*	0.040	−0.05	0.054	−0.04	0.052
High	−0.11**	0.036	−0.11**	0.036	−0.08†	0.044	−0.05	0.043
Duration between union 1 and 2	−0.005	0.005	−0.003	0.005	0.02*	0.006	0.01*	0.006
Widowhood (first union ended by death)	0.2*	0.101	0.2*	0.101	0.06	0.179	−0.001	0.171

Table 2 continued

Variable	Women				Men			
	Before control		After control		Before control		After control	
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Union cohort (ref = 1970–1979)								
1990–1999	0.17***	0.048	0.17***	0.048	−0.04	0.058	−0.02	0.056
1980–1989	0.25***	0.048	0.25***	0.048	0.06	0.058	0.06	0.056
Before 1970	0.1†	0.060	0.1†	0.060	0.04	0.084	0.02	0.083
Constant	−0.36***	0.075	−6.72***	1.418	−0.88***	0.114	−5.12***	0.346
Cure	−1.91***	0.075	−1.91***	0.075	−2.06***	0.110	−2.41***	0.137
N (event)	15,021 (7,344)		15,021 (7,344)		8,275 (4,178)		8,275 (4,178)	

In the models, we control for fecundity, which is the exact inverse of sterility (see "Method" section). The coefficients of the other variables are unaffected by this choice

The coefficient "cure" allows to calculate the proportion c = exp(cure coeff) considered as not at risk by the model (either sterile or that will not have children)

Source Family History Survey (FHS), Insee, 1999

† $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Figure 5 focuses on the coefficients of the age parameter introduced together with other covariates in the sub-models—women and men, with and without control for sterility risk. Age, which is a time-varying covariate, is depicted in a very flexible non-parametric form with dummies covering 2 years each from 24, and additional age classes for the tails: before 24 and after 44. The age chosen for the baseline hazard of one is 32–33.[9] Controlling for all covariates except sterility, the age effect takes the form of an upturned U-curve for men and women. The likelihood of having a first child in a second or subsequent union increases with age to a maximum reached around 30–31 for women and 32–33 for men. The decrease is larger and takes place at earlier ages for women than for men. To what extent might this decreasing trend be due to a natural increase in infecundity with age and/or to a decreasing desire for children? For women, a new shape of the age effect actually appears at later ages when fecundity is controlled for, very similar to men's crude curve. The likelihood of having a child in a second or subsequent union decreases only slightly with age over the fertile period up to age 40. In other words, if the fecundity remained stable at each age, older women would continue to have almost as many children as younger women. One could have expected that social determinants such as social norms about parenthood at older ages would also explain the decrease. However, it seems that these social and normative determinants do not discourage women, and that increasing sterility mainly drives the observed decrease in the risk of childbearing with age.

Without controlling for fecundity decline, men's childbearing risk decreases slower with age than women's. Contrary to women, for men, the introduction of the fecundability variable of the couple does not change the likelihood of having a child

[9] The shape of the curve does not depend on the age of reference chosen.

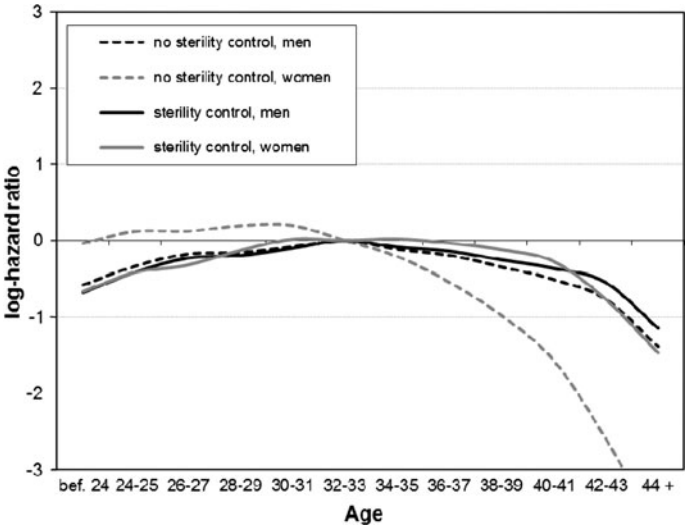

Fig. 5 Age effect on timing of *first birth* during the second or subsequent union, before and after controlling for sterility, women and men of any parity at union formation; estimates from the cure model; France. *Source* Author's estimation based on FHS data, Insee, 1999

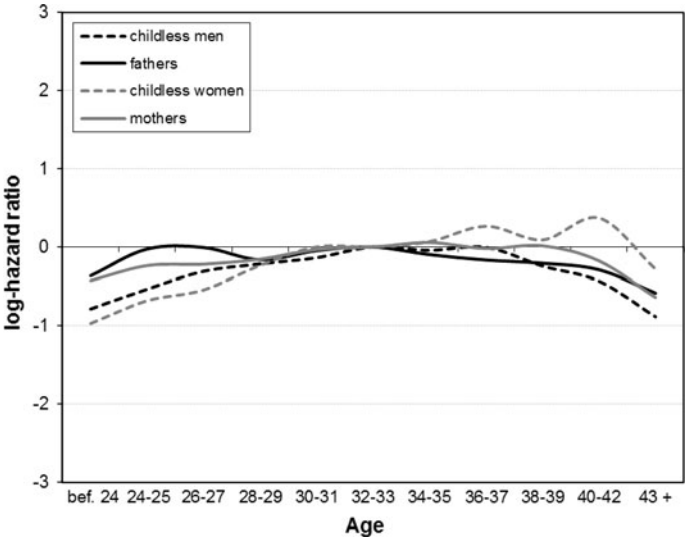

Fig. 6 Age effect on timing of *first birth* during the second or subsequent union *when sterility is controlled for*, depending on the parental status at the start of the partnership, women and men of any parity at union formation; estimates from the cure model; France. *Source* Author's estimation based on FHS data, Insee, 1999

at older ages. The curves by age are very similar for men with and without this control (Fig. 5). It is noticeable that, once sterility is controlled for, women's first birth curves are very similar to men's. This suggests that, without sterility

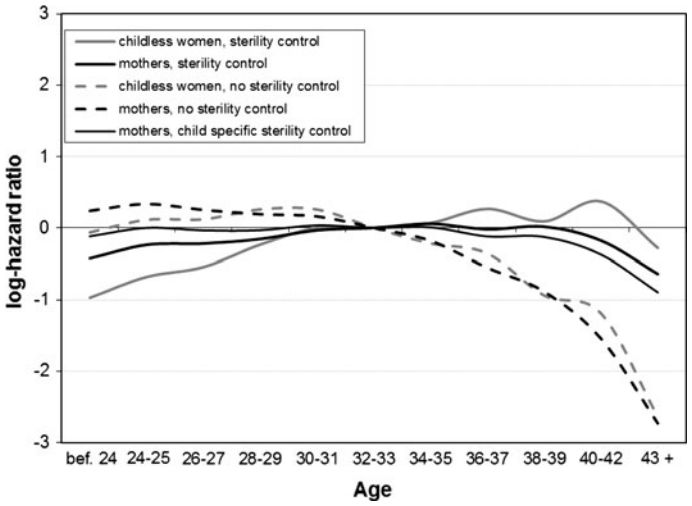

Fig. 7 Age effect on timing of *women's first birth* during the second or subsequent union, according to the parental status at the start of the partnership, with and without control for sterility; additional control for fecundity according to the age of the last child; women of any parity at union formation; estimates from the cure model; France. *Source* Author's estimation based on FHS data, Insee, 1999

constraints, women's fertility behavior would be quite similar to men's. Also, the parameter of the fecundity variable introduced as a function of woman's age in the split model is lower in the male than in the female model (Table 2), and so the fecundity decline with age appears less limiting for men. One reason is that their biological constraints are less strong: men who re-partner are able to have children during a much longer period, notably because their female partner is likely to be younger than they are (Beaujouan 2011). As shown in Table 1, while their own mean age at second union's formation is 34 years (over all observations used in the model), their partner's average age at that time is 29. As a consequence, men's unions are less likely to have sterility constraints than women's.

Using the Family and Fertility Survey, Thomson et al. (2002) have shown that the partner's age at the beginning of the union had a significant impact on childbearing in stepfamilies in France. We control for the age of the partner at the beginning of the respondent's second or subsequent union (Table 2), choosing a specification in three bracket classes to minimize multicollinearity problems since ages of the partners are strongly correlated. This time-constant variable is a tool to capture the age-matching process but also helps to handle the possible problem of considering only the woman's age and not the man's age when estimating the couple's fecundity. Before fecundity control, the older the new spouse, the lower the chances of having a child in the new union for both sexes, but with a larger magnitude in the male model. After controlling for the fecundity of the couple, the results become gender-sensitive. In the regression for women, having an older male partner still decreases the probability of motherhood in a second or subsequent union, whereas

in the male regression, the coefficient of the female age at the beginning of the union is no longer significant. Fecundity limitations might thus explain most of the effects linked to women's age. This last result corroborates the previous result from the women's model, of an absence of age effect when approaching the biological time limit once the decline in age-related fecundity has been neutralized.

Here, we discuss further the possible consequences of considering only couple's sterility curves by woman's age in the male model, due to the non-availability of sterility equations with man's age. The very similar results regarding male age at union formation in the female regression and the direct net effect of male age in the male regression signals that the drawbacks of such asymmetry in the models are limited: in both cases, introducing the fecundity variable has little impact on the male age effect. If we observe now the effect of the women's age both in the female regression and as partner's age in the male regression, the results are similar when introducing the fecundity covariate: the parameters show a declining risk by age of the woman before, and a lessened effect after. This suggests that using couple's fecundity estimates that depend on woman's age only controls for most of the couple's infecundity in both male and female model.

Despite the differences in the structure of second unions for men and women, some individual characteristics have very similar effects for both genders. The coefficients estimated in the models for all the covariates (Table 2) show that marital status of the new union—time-varying since it could change during the partnership—changes the risk of first birth. Being cohabiting instead of being married substantially decreases the likelihood of having children for both men and women.[10] This result is in line with the European results for first unions (Pinnelli et al. 2002) as well as for second unions (Buber and Fürnkranz-Prskawetz 2000).

In previous studies, the impact of the number of children from previous unions is usually negative although it depends on whether the children are co-resident or not. The literature also shows that there are interaction effects between own children and the partner's children (Thomson et al. 2002; Toulemon and Knudsen 2006). As we do not have symmetrical information about the number of previous children (we know the number of previous children for the respondent but only the existence for the partner), we prefer to build a variable that describes from which partner the previous children come. The reference category is couples in which only the woman already has children from a previous partnership. The results show that, if both partners already had children, it sharply slows down the arrival of another child in the new union. If none of the partners or only the man had children, the birth of the next child takes place slightly later than if the woman is already mother. Literature reports a large range of specifications for the children covariates, which makes comparisons challenging. The most comparable specifications were done by Griffith et al. (1985) on second marriage in the United-States and Vikat et al. (1999) on "higher-order" unions in Sweden, who didn't find a significant impact of the number of pre-union children on first birth risks in these contexts. In France, results of the 2005 Generation and Gender Survey show no significant difference in the risk

[10] Models have also been performed without this variable and the results are very similar.

of having a child in the second unions with one or with two childless partners (Beaujouan 2011).

To illustrate more clearly the timing effects according to the parental status of the partners, we represent the net age effect (after controlling for sterility) separately for parents and for childless women and men in Fig. 6. The results of the two regressions are available in appendix. Some age dummies have been grouped since the sample size is reduced. In line with the previous results, once fecundity is controlled for, the risk by age of having a child in a second or subsequent union differs according to whether the person had children from a previous union or not. We observe rising birth risks—i.e., an acceleration—for childless women, but a slight decrease after age 34 for mothers. From this age mothers appear less in a hurry to have a child than childless women. This result also suggests that there is a desire to become a parent among childless women who enter a second partnership at later ages, since they "accelerate" conception. This can be observed only when interacting age and past fertility and once fecundity decline has been controlled for, so could not be seen in models on stepfamilies with other specifications.[11]

To better use the information at our disposal and as a robustness check, in another specification of the female's model, we control for fecundity more precisely by using sterility equations that depend on mother's age at last childbirth. Women's risks of births by age are recapitulated in Fig. 7: with the child's age specific fecundity control, mothers' childbearing risk is transformed to a lesser extent than when controlling for the overall sterility probability, but remains much higher than without a control after age 32.[12]

For men, the differences in age effect according to fatherhood status are not significant (Fig. 6). At a same age, men do not seem to have different fertility strategies according to their parental status. They are perhaps less concerned, or may not need be concerned by a decline in fecundity, because they can choose a partner young enough to fulfill their wish to have a child.

Education level acts as expected, and the effect remains unchanged when controlling for fecundity decline. All other things being equal, having no diploma increases the risk of having other children for both men and women. Highly educated (higher than secondary) women and men have children less quickly than lower educated women and men in the second or subsequent union. Generally, in France, highly educated women are more likely to remain childless, even when having a partner (Robert-Bobée 2006). The same effect is visible for men, but woman's education is a greater explanatory factor. According to the New Household Economics, one reason may be that highly educated women bear a higher child opportunity cost.

Previous studies have shown that the older a person at first union formation, the lower their risk of separating (Castro Martin and Bumpass 1989; Villeneuve-Gokalp

[11] We also base our study on second unions rather than stepfamilies, which might make a slight difference, together with the cure specification of the model that disentangles level and speed.

[12] Another specification of fecundity that takes only risk of conception into account instead of risk of birth (called fecundability) has been tested, and the results are robust using this definition of sterility.

1994). They often interpret this as sign of a better match since the duration for finding a partner was longer. For second unions, the best indicator of partner search time would be the duration between the end of the preceding union[13] and the formation of the new one, even if, in some cases, the future partners were acquainted before the end of the previous union. People who waited a long time to enter a new couple may have formed a "better" match, and may also be more in a hurry to have children in the new couple to catch up the lost time. However, waiting longer may also indicate greater difficulties in repartnering. The constraints on the remarriage market are known to be stronger for women than for men, especially at higher ages (Ní Bhrolcháin and Sigle-Rushton 2005). Thus, longer duration between the two partnerships does not necessarily mean that the match quality would be better, or that these women would be more likely to want children. Our results show no impact for female second unions and only a weak impact for men, in the direction of a better quality match: men who wait longer to find their partner will have a child somewhat sooner.

The way in which the first union ends may have an impact. Given the size of our sample, we are able to control for the type of first union dissolution. First unions ending with the partner's death instead of separation has a positive impact on the risk of having (other) children for women, but not for men. Since women are less likely than men to repartner after the death of the partner (Cassan et al. 2001), it is possible that our result reveals a selection effect, i.e., that widows who do repartner would also be the one more likely to have children again. In the earliest period of the study separated women could also still bear the social stigma of their preceding marital dissolution. Finally, recent second union cohorts, especially since the eighties, seem to decide more quickly to have children compared with the cohorts of unions formed before 1970. This may be explained by the more widespread use of divorce, offering more freedom to form a new family and to have children in the new union, but also by the compositional change of the population experiencing separation.

4.2 Second Child Timing

In this section, we model the risk of having a second child following the birth of the first child in a second or subsequent union. Without controlling for sterility, the likelihood of having a second child diminishes dramatically with age, especially for women (Fig. 8) as observed for the first child. After controlling for sterility—either the version that depends on the age of the last child or the general one—the age effect is no longer significant for women and only from age 38 for men. As for the first child, the counterbalancing effect of the natural decrease in female fecundity with age is stronger for women than for men.

This result reinforces the findings on first births that showed that women reaching older ages seem to struggle more strongly against their biological clock than men of

[13] This duration is calculated from the end of the first union, and we assume in this interpretation that it is an acceptable proxy of duration since the last partnership, people having formed three or more unions at fertile ages being a minority.

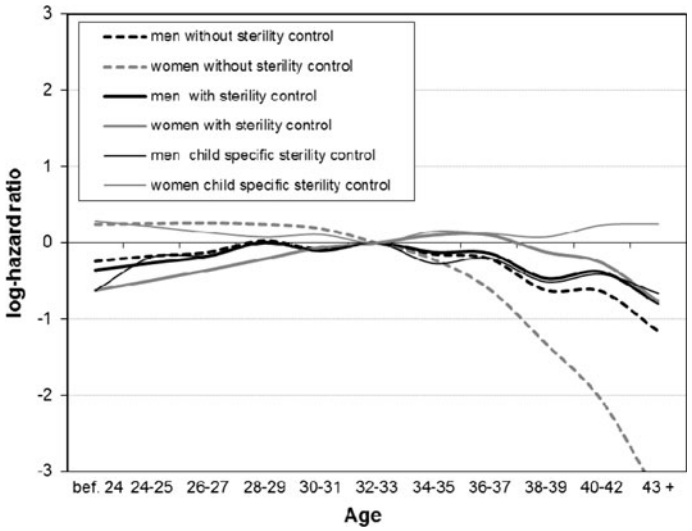

Fig. 8 Age effect on timing of *second or subsequent union's specific second birth* after the first birth that took place during this union, before or after controlling for sterility; additional control for fecundity according to the age of the last child; women and men of any parity at union formation; estimates from the cure model; France. *Source* Author's estimation based on FHS data, Insee, 1999

the same age. One reason is that women may be more conscious and worried about their last chance to have children than men.

For the second child, obviously, the proportion of the "cured" population (i.e., not at risk of having any more children in second union) is larger (44 % of women and 26 % of men) and the population at risk smaller (Table 3). Some determinants of the timing of second birth act in almost the same way as for first birth, even though the sub-population at risk differs. For instance, cohabitation tends to diminish the likelihood of having a second child, as was the case for first births. Also as for first births, people in the less educated group have the highest risk of second birth. But an interesting accelerating effect is observed for the most educated people. A catch up effect has to be considered for this population who begin their first family steps later than average (Kravdal 2001). They might also have easier access to treatment in case of fecundity problems (Jain and Hornstein 2005). There is then a strong polarization of the effect of education for women as well as for men: once the first child is born, the extreme groups, lower and higher educated, are the most fertile in second union.

Parental status interactions bring new elements. The likelihood of having a second child is higher for the couples in which both partners were childless before second union formation than in all other situations. Their wish to quickly give a brother or a sister to the first child, which can be linked in France to the strong social norm around the two-child family (Régnier-Loilier and Solaz 2010), seems to counter-balance the overall negative effect of increasing sterility with age. When

Table 3 Estimates of the cure model, risk of *second birth* during a second or subsequent union, since birth of the first child in the second union; after control for sterility; women and men of any parity at union formation; France

Variable	Women		Men	
	Estimate	SE	Estimate	SE
Duration (log)	0.18***	0.043	0.36***	0.051
Age (ref = 32–33)				
Age ≤ 23	−0.62*	0.253	−0.36	0.260
Age = 24–25	−0.49*	0.215	−0.26†	0.150
Age = 26–27	−0.36*	0.180	−0.18	0.109
Age = 28–29	−0.21	0.139	0.002	0.091
Age = 30–31	−0.06	0.095	−0.1	0.087
Age = 34–35	0.1	0.112	−0.12	0.087
Age = 36–37	0.1	0.206	−0.14	0.092
Age = 38–39	−0.12	0.334	−0.47***	0.109
Age = 40–41	−0.26	0.500	−0.38**	0.115
Age ≥ 42	−0.77	0.735	−0.79***	0.146
Fecundity (probability not to be sterile)	0.1***	0.027	0.07***	0.007
Cohabitation (vs. marriage)	−0.25***	0.047	−0.21***	0.057
Partner's age (ref = 36–40)				
Partner under 35	−0.05	0.078	−0.25	0.198
Partner >40	−0.22†	0.120	1.44**	0.416
Previous children (ref = only woman)				
Both partners already have children	−0.28**	0.085	−0.24	0.149
Only man has previous children	0.13	0.091	0.15	0.132
None has previous children	0.37***	0.060	0.54***	0.130
Education (ref = low)				
No diploma	0.26***	0.066	0.31	0.085
Medium	−0.08	0.074	0.15†	0.085
High	0.34***	0.062	0.39***	0.069
Duration between union 2 and first child	−0.1***	0.015	−0.08***	0.017
Widowhood (first union ended by death)	0.05	0.142	0.47	0.260
Union cohort (ref = 1970–1979)				
1990–1999	−0.03	0.084	0.11	0.092
1980–1989	0.08	0.082	0.26**	0.086
Before 1970	0.36***	0.096	0.26*	0.113
Constant	−10.72***	2.364	−8.62***	0.564
Cure	−0.93***	0.083	−1.46***	0.111
N (event)	7,344 (2,876)		4,178 (1,828)	

See Table 2

Source Family History Survey (FHS), Insee, 1999

† $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

both partners already had children, their risk of second birth in second union is reduced, though significantly only for women.

For the second child, we introduced another duration covariate (time between union formation and first child's birth). The longer this duration, the lower the likelihood of having a second child (Table 3). This effect is significant for both sexes. This time effect shows again that any delay after a break-up, whether in age at union formation or age at first birth, diminishes fertility, especially for women. But delaying the first birth may also be a characteristic of couples with a lower desire for parenthood, particularly within a second union, which would explain why they are slower in having another child. It may also capture individual fecundity problems for having the first child that are not linked to age.

5 Conclusion and Discussion

Completed fertility is generally slightly reduced for both sexes in the event of separation. If separation is followed by a new union, repartnered men reach a slightly higher fertility level than men who have never separated, while repartnered women catch up the fertility of women still in first union just about. Overall, men's fertility is less affected by separation than women's because they repartner more and have more often children in the new union. This evidence has suggested us to analyze the specific fertility process of second or subsequent unions in France, in an environment possibly constrained differently by biological patterns for women and men.

This paper contributes to the growing literature which takes into account the age patterns of sterility in the fertility process. The model succeeds in removing the effect of sterility, and fuels the research that tries to disentangle the biological and behavioral effect of age. The inability to have a live birth either due to women or to men can be incorporated using the prevalence of couple's sterility by woman's age. Our key-result is that birth risk does not vary any more with age between age 31 and 41 once this control is introduced. In second or subsequent partnerships, older women have the same risk of having a child as younger women from age 31, once couple's sterility risk and other characteristics are accounted for. It thus seems that they still try to have children even at later ages in a new union, even if some of them cannot proceed because of infecundity constraints. Women seem to anticipate that they have a limited amount of time for conception. Men, however, don't seem as preoccupied as women about the time they dispose of for trying to have (further) children when they enter a second partnership. This might partly be because they often enter a second partnership with a much younger woman.

However, results differ between childless women and those who were already a mother at second union formation. Once the decline in couple's fecundity is controlled for, the fertility timing of mothers still slightly slows down, whereas childless women's fertility timing tends to accelerate (or at least remains stable according to a less restrictive definition of fecundity decline) until age 42. The absence of a slowdown of the childbearing process for childless women in second or subsequent unions, net of sterility, appears as a clue of the couple's anticipation of

fecundity decline with age. It also appears as a previously unseen evidence of a parental effect—the strong desire of having at least one child for women who experienced a separation. This effect appears only when the fecundability decrease is controlled for. A higher probability of having a second child for partners without children from previous unions is observed, showing a positive sibling effect, probably supported by strong social norm around the two-child family in France.

This important process is taking place in a context of major family change. More and more people are entering a second union, and notably young people who do not (yet) have children. Despite the sterility decrease with age, recent second or higher-order unions are more likely to produce children than earlier cohorts, even when there are previous children. The spread of second unions and of step-families may be a reason for the increasing occurrence of births in that type of partnership, but it might be limited by fecundity constraints. The results were not self-evident, since the recent progress in the treatment of sterility may have led people to believe that they can have children irrespective their age, and feel too confident about the future. However, the results for childless women could appear as a sign of race against the biological clock. This does not mean that they accurately estimate the couple's infecundity risk, but that their fertility choices take account of the fact that, on average, the risk of sterility increases with age.

However, our results are based on the implicit assumption that the births observed are planned by the partners. The frequency of unplanned or poorly planned births is not insignificant and exceeds 0.2 child per man or woman in France according to Toulemon (2006). Whether these "conceptions by chance" are affected by sterility anticipation the same way as planned births is undetermined, but they might create heterogeneity regarding childbearing decisions among people in a second union. Our results might also be affected by not taking unobserved heterogeneity into account when studying interrelated events (first and second births), as in other research on fertility. They are also based on the reliability of estimations of couple's sterility by epidemiologists on historical data that, although mostly convergent, may be another source of bias. Finally, we are not able at this stage, to measure to what extend our results may be country-specific since France is a country with high family values, and in which childbearing even in step-families is well accepted and supported actively by a generous family policy. But our tool for taking into account biological constraints may help assessing the limitations due to age-related sterility in other countries.

In spite of the possible criticisms just mentioned, such evidence of the struggle against the biological clock for women in second or subsequent unions is of great importance because it contributes to the debate about the effects of late partnership on fertility levels. Social and psychological factors like norms about the ideal age of motherhood and fatherhood or the anticipation of health problems may prevent people from having children at advanced ages. Our results show that these factors might play a minor role compared to biological constraints, especially for childless women who want to catch up the time-loss due to first partnership dissolution. But childbearing decelerates with age for mothers forming a second partnership, which might show their reserve to have other children at later ages. More generally, taking into account sterility may stimulate new research on tempo and level of fertility in

low fertility countries, by being generalized to all fertility decisions at late ages regardless the union order, and is worth consideration in future research.

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Appendix

Table 4 Estimates of the cure model, risk of first birth during the second or subsequent union for childless women and men and for mothers and fathers; France

Variable	Women				Men			
	Childless		Mother		Childless		Father	
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Duration (log)	−0.41***	0.035	−0.6***	0.035	−0.38***	0.043	−0.3***	0.043
Age (ref = 32–33)								
Age ≤ 23	−0.97***	0.247	−0.43*	0.179	−0.79***	0.160	−0.36†	0.209
Age = 24–25	−0.68**	0.213	−0.24	0.153	−0.53***	0.111	−0.03	0.147
Age = 26–27	−0.54**	0.180	−0.22†	0.129	−0.31**	0.091	−0.01	0.112
Age = 28–29	−0.23†	0.141	−0.16	0.102	−0.22*	0.084	−0.16†	0.097
Age = 30–31	0.001	0.100	−0.03	0.074	−0.14†	0.082	−0.05	0.084
Age = 34–35	0.07	0.123	0.06	0.083	−0.04	0.091	−0.1	0.082
Age = 36–37	0.27	0.211	−0.02	0.142	−0.005	0.104	−0.17†	0.085
Age = 38–39	0.09	0.342	0.02	0.224	−0.24†	0.131	−0.21*	0.089
Age = 40–41	0.37	0.501	−0.18	0.333	−0.43**	0.152	−0.29**	0.095
Age ≥ 42	−0.28	0.760	−0.64	0.499	−0.89***	0.173	−0.58***	0.098
Fecundity (probability not to be sterile)	0.09**	0.027	0.08***	0.018	0.03***	0.006	0.07***	0.006
Partner's age (ref = 36–40)								
Partner under 35	0.02	0.068	0.06	0.054	0.03	0.146	−0.1	0.116
Partner >40	−0.3**	0.095	−0.36***	0.069	−0.75*	0.299	0.15	0.210
Cohabitation (vs. marriage)	−0.95***	0.045	−0.7***	0.041	−1.01***	0.055	−0.73***	0.051
Partner has previous children	−0.06	0.052	−0.52***	0.043	0.15*	0.070	−0.3***	0.056
Education (ref = low)								
No diploma	0.04	0.084	0.26***	0.048	−0.04	0.092	0.27***	0.071
Medium	−0.12*	0.056	−0.08	0.058	0.03	0.075	−0.08	0.074
High	−0.14**	0.047	−0.06	0.058	−0.06	0.061	−0.02	0.062

Table 4 continued

Variable	Women				Men			
	Childless		Mother		Childless		Father	
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Duration between union 2 and first child	−0.005	0.008	−0.005	0.007	0.01	0.009	0.02†	0.009
Widowood (first union ended by death)	−0.05	0.225	0.21†	0.112	−0.18	0.316	0.09	0.206
Union cohort (ref = 1970–1979)								
1990–1999	0.07	0.079	0.24***	0.059	−0.09	0.093	0.06	0.072
1980–1989	0.24**	0.080	0.23***	0.059	0.05	0.093	0.06	0.071
Before 1970	−0.17	0.115	0.19**	0.071	0.28*	0.133	−0.08	0.101
Constant	−8.5***	2.373	−7.24***	1.575	−3.17***	0.515	−6.99***	0.455
Cure	−2.36***	0.153	−1.86***	0.112	−2.36***	0.166	−2.49***	0.212
N (event)	5,744 (2,227)		9,277 (4,119)		3,479 (1,951)		4,796 (3,225)	

See Table 2. The cure parameters are significantly different from zero and large, which means that for a non-negligible proportion of the population, no new birth occurs

Source Family History Survey (FHS), Insee, 1999

† $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

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