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Abstract

Focusing on the issue of rational decision-making and human agency in historical contexts this paper investigates the influence of childhood mortality and the sex composition of the surviving offspring during the demographic transition in Spain. The main results show that parents adjusted their behavior in accordance with the number of surviving children and that child fatalities tended to stimulate further childbearing. Results also indicate that the importance of this pattern of active fertility adjustment increased in importance as the fertility transition progressed in the early twentieth century. When looking at the sex composition of the surviving sibset, the results indicate that families lacking surviving male offspring show a significant increase in the propensity for additional childbearing. Couples appear to have actively regulated their fertility in order to achieve a minimum number of surviving children and the desired sex composition of their family.

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Introduction

This paper addresses the issue of rational decision-making and human agency in historical contexts and aims to evaluate empirically how it worked during the demographic transition. A central part of the demographic transition and of demographic transition theory is that reproduction began to be determined more by rational decisions than by cultural constraints (Johnson-Hanks, 2008; Reher, 2011). As the story goes, before the transition reproductive decisions tended to be made at a societal or group level often by means of changes in marriage timing and intensity, but as the transition proceeded these decisions became increasingly individual and family-based, responding to concrete conditions of individual families more than to accepted societal norms. Proving the existence of rational decision-making during the demographic transition empirically, however, has proven to be difficult and until fairly recently was more a basic postulate than a proven cornerstone of transition theory.

When addressing this issue the role of mortality is difficult to avoid because of the major changes it underwent as part of the transition itself. According to Notestein's original formulation of demographic transition theory (1945) mortality change was seen as the key factor –or a key factor- triggering fertility decline in the late nineteenth century, both at a societal and a familial level (Reher, 2004). Underlying this argument is the supposition that couples generally desired a given number of surviving children. which, judging from prevailing growth rates prior to the demographic transition, tended to be small. This cornerstone of transition theory subsequently came under severe criticism, especially within the context of the Princeton European Fertility Project (Knodel, 1974, p. 185; Knodel, 1978, p. 43; Lesthaeghe, 1977, pp. 171–176; Livi Bacci, 1977, pp. 205–213; Matthiessen & McCann, 1978; Palloni & Rafalimanana, 1999; Rosero-Bixby, 1998; van de Walle, 1986, pp. 228–230). Many other scholars, however, have insisted on its validity (Bhat, 1998; Chesnais, 1986; Galloway, Lee, & Hammel, 1998; Haines, 1997; Kirk, 1996; Knodel, 1988, pp. 393–442). An important reason for this difference of opinion in the field is that the mechanisms whereby mortality change intervened in reproductive decisions are not well understood because of a lack of requisite data

Two recent publications have addressed this issue specifically by making use of longitudinal micro data (Reher & Sanz-Gimeno, 2007; Van Poppel et al., 2012). The initial article used linked reproductive histories over the period of the demographic transition for the Spanish town of Aranjuez in order to study the extent to which mortality and mortality change was a factor for fertility limitation. In response to rapidly declining childhood mortality, families made increasing use of family limitation within marriage. At the outset, this was achieved almost entirely by stopping behavior while both stopping and spacing were used at a more advanced stage of transition. Throughout the period studied, families appeared to have been increasingly aware of the implications of the number of surviving children though they may not always have been successful in meeting their goal. The second paper was based on similar data from the Netherlands during the same period of the demographic transition. Adopting a analytical strategy like the one used in the 2007 publication, the authors found that mortality exercised important constraints on fertility by means of the way the likelihood of having an additional child was contingent on the number of surviving offspring at the time when reproductive decisions were made. In both papers the authors found that at any given parity the likelihood of having another child was closely linked to the number of surviving children present in the family. Thanks to the quality of the Dutch data, the authors were able to address certain issues beyond the scope of the original paper, exploring differences by urban/rural status, religion and specifying changes over time more precisely. In both papers, the authors made use of detailed descriptive data in order to make their cases.

The goal of this paper is to push this approach further, both by widening the analysis and by deepening it. This is done in two different ways:

(1) Since this paper is about rational decision-making by couples, the number of surviving siblings at the time individual reproductive decisions were made will continue to occupy a central part of the paper. Our analysis will also include the sex composition of the surviving sibs at the time of different reproductive decisions. While this subject has seldom been addressed within the context of the demographic transition, its relevance as an example of decision-making is evident since boys and girls fulfilled very different economic, social and cultural roles within the household. Parents were well aware of the implications of not having one of them. Some recent studies have found evidence that a lack of male offspring leads to an increased propensity for additional childbearing as compared to couples with a mixed or only girls sibset in both Germany (Sandström & Vikström, 2013) and in the US (Bohnert et al., 2012) during the fertility transition. For a discussion of the role of sex-preferences for fertility dictions in past and contemporary societies see Sandström and Vikström (2013). In this paper, these results will be put to the test using the Aranjuez data set.

(2) Unlike in the original papers, here behavior is modeled formally using multivariable event history analysis that takes into account both the incidence and timing of the event of interest.

Methodological considerations

The paper takes advantage of data collected from civil registration records for the Spanish town Aranjuez located some 50km outside Madrid that allow us to follow approximately 900 couples married 1870-1939 over their entire fertile period. The quality of the data has been determined to be high and the particulars of the context of Aranjuez have been extensively discussed in other publications (Reher & González-Quiñones, 2003; Reher, Ortega, & Sanz-Gimeno, 2008; Reher & Sanz-Gimeno, 2007) and will therefore not be further addressed here.

Both Reher & Sanz-Gimeno (2007) and Van Poppel et al. (2012) find substantive evidence that child survival influenced choice regarding additional children during the fertility transition in Spain and the Netherlands. Here we deepen the descriptive findings of the original paper by applying event history analysis to the Aranjuez dataset. Data analysis is based on non-parametric survival estimates and on Cox proportional hazards regressions to formally test the statistical significance and estimate the size of the effect of child fatalities in both a univariate and multivariable settings.

The main advantage of applying event history methods is that it allows us to account simultaneously for differences in both the pace and the propensity of having an additional child, given the survivorship and sex composition of the children at lower parities.

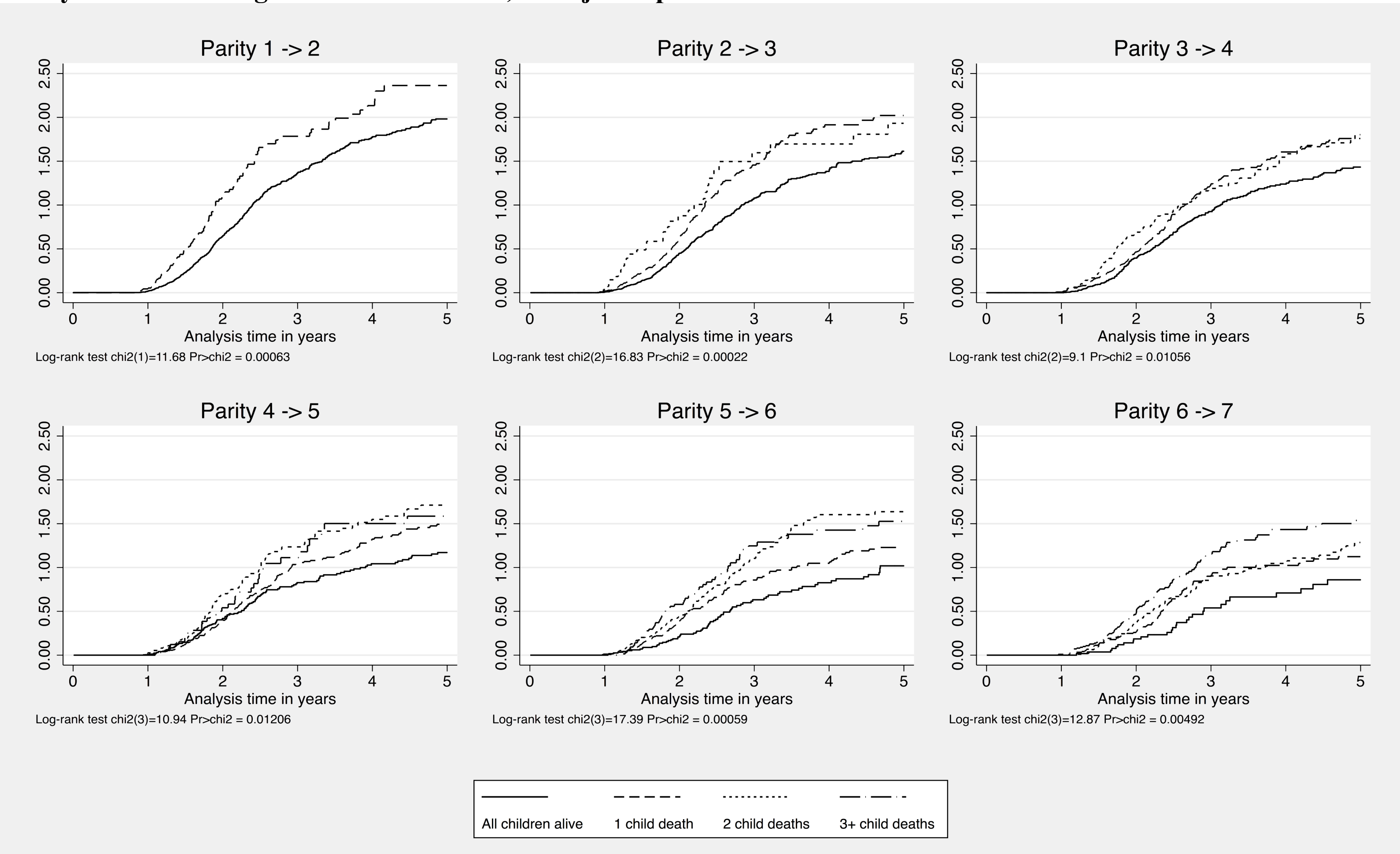
To test the statistical significance of child fatalities in a univariate setting we use Nelson-Aalen estimates of the cumulative hazard and log rank tests of the equality of the survivor function for parity 2-7. In the multivariable analysis we model the effect of child survival and the sex composition of the surviving children by using multiple failure Cox proportional hazards regression. The propensity to have additional children is modelled dependent on the number of surviving children and the sex composition of the children in the household at time *t* when the couple becomes at risk of confinement of the second child. The model includes controls for the marriage cohort, the socio-economic position of the father and the age of the mother when entering the risk set for parity 2, 3, …11.

The main reason for pooling the parities is to achieve high statistical power and to be able to estimate additional variables in a joint model that describes the effect of child survival and sex composition during the full reproductive history. As we have only included couples that are under observation for their entire fertile period, observation only stops when the mother reaches 50 years of age or if she has her 12th child. We treat the number of surviving children and the sex composition of the sibset as time-varying covariates that are recalculated if the death of a sister or brother occurs during the time at risk. The specification of the multiple failure process is done according to the conditional counting process approach suggested by Prentice, Williamson and Peterson (1981). The model is conditional as subjects are treated as not being at risk for event *n* prior to experiencing event *n-1*. The model is stratified on the number of events so that each parity has a separate baseline hazard that can vary freely in relation to the other parities and standard errors are adjusted for intra subject clustering. Time is treated on a continuous scale and time 0 occurs as subjects enter the first risk set after giving birth to their first child. The reason for starting the analysis only after the first birth is that the variables for child fatalities and gender composition—of central analytical interest here— require that at least one child has already been born. The clock is not reset after each event and subjects enter subsequent risk sets through late entry in order to achieve a model of the hazard of additional births over the full course of the recurrent event process (Hosmer & Lemeshow, 2008, p. 294-296). For a discussion of other approaches to recurrent event models see, for example, Hosmer & Lemeshow (2008, pp. 287-296), Kalbfleisch & Prentice (2002, pp. 279–299) and Prentice et al. (1981).

Results

Figure 1 shows the cumulative hazards of having an additional child at parities 2-7 for couples having different number of surviving children at time *t* and Log-rank tests of difference in survival between groups. The results show that there is a clear univariate association between the hazard of having an additional child and the number of surviving children. Couples that experience child fatalities have substantially higher risks of progressing to the next parity for all the parities up until child 7. The differences in the survival are clearly significant at either the 5 or 1 percent level depending on the parity in question. Estimates for higher parities over 7 (not shown) followed the same trend although effects were no longer significant due to diminishing sample size as most couples stopped childbearing at parities below 8. The univariate analysis thus clearly indicates that parents tended to adjust their behavior in accordance with the number of surviving children and that child fatalities tended to stimulate further childbearing. In this way, parents appear to have actively regulated their fertility in order to achieve a minimum number of surviving children that would reach adulthood.

Figure 1: Nelson-Aalen cumulative hazards of birth by cumulative number of child fatalities and Log-rank tests. Parity 2-7 for marriage cohorts 1870-1939, Aranjuez Spain



Source: Civil registers, Aranjuez, Spain

We now switch to a multivariable setting to see how the influence of child survival played out over the entire reproductive history when we control for other influences on fertility. We will also see if there are indications of changes in the effect of child fatalities over the course of the fertility transition in terms of a greater importance of child fatalities as the demographic transition progressed as suggested by both Reher & Sanz-Gimeno (2007) and Van Poppel et. al. (2012). Further, we will test if there are indications of different fertility behavior among couples that lacked one of the sexes in the surviving sibset indicating another aspect of rational decision making.

Table 1: Cox proportional hazard regressions parities 2-12 (multiple failure per subject model) for marriage cohorts 1870-1939, Aranjuez Spain (Aggregated child fatalities at time _t) (Std. Err. adjusted for clusters in id)

Variable	Value	(1) Model 1870-1939	(2) Model 1870-1909	(3) Model 1910-1939
Mothers age at birth of child	25 and younger	1	1	1
	26-30	0.79***	0.77***	0.84
	31-35	0.48***	0.49***	0.42***
	36 and older	0.21***	0.24***	0.15***
Marriage cohort	1870-1879	1	1	---
	1880-1889	1.09	1.03	---
	1890-1899	1.18**	1.05	---
	1900-1909	1.14	0.96	---
	1910-1919	1.11	---	1
	1920-1929	0.91	---	0.79***
	1930-1939	0.67***	---	0.55***
SES	Day laborers	1	1	1
	Urban workers	0.848**	0.919	0.761***
	White-collar low	0.897**	0.978	0.736***
	White-collar high	1.012	1.065	0.917
	Others/no data	0.915	0.977	0.773**
Gender composition of living children	Mixed	1.04	1.07	1.01
	Only boys	1	1	1
	Only girls	1.13**	1.14**	1.13
Total number of child deaths at time _t	No child death	1 (@12 years)	1 (@12 years)	1 (@12 years)
	1.sibdeaths	1.47*** (1.05)	1.33*** (1.04)	1.20*** (1,06)
	2.sibdeaths	2.14*** (1.54)	1.90*** (1.48)	3.61*** (1,92)
	3.sibdeaths	3.40*** (2.45)	2.77*** (2,17)	6.49*** (3,46)
time-interactions				
Mothers age		1.07***	1.05***	1.09***
Marriage cohort		0.99***	---	---
Child deaths		0.97***	0.98***	0.95***

(Exponentiated coefficients.)
** $p < 0.05$, *** $p < 0.01$
Source: Civil registers, Aranjuez, Spain

Table 1 shows the results of the multiple failure Cox regression. As seen by the estimates of Model 1 that includes all marriages formed between 1870 until 1939 child fatalities have a substantial positive effect on the propensity for having additional children. The effect is significant below the 1 percent level for one child death and these couples have a 47 percent increase in the relative hazard of having another child as opposed to couples having no child deaths. To adjust for non-proportionality in the effect of child deaths we include an interaction effect with analysis time to relax the constraint of proportionality. The estimate (0.97) shows that the effect decreases as a function of time at risk and to facilitate the interpretation we include the interacted parameter in parenthesis at 12 years of exposure corresponding to approximately half of the mean time at risk (23.3 years). In a context of repeated failures this indicates that the effect of child fatalities decreases for higher parities that occur successively later during the reproductive history. This could equally well have been modeled with an interaction between the parity/risk set and the variable of interest to get the event specific estimates. However, we choose to model the time dependence of the association with a time-interaction rather than an event specific estimate. The time-interaction approach only requires the estimation of 1 additional parameter, rather than 33 and was chosen for reasons of parsimony as the two approaches yielded the same results regarding hypothesis tests. The more parsimonious parameterization was also favored based on difference in information criteria (AIC). No other significant interactions appeared and the diagnostics of the final models indicate that all estimates are robust. As seen by the estimates for 2 and 3+ child deaths the effect of additional child fatalities increase in a linear fashion. Although the effect of 1 child death has been reduced to just a 5 percent increase after 12 years of exposure, 2 and 3+ child deaths has a substantial impact resulting in 1.5 and 2.45 times higher hazard of having additional children after 12 years of exposure.

Models 2 and 3 show differences over time between couples married before 1910 and after. The results support the finding that the effect of child fatalities tended to increase as the fertility transition progressed. Comparing the effect for marriages formed before 1910 and after the effect is almost doubled in size for the couples married after 1910 as opposed to those that married in the earlier period.

Looking at the sex composition variable, we find that couples having only girls were more prone to have an additional child than those having children of both sexes or only boys. It appears that the desire to have surviving boys was more important in Aranjuez than having girls and so couples actively regulated their fertility to achieve this goal. Regarding the control variables included in the models the associations do not offer any surprises. Clearly the fertility transition is quite late in this setting and substantial drops in fertility start occurring only well into the twentieth century for marriages that are contracted after 1920. Regarding the socio-economic differentials it is interesting to note that SES differentials in fertility were very weak before the onset of the fertility decline but become much more accentuated later in the period when fertility control started to become widespread. In this setting, urban workers and the middle class were the pioneers of family limitation, while participation in the transition process was more delayed among agricultural workers as well as among the upper strata of the population.

Concluding remarks

In this paper we set out to investigate the impact of child survival and sex-composition as an expression of rational decision-making in fertility decisions during the course of the demographic transition in Aranjuez Spain. The evidence shows that couples responded to both the number and the sex of surviving children in terms of being more prone to go on to additional births if one or more previous children had died, or if they lacked at least one surviving male offspring. Further, the results show that this tendency to regulate fertility based on child survival and sex-composition increased in strength as fertility control became more widespread during the late stage of the fertility transition. Consequently, the findings support the notion that rational decision-making and agency became more important for individual level fertility outcomes as the fertility transition progressed in this region of Spain. The importance of childhood survival for fertility outcomes during the demographic transition receives strong validation in this study. The paper also illustrates the usefulness of a multivariable modeling technique that accounts for the influence of independent variables over the full reproductive history. We argue that event history methods of this sort can and should be used to look at similar issues in other data sets.

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