Cohort Trends in Child Loss: Evidence from Sweden*

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Abstract

We investigate historical, current, and projected trends in child loss in Sweden with an aim of understanding how the risk of losing a child changes over the course of the demographic transition. We use a long series of historical and projected age-specific fertility and mortality rates along with demographic formulas and microsimulation to quantify the expected number of children lost and surviving by mother's age, the average number of children lost by mother's birth cohort, and the proportion of the cohort of mothers that can expect to experience a child loss. We find considerable variation in expected child loss and in the expected number of surviving children by mother's age across birth cohorts of mothers. While it has become increasingly rare that a mother will experience child loss, mothers in more recent cohorts who do lose children experience these losses when they themselves are elderly.

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Improvements in mortality conditions over roughly the past two centuries have fundamentally altered how and when humans die (Omran, 1971). Individuals in low mortality settings today enjoy much greater survival prospects in comparison to their ancestors. Beyond survival of the self, however, these individuals also benefit from the improved survival prospects of their kin. As death becomes increasingly concentrated at the oldest ages, individuals may take comfort in knowing that deaths in their family are likely to occur in the "proper" order, with the deaths of members of older generations preceding the deaths of members of younger generations.

This type of security in familial temporal ordering of death is a relatively recent phenomenon, as for most of human history, high infant and child mortality rates coupled with high fertility rates meant that many individuals who survived to adulthood experienced the death of younger family members. Indeed, one theory of demographic transition suggests that declines in infant and child mortality led directly to declines in fertility as parents were able achieve their desired (surviving) family size with fewer children (Davis, 1963).

While child loss is surely a more rare event in low mortality societies, where period mortality schedules indicate that 99.7% of babies born in Sweden at the beginning of the 21st century (2000-2004) survived their first year of life in comparison to around 80% at the beginning of the 19th century (1800-1804), child loss still occurs (HMD, 2010). Even as death in infancy, childhood, and young adulthood becomes more rare, improvements in mortality at the oldest ages potentially lead to increasing child loss at older ages as elderly parents lose children to diseases that affect middle and old age adults. A period life table for Sweden around the turn of the 20th century (2000-2004) suggests that around 7.4% of individuals in the synthetic cohort would die before age 60 (HMD, 2010).

In this paper, we investigate historical trends in child loss across birth cohorts in Sweden with an aim of quantifying directly the trajectory of the risk of child loss over the course of the demographic transition.

1 Data, methods, and measures

1.1 Data

To document historical trends in child loss across the demographic transition in Sweden, we take advantage of the long series of historical data on vital rates available in the Human Fertility Database (HFD) and Human Mortality Database (HMD) along with period vital rates projected through 2110 available from Statistics Sweden (HFD, 2010; HMD, 2010; Statistics Sweden, 2010). Sweden is the country for which the longest series of data is available in the HFD and HMD. The Swedish cohort mortality data in the HMD extend back to the birth cohort of 1751. Complete cohort fertility histories are available in the HFD beginning with the cohort born in 1878. Partial information is available for cohorts extending back to 1836.

Unfortunately, the cohort fertility series available in the Human Fertility Database

for Sweden does not fully encompass the fertility change observed over the course of the demographic transition. Figure 1 shows trends in the Swedish total fertility rate (TFR) by birth cohort. The earliest cohort for which full information is available, the cohort of 1879, exhibits a TFR around 3.3. Information on trends in period fertility included in the classic demographic text *The Decline of Fertility in Europe* suggests that prior to the demographic transition the TFR was closer to 4.5 in Sweden (Coale, 1986, Figure 1.4). Partial data on cohort fertility histories and the strong linear trend in decline in TFR across the earliest cohorts for which full information is available suggest that perhaps some type of modeling can be used to generate full fertility schedules from partial schedules. We are currently pursuing different methods for doing this so that we can extend our analysis to earlier cohorts in order to capture the full demographic transition.

1.2 Methods

We pursue two strategies for quantifying changes in child loss across birth cohorts of potential mothers. First, we rely upon aggregate level demographic analysis using methods for calculating the probability of living kin presented in earlier work (Goodman et al., 1974). Secondly, we employ SOCSIM, a computer-based population microsimulation program. We can use this program to both verify the results obtained from the aggregate demographic analysis as well as to extend our analysis to examine the likelihood of extreme events like losing multiple children. Our work builds on that of our predecessors in that we use similar methods but with a data set that allows us to examine real change in the experience of child loss across birth cohorts of potential mothers. Prior studies often relied on period rates and made inferences about stable populations corresponding to those rates (Watkins et al., 1987, for example).

1.3 Measures of expected child loss

Using aggregate demographic rates, we calculate the expected number of children a woman born in cohort c will lose conditional on surviving to age a, $ECLC_{(a,c)}$, using the following formula:

$$\underbrace{ECLC_{(a,c)}}_{\text{children lost}} = \underbrace{\sum_{x=15}^{x=a} {}_1F_{(x,c)}}_{\text{children born}} - \underbrace{\sum_{x=15}^{x=a} {}_1F_{(x,c)} l_{(a-x,c+x)}}_{\text{children surviving}} \tag{1}$$

(2)

- ${}_1F_{x,c}$ represents age-specific fertility rates for cohort c
- $l_{(a-x,c+x)}$ represents age-specific survival probabilities for cohort $c+x$.

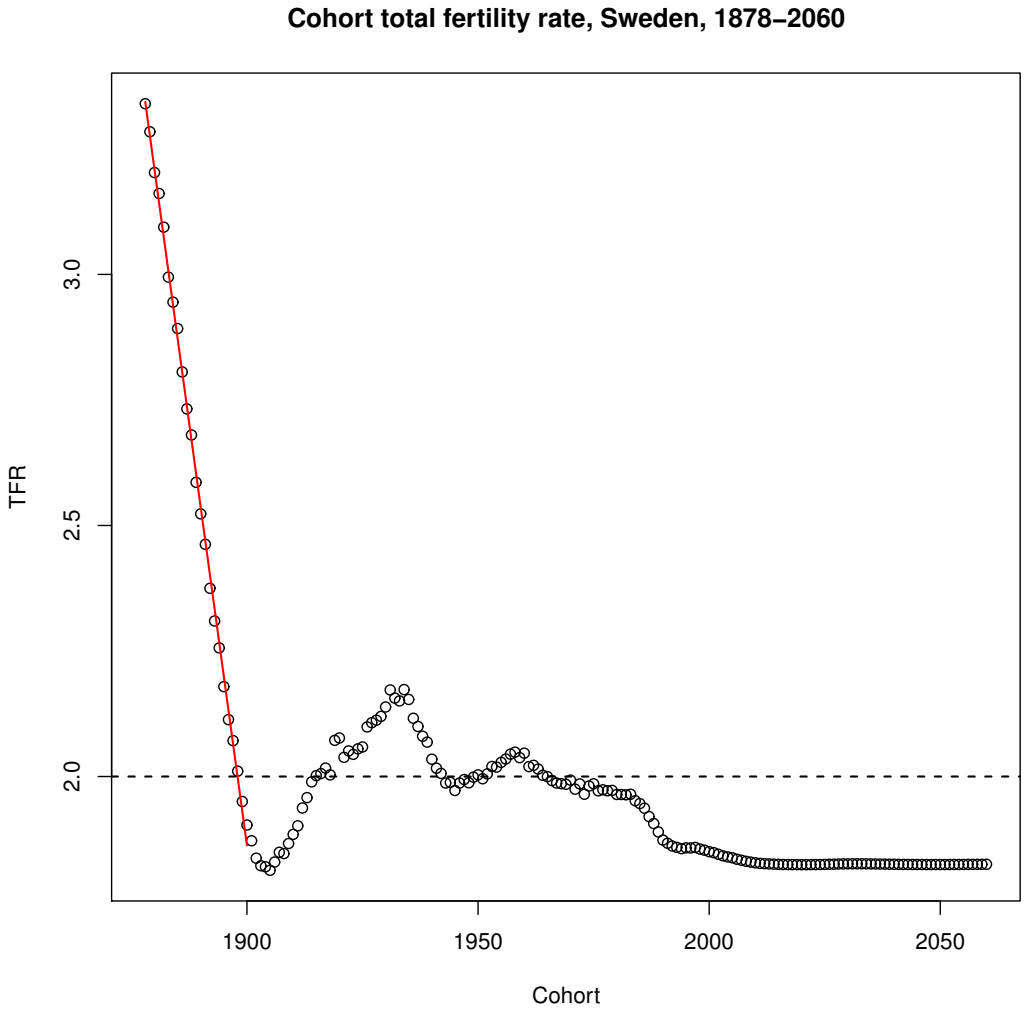

Figure 1: Cohort total fertility rate, Sweden, 1878-2060

$ECLC$ is a function of mother's fertility and child survival but not mother's survival because we assume that she lives to age a.

We use information on expected child loss by age to estimate for a particular cohort of mothers how many children they can expect to lose during their lifetime, $E[ECLC_{(a,c)}]$, by weighting $ECLC_{(a,c)}$ by the cohort life table death distribution, $d_{(a,c)}$, of potential mothers.

$$E[ECLC_{(a,c)}] = \frac{\sum_{a=0}^{120} d_{(a,c)} ECLC_{(a,c)}}{\sum_{a=0}^{120} d_{(a,c)}} \tag{3}$$

2 Results

2.1 Expected child loss

Cohort trends in $ECLC_{(a,c)}$ are depicted in Figure 2. As expected, later birth cohorts of mothers experience less child loss at all ages. For the birth cohort of 1880, the trend in $ECLC$ across age indicates that mothers were losing children during their reproductive ages. Thus, the children were likely dying in infancy and childhood. For the most recent birth cohorts, for instance the birth cohort of 2000, the projected vital rates indicate that mothers are not likely to lose children before their 80th birthday; however, mothers who are long lived accumulate child loss at a steadily increasing rate above age 80.

Figure 3 depicts similar results to Figure 2 but focuses on the number of children a birth cohort of mothers can expect to have surviving at a particular age rather than the number of children lost. Looking at the question of child loss from this perspective, we are interested in knowing if the number of surviving children at any age is similar across birth cohorts of mothers despite differences in child loss. The two earliest cohorts observed here, the birth cohort of 1880 and 1900, clearly demonstrate the differences in surviving children across birth cohorts of mothers. Those potential mothers born in 1880 could expect to have over 2.5 surviving children at the end of their childbearing years if they themselves survived. In contrast, potential mothers born in 1900 surviving through to the end of their childbearing years could be expected to have only slightly over 1.5 surviving children. If replacement level fertility is considered the goal, the cohort of 1900 undershot the target (as Figure 1 demonstrates, fertility for this cohort was not even above replacement level without even considering the likelihood of child survival).

In addition to thinking about the number of children a woman can expect to lose if she survives to a particular age, it is useful to try to summarize the experience of a particular cohort by calculating the average number of children a woman born into a particular cohort loses during her lifetime. There are three factors which influence this average: (1) a potential mother's survival (i.e. women dying before they even reach child bearing age can expect to lose zero children), (2) mother's fertility (a greater number of children increases the risk of child loss), (3) child survival (declines in mortality, especially improvements

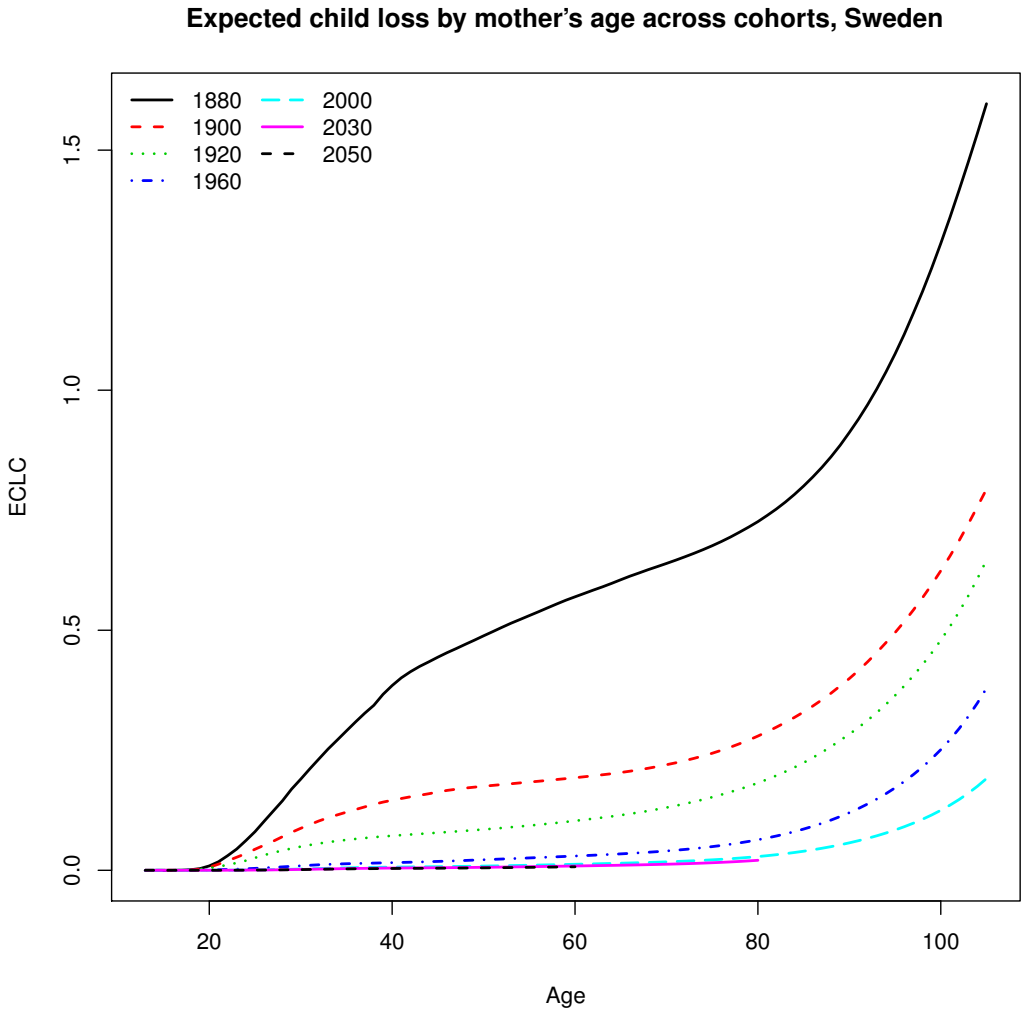

Figure 2: Expected child loss by mother's age across cohorts, Sweden, 1880-2050.

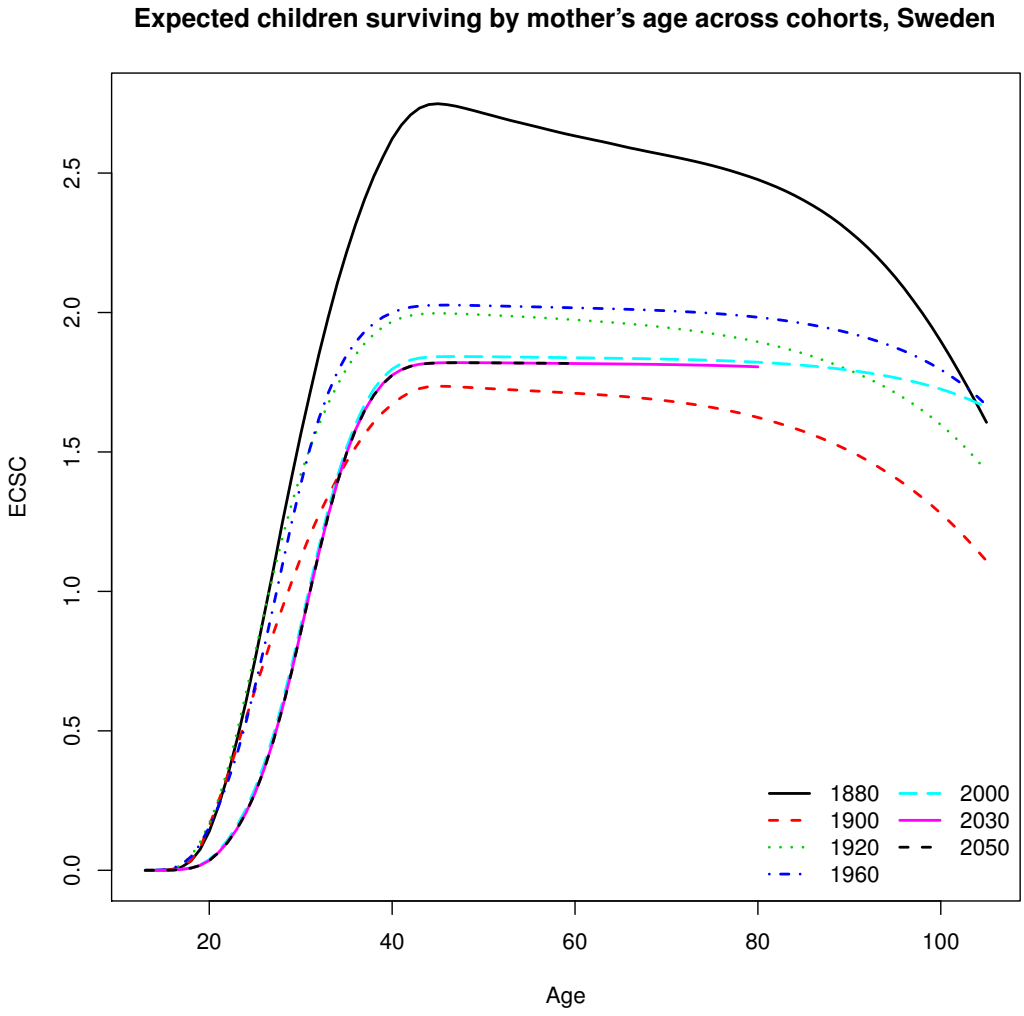

Figure 3: Expected child surviving by age across cohorts, Sweden, 1880-2050.

among infants, children, and young adults, lead to a decrease in the risk of losing the child as the child survives to older ages).

Trends in the expectation of the expected child loss conditional on surviving to age, a, ($E[ECLC]$) across birth cohorts of potential mothers are shown in Figure 4. For the earliest birth cohort of potential mothers, born in 1880, $E[ECLC]$ was over .5 children. The average number of children lost rapidly declined roughly between the births cohorts of 1880 and 1900 (likely mainly due to rapid reductions in fertility), stabilized across the birth cohorts of 1900 to 1930 or so (as fertility rises and mortality falls), and then declines again across the birth cohorts from 1930 or so forward. Looking at $E[ECLC]$ as a proportion of TFR gives some insight into the significance of these losses even for the most recent cohorts. In the earliest cohorts, mothers could expect to lose around 15% of the children they bore during their life time compared to less than 5% for the most recent cohorts.

2.2 Proportion of mothers losing children

What we have presented thus far in this section on child loss has focused on quantifying the number of children that a woman can expect to lose during her lifetime. Now, we want to consider the frequency of the experience of child loss within a particular cohort of women. We are interested in knowing whether child loss was a universal phenomenon prior to the demographic transition and how rare of a phenomenon child loss is today when mortality declines should have produced a more predictable ordering of death within families. We focus on the proportion of mothers who experience child loss during their lifetime.

Figure 6 depicts the fraction of mothers of age 60 with at least one child dead by mother's birth cohort. These results were obtained using simulation methods. From this figure, it is apparent that a mother's risk of losing a child before age 60 declined rapidly around the turn of the twentieth century. For cohorts born around 1880, over 50% of the mothers born into these cohorts who survived to age 60 experienced child loss. In contrast, for cohorts born around 1920, only around 10% of mothers who survived to age 60 experienced child loss. For mothers born in the last quarter to the 20th century and the beginning of the 21st, the likelihood of losing a child before age 60 is negligible.

3 Conclusion

Considering changes in child loss across the demographic transition, our results are as expected given the direction of mortality and fertility change. Child loss has become increasingly rare especially during a mother's reproductive years. For recent birth cohorts of potential mothers, these women are unlikely to lose children until they themselves are elderly and their children are entering old age. We find considerable variation in expected child loss and in the expected number of surviving children by mother's age across birth cohorts of mothers.

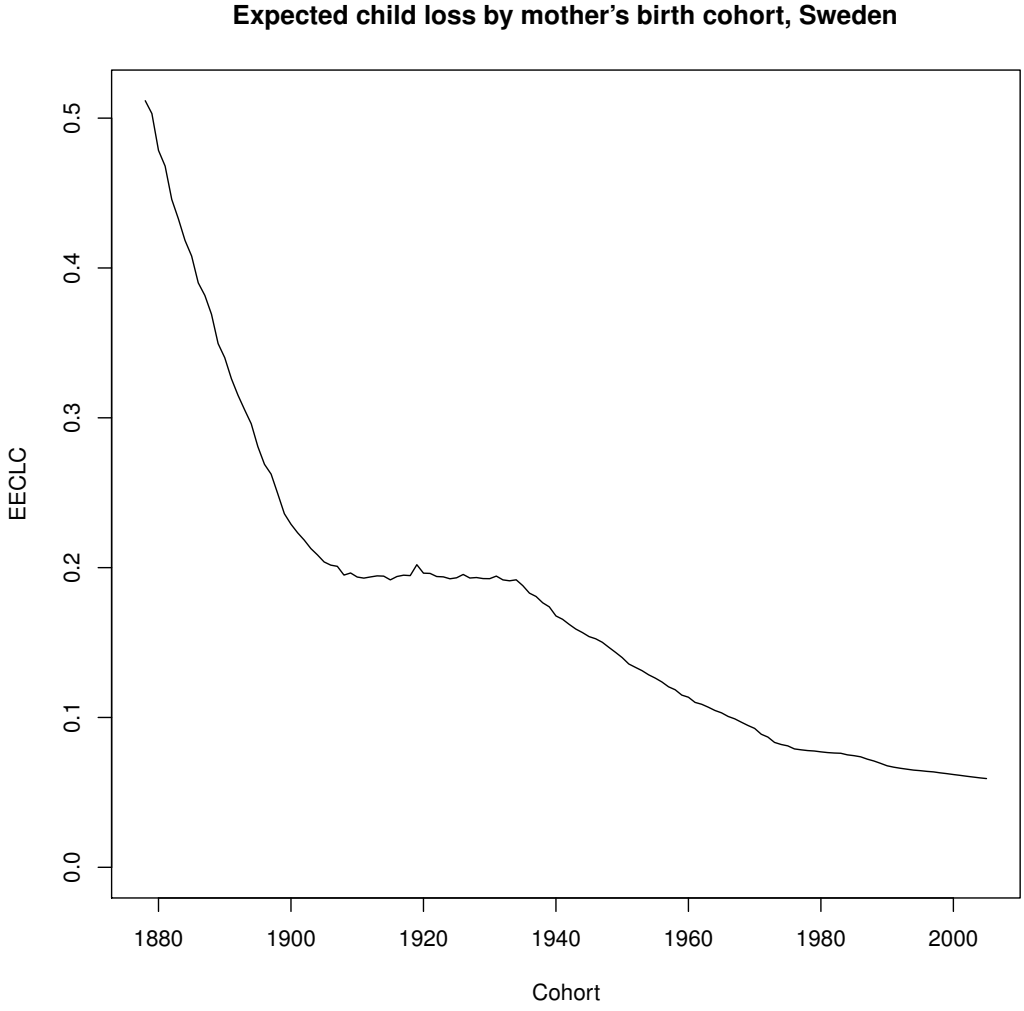

Figure 4: Expected child loss by mothers birth cohort, Sweden, 1880-2005

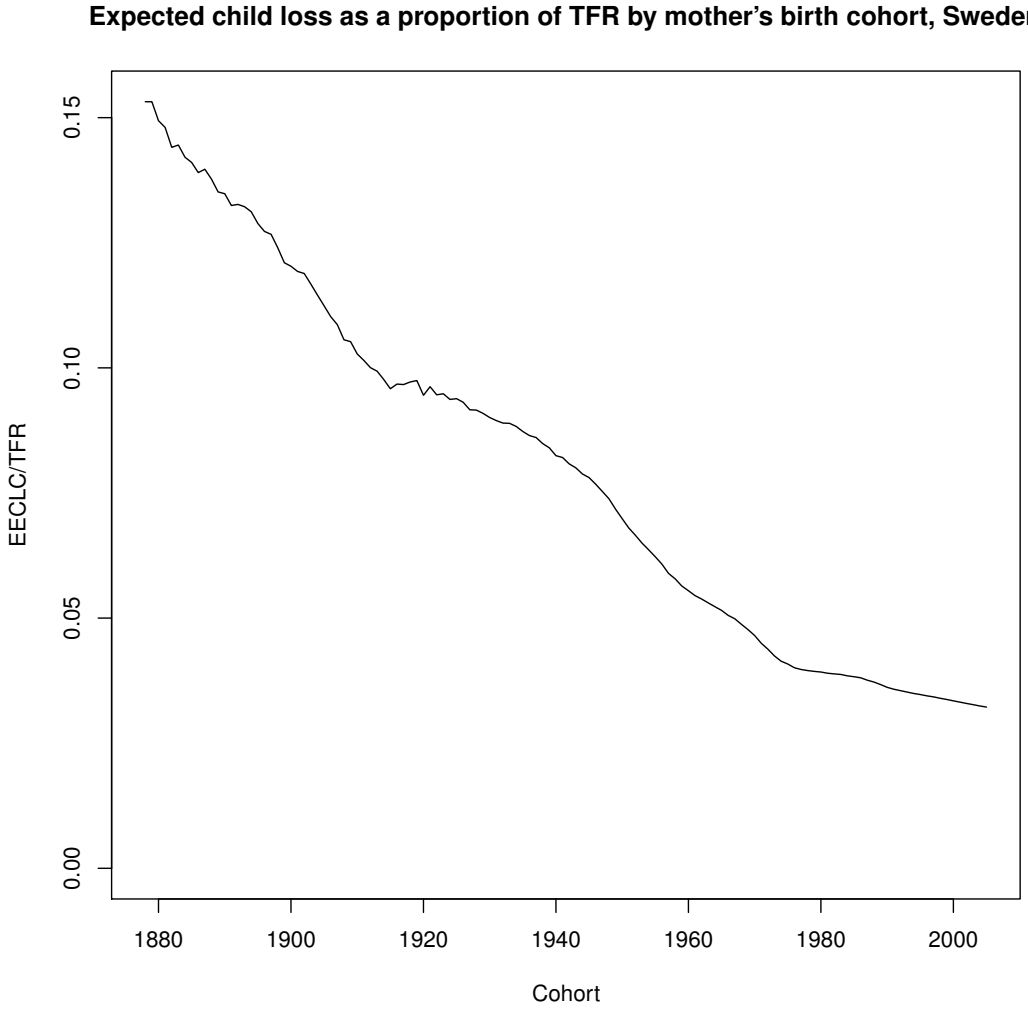

Figure 5: Expected child loss across cohorts as a proportion of TFR, Sweden, 1880-2005.

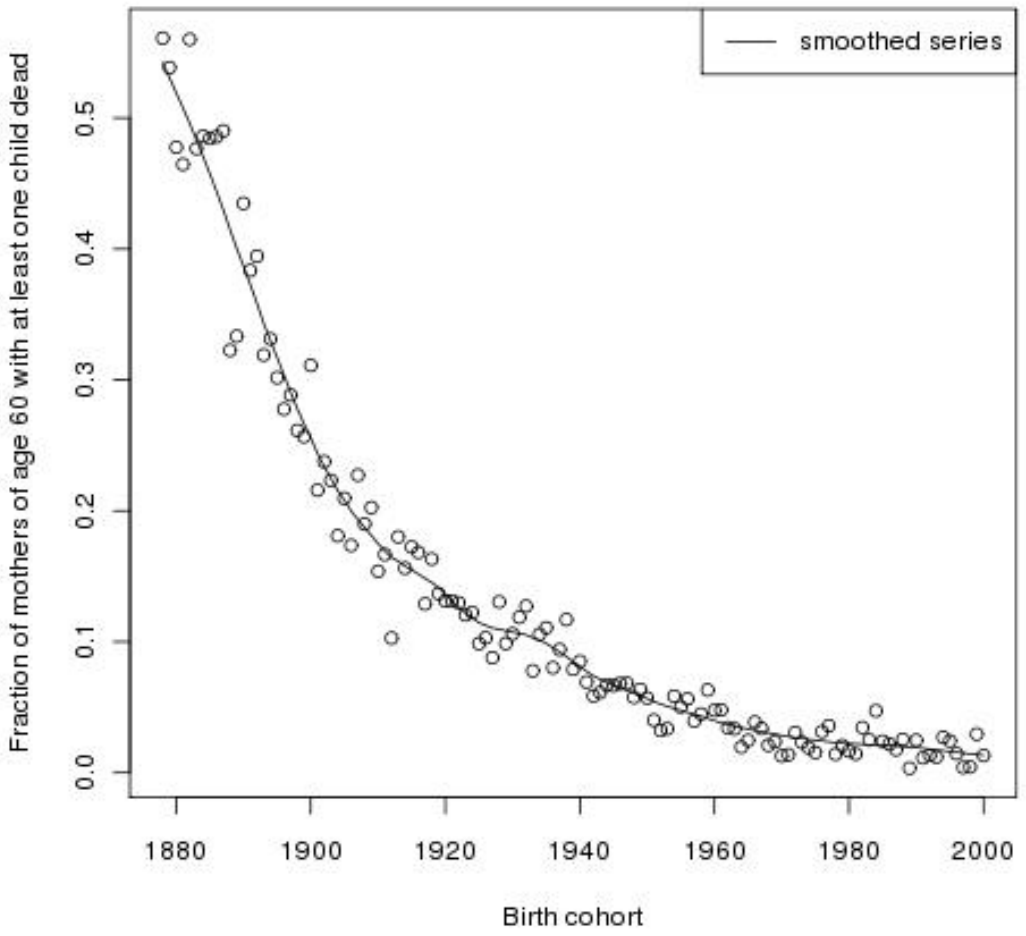

Figure 6: Fraction of mothers of age 60 with at least one child dead by birth cohort. Simulation based on fertility and mortality data for Sweden

4 Future directions

A mother's chance of losing a child is a function of her fertility, the survival probability of the child, and her own survival probability. The more children a woman has and the longer she lives, the greater risk she has of losing a child. Conversely, reductions in the child's mortality risk reduce the mother's chances of losing her child. In the future, we also intend to analyze the contribution of declines in fertility versus improvements in mortality to the decline in risk of child loss across cohorts.

In addition to the results presented here, we plan to examine the proportion of mothers losing children at other ages besides age 60 since results from our analysis of expected child loss indicate that the most recent birth cohorts will experience child loss when they themselves are relatively old (i.e. above age 80). With the simulations, we can also examine the likelihood of a mother experiencing multiple child deaths or the loss of all of her children. This is an especially interesting avenue to pursue because it might be the case that extreme mortality events hold more sway over fertility behaviors in comparison to average outcomes in the context of the demographic transition.

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