HISTORICAL CONTEXT AFFECTS PATHWAYS OF CHILDHOOD PARENTAL INFLUENCE ON REPRODUCTIVE TIMING: AN EMPIRICAL TEST FROM 20TH CENTURY SWEDEN.

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ABSTRACT
Several studies have found that parental absences in childhood have long-term consequences for individuals’ reproductive strategies. However, debate remains about the ultimate explanations for these life history effects. In this paper, we have three goals. First, we test whether different kinds of parental availability in childhood and adolescence affect women’s and men’s ages at first birth and lifetime fertility using the intergenerational and longitudinal Uppsala Birth Cohort Study (UBCoS) dataset from Sweden. This cultural context provides a strong test of the hypothesis given that robust social safety nets may buffer the effects of parental absences. Second, we examine whether investments in educational capital help explain why early parental presence is associated with delayed ages at first birth in many post-industrial societies given that parents often encourage educational achievement and status seeking. Third, we test whether changes in university attendance for men and women across the 20th century have changed these pathways of parental influence. We find that parental absences tend to delay first births, and that these effects are partially mediated by university attendance. However, we also show that the effect of paternal deaths become similar for sons and daughters in the more recent cohort when parents and children share more similar experiences with women in higher education, while the effects of maternal deaths become more differentiated by the child’s sex.

1. INTRODUCTION
Parental absences in an individual’s early life often expedite their reproductive development both physiologically (Matchock & Susman, 2006; Sheppard & Sear, 2012; Surbey, 1990) and behaviourally (Chisholm, Quinlivan, & Petersen, 2005; McLanahan & Bumpass, 1988). Evolutionary social scientists have been puzzled by this empirical observation. Natural selection should favor organisms with strategies that increase their reproductive success (often proxied by number of surviving children). The observation that parents delay reproduction contradicts one straightforward evolutionary prediction that help from family should improve individual's fitness, in part by allowing them to reproduce earlier. The human data also counters several observations of delayed or suboptimal reproductive behavior among non-human mammals experimentally reared without parents (Bastian, Sponberg, Suomi, & Higley, 2003; Schradin, 2004; Wuensch, 1985).

Evolutionists have proposed several theoretical accounts of the association between parental absences in childhood and faster life history strategies (i.e. faster reproductive maturation and
usually lower investment per child). These include roles for 1) inbreeding avoidance mechanisms (Matchock & Susman, 2006), 2) intergenerational conflicts (Moya & Sear, 2014) 3) parental guarding of children’s reproductive value (Flinn, 1988), 4) mechanisms for assessing environmental mortality risks (Chisholm, 1993), 5) assessments of the availability of investing partners in one’s environment (Draper & Harpending, 1982; Thornton & Camburn, 1987), 6) strategies for extracting parental investments for longer (Ellis, 2004), or adaptive responses to one’s own increased mortality risks given the lack of parental investments (Geronimus, 1991; Rickard, Frankenhaus, & Nettle, 2014).

In this article we focus on the possibility that parental presences delay reproduction in part because parents encourage education, which in turn trades off with early reproduction and high total fertility. Parental deaths in childhood are often associated with various negative educational and social outcomes (Case & Ardington, 2006; Gertler, Levine, & Ames, 2004; Willführ, 2009). These deficits in direct parental care in childhood might impact an adolescent’s economic and educational decisions, which in turn can have repercussions for reproductive choices. These parental influences can include at least two pathways. First, parents may invest in their children’s primary and secondary schooling, thus improving the socio-economic returns to further university education for these children. Second, independent of tangible investments in their children’s academic success, parents may encourage their children to engage in status-seeking behavior. In this paper we cannot differentiate these various forms of cultural capital that parents may provide (Bourdieu & Passeron, 1990).

In many post-demographic transition and transitioning contexts indicators of socio-economic status have become decoupled from reproductive success, particularly for women who experience more tradeoffs between reproduction, and education or market labor (Beydoun, 2001; Goodman & Koupil, 2009; Huber, Bookstein, & Fieder, 2010; Snopkowski & Kaplan, 2014; Upchurch & McCarthy, 1990). The fact that both adolescents and their parents are motivated by status-seeking behavior and resource accumulation requires an evolutionary explanation, given that these strategies do not necessarily translate into fitness – i.e. long-term number of descendents (Goodman, Koupil, & Lawson, 2012; Kaplan, Lancaster, Johnson, & Bock, 1995). While a full treatment of this debate is beyond the scope of the current article, we suggest that for much of human evolutionary history behaving according to status-seeking norms was associated with higher reproductive success, and that cultural evolutionary forces have only recently – but perhaps going as far back as ancient Rome (Caldwell, 2004) – favored institutions where this is not the case. Heuristics for socially learning appropriate status-seeking norms may thus have been favored by natural selection, even if they are currently maladaptively misfiring across many cultural equilibria (Boyd & Richerson, 1985; Kaplan, 1996). This interpretation is consistent with observations that community-level educational norms moderate an individual’s fertility, above and beyond their own educational level (Colleran, Jasienska, Nenko, Galbarczyk, & Mace, 2014).

There may be limits in the extent to which parents encourage status-seeking. For example, there is some evidence that kin may also encourage pro-natal behavior, even in low fertility contexts (Newson, Postmes, Lea, & Webley, 2005). This may be part of a fitness maximizing strategy since parent’s long-term reproductive success is largely dependent on their children’s (Newson et al., 2007). Alternately, parents may have pro-natal influences on their children if they hold cultural beliefs that are rapidly changing and thus differ from the reproductive and educational norms of their children.
To examine the plausibility of these theoretical accounts we address the following three questions:

1. Do parental deaths or separations in childhood affect reproductive timing and fertility?
2. Are parental effects on age at first birth mediated via educational attainment, specifically university attendance?
3. Are there historical changes in the pathways of parental influence?
   More specifically, do changes in the gender composition of university attendees accompany changes in how parents affect their sons' and daughters' reproductive timing?

This enterprise contributes to our understanding of the potential proximate mechanisms and ultimate explanations for family background effects on reproductive outcomes. We structure each section of this paper with reference to the three questions posed above. In the next section we discuss the previous work that addresses these issues. Section three introduces the dataset, historical and cultural context, and describes their relative benefits for addressing our questions. We then discuss our analytical methods. Section 4 describes the results with respect to each question in turn. In Section 5 we discuss how well the answers to each question and other patterns in the data fit the various theoretical accounts.

2. PREVIOUS WORK

2.1 DO PARENTAL DEATHS OR SEPARATIONS IN CHILDHOOD AFFECT REPRODUCTIVE TIMING AND FERTILITY?

Parental absences have been shown to both delay and expedite first births. In some subsistence-based societies early parental absences correspond to delayed reproductive events suggesting the importance of parental investments for coordinating marriages and allowing reproduction (Allal, Sear, Prentice, & Mace, 2004; Jennings, Sullivan, & Hacker, 2012; Lahdenperä, Lummaa, Helle, Tremblay, & Russell, 2004; Lahdenperä, Russell, & Lummaa, 2007; Mattison, Scelza, & Blumenfield, 2014; Scelza, 2010; Waynforth, Hurtado, & Hill, 1998), but see Winking, Gurven, & Kaplan, 2011 for a society where father absences have no effect). However, most research on the topic, conducted in post-industrial settings, shows the reverse pattern, namely parental absences in childhood expedite the onset of reproduction (Chisholm et al., 2005; Ellis et al., 2003; Kiernan, 1992; Lee, 2001; Manlove, Terry, Gitelson, Papillo, & Russell, 2000; McLanahan & Bumpass, 1988; Palermo & Peterman, 2009; Sheppard & Sear, 2012; Wu & Schimmele, 2003). The relationships between early parental availability and total fertility are less clear with most papers finding no significant effects (Alvergne, Faurie, & Raymond, 2008; Quinlan, 2003; Rijken & Liefbroer, 2009; Winking et al., 2011).

2.2 ARE PARENTAL EFFECTS ON AGE AT FIRST BIRTH MEDIATED VIA EDUCATIONAL ATTAINMENT, SPECIFICALLY UNIVERSITY ATTENDANCE?

Little work has been conducted to assess whether investments in educational capital mediate the relationship between parental absences in childhood and later reproductive outcomes. In part, this
may be because childhood family background can affect timing of menarche and adrenarche (Ellis, 2004; Hoier, 2003; Sheppard & Sear, 2012), which implies pathways of influence that are developmentally earlier than higher educational investments that trade-off most directly with reproduction. However, early educational and somatic investments may be reasonable proxies for later parental investment and thus afford reasonable cues about adaptive life history strategy. Additionally, the early investments themselves might change the payoffs to various economic and reproductive strategies. For example, having received a good elementary school education may indicate one will get a good high school or university education, or it may indicate that the relative benefits of going to university are high. Independent relationships between parental absences and educational achievement (Case & Ardington, 2006; Gertler et al., 2004), and between education and age at first birth (Rindfuss & John, 1983) have been documented, but this need not imply that education mediates the parental effect on first births. Furthermore, multiple pathways of influence, not just physiological ones in early childhood, may be involved. These can also include parental influences on income that may act at odds to the effects of education since higher income can expedite and increase reproduction (Beydoun, 2001; Goodman & Koupil, 2009; Huber et al., 2010).

Some previous work in a predominantly German sample indicates that growing up with both biological parents in early childhood and parental socio-economic status independently delay age at first sexual intercourse via their effects of increasing education (Neberich, Penke, Lehnart, & Asendorpf, 2010). However, early age at first intercourse need not be linked to earlier reproduction in societies like contemporary Germany with readily available and effective contraception. This article did not consider any actual fertility outcomes, but it does suggest that parental effects on education may delay adolescents' sex-seeking strategies and thus their age at first birth, even in contexts where the former behavior does not necessarily have to trade-off with higher education.

2.3. ARE THERE HISTORICAL CHANGES IN THE PATHWAYS OF PARENTAL INFLUENCE?

To our knowledge this is the first paper that addresses whether the pathways of parental influence on age at first births have changed through time. However, several lines of evidence suggest such changes are plausible. The 20th century has seen reductions in total fertility, delays to first births and decrements in family orientation, especially in post-industrial countries (Newson & Richerson, 2009; van de Kaa, 1987). Several researchers have suggested that this dissolution of dense kin social networks has been partly responsible for the commensurate decrements in group-level fertility (Newson et al., 2007; Turke, 1989).

Historical changes during the past century could have also changed whether, and how, kin affect individual-level fertility. For example, if children and their parents adopt changing cultural norms the nature and mechanisms of the latter's influence may change through time. Furthermore, expansions of state help in reproduction and parenting (e.g. subsidizing prenatal health care and preschool) may reduce the importance of alloparental help from family members. This could decrease the effect parents have on reproductive decision-making.

More importantly for testing our hypotheses about pathways of influence, changes in social network structure and reproductive behavior have been accompanied by unprecedented democratization in higher education attendance. There are several ways this can change parental effects on reproduction via education. Below we describe two mechanisms whereby the direct parental effects
on reproduction and their indirect effects via education would be expected to decrease through the course of the 20th century, and one mechanism whereby their indirect effect might increase through time.

We have previously shown that university attendance became both more common and more meritocratic in Sweden across the 20th century (Goodman, Gisselmann, & Koupil, 2010), and also that Sweden followed other countries in shifting from a marked male dominance among university attendees to an overall female bias (Goldin, Katz, & Kuziemko, 2006). This implies that parental support in educational endeavors and intergenerational inheritance of cultural capital may matter less as state policies can make university attendance achievable for young men and women from wider socio-economic and family backgrounds. This leads to the prediction that indirect parental influences on reproduction via education should go down through the 20th century.

Additionally, several models have shown that the transmission of beliefs from teachers rather than parents facilitate the spread of low fertility behavior that is maladaptive and would otherwise be selected against (Boyd & Richerson, 1985; Cavalli-Sforza & Feldman, 1981; Ihara & W. Feldman, 2004). Universities represent institutions with large opportunities for cultural transmission from peers and teachers, at the expense of parental influences. This leads to an additional prediction that direct parental effects on reproduction should decrease through the 20th century as university attendance, and therefore non-kin social influences, increase. To illustrate this logic consider the following extreme case; if social transmission were the primary pathway of parental influence on their children's fertility and interactions with parents were completely supplanted by social learning from peers and teachers upon reaching university, then parents would be predicted to only have indirect effects on their children's reproduction via their effects on their university attendance.

The pace of historical change in the 20th century also means that parents and their children may belong to different generational cultures. Parents and children need not adopt the same set of beliefs synchronously given the importance of social learning from peers (Harris, 1999; Kline, Boyd, & Henrich, 2013; Moya, Boyd, & Henrich, in press). Historical changes in university attendance can produce intergenerational discrepancies in beliefs about the necessity, propriety and prestige of higher education, especially as an endeavor for women. As cultural change in beliefs about education slows down there will be less of an intergenerational gap in expectations as the parent and child generations experience more similar social environments. This suggests that earlier in the 20th century parents may try to discourage their daughters' university attendance more given that the generations have more discrepant life experiences with higher education for women, whereas later in the 20th century parents may invest more in daughters' education, and thus delay first births more via this indirect pathway.

3. Methods

3.1 Dataset
To address our questions we used data from the Uppsala Birth Cohort Multigenerational Study (UBCoS Multigen), a longitudinal and intergenerational dataset spanning most of the 20th century in Sweden. This dataset has various strengths and interesting features for this investigation: 1) it includes individuals' complete reproductive histories and several socio-economic indicators across
generations, 2) it represents a social context where education, healthcare and childcare have long been heavily subsidized by the state (B. Hoem & Hoem, 1996) and 3) it spans a period with little change in fertility rates, but delays to reproduction (J. Hoem, 2005) and a large historical change in higher education attendance, especially for women (see Goodman et al., 2010 for further analysis of educational changes in UBCoS dataset).

The first feature of this dataset is primarily a methodological benefit that allows us to examine both the timing of reproduction and completed fertility, and how these are associated with changes in parental availability throughout adolescence. Furthermore, there are few datasets that allow us to control for the influence of as many potential confounders, including parental and grandparental socio-economic position and parental reproductive history. Several of these family background measures are known to be intergenerationally transmitted (Borgerhoff Mulder et al., 2009; Murphy & Knudsen, 2002) and are likely to affect both parental availability and ego’s reproductive outcomes.

The two other features are of more theoretical importance. This cultural context provides a strong test of the hypothesis that parental presence helps explain variation in reproductive and socio-economic outcomes, given that the Swedish state from the early 20th century onwards has provided much social assistance for individuals to attain their educational and reproductive goals (B. Hoem & Hoem, 1996), thus potentially reducing the importance of kin support. On the other hand, 20th century Sweden might represent a context with relatively high rates of paternal care compared to most societies (Duvander, Lappegard, & Andersson, 2010), making it more likely that we detect effects of father absence than in societies where fathers are not involved in child-rearing. The third feature of this dataset is essential for testing our hypotheses about the relevance of historical changes for parental effects on reproductive timing. Shifting rates of university attendance, especially for women, may have consequences for parents’ pro-natalism and educational investment strategies for their children.

3.2 Samples
We focused our analysis on the second index generation (20,727 individuals) of the Uppsala Birth Cohort Multigenerational Study (UBCoS Multigen). These are children of the original cohort of individuals born in Uppsala between 1915 and 1929 (Figure 1a) who were followed through their life to measure social and biological data of relevance to several health outcomes. We refer to this original cohort as the parent generation. The index generation of this multigenerational, longitudinal dataset represents the only cohort for which we have complete information about parental death dates and nearly complete information about their full reproductive lives. These members of the index cohort were born between 1932 and 1990, but 93% of them had reached 45 years of age by the last time they had been observed (see Supplementary Materials Figure S1). Data from members of the cohort born before 1964 indicate that 99% of these women had their last child by age 43 and 99% of men had their last child by age 50. Therefore, we restricted our analyses of completed fertility to the 19,242 index generation members who were at least 45 the last time their data were updated (date of death, date of extended emigration outside the country, or December 2009, whichever was earliest). For analyses of first birth timing, we included the full second generation in the analysis since the vast majority would have progressed to this event (Figure 1b).

To test whether family background effects on timing of first births and their pathways have changed in recent history, we also analyzed ages of first birth for the children of index individuals. We will call
them the child generation (n=37,118). There are more individuals in the child cohort who had yet to reach their first birth than in the index generation – i.e. they are censored since they have no age at first birth data. However, event history analyses can incorporate these censored individuals to provide less biased estimates (Singer & Willett, 1993) and we found that they give us substantively similar results (see Supplementary Materials Section 2 for robusticity checks).

Several historical changes between the index and child generations are likely to interact with parental effects on timing of first births. Of primary interest for us, 1) there is less intergenerational discrepancy between parents and children in university attendance rates in the more recent generation (Goodman et al., 2010). The gender ratio of university attendees is also more similar for the index and child generation than it is between the parent and index generation (Error! Reference source not found., Table S1 in the Supplementary Materials). These patterns reflect national level dynamics (Figure S2). Additionally 2) the average age at first birth is delayed in the child cohort relative to the index cohort (Figure 1b), and 3) through time parental deaths in childhood and adolescence becomes even rarer while parental separations are more common (Table 1).

Swedish individuals born in the early 1930s represent the first cohort where women would outnumber men among university attendees. The UBCoS parent and index cohorts perfectly straddle this historic shift. All of the original cohort members were born before 1930 while all index cohort members were born after 1930. This means that when studying index individuals we are examining a context where parents and children experienced different educational norms (statistical, if not prescriptive norms), but not remarkably different reproductive norms in terms of total fertility (Table S1). The index generation and their children, on the other hand, belong to cohorts with relatively more similar university attendance rates and sex ratios.
Figure 1. Historical changes in UBCoS cohorts.

a) Birth years by generation. The red solid line represents the *index* generation, the primary focus of this study. The *child* generation in solid light blue was used to test for historical changes in parental effects on first births. Their children are represented by the most recent dotted line. Robusticity checks of individuals older than 35 years of age when last seen would include individuals born before the vertical dotted line.

b) Survival curves for progression to 1st birth. The index generation is shown with open markers, and the child generation with filled in ones. Individuals who were censored for non-reproductive reasons were taken out of the analysis.

Table 1. Descriptive statistics for all variables by cohort and gender. For clarity, standard deviations are omitted for categorical variables and means refer to proportion of individuals within that category. NB: many in the child generation had not completed reproduction.

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<th>Men</th>
<th>SD</th>
<th>N</th>
<th>Women</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
<th>Child (G3)</th>
<th>Women</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
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<td>3174</td>
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<td>-</td>
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<td>7935</td>
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<td>8157</td>
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<td>-</td>
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<td>4.03</td>
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</tr>
</tbody>
</table>

* does not account for people who have yet to reproduce

** all Cohort 2 members born after 1965 were coded as a 1965 and later birthband due to small samples thereafter
3.2 Analysis

All variables used in regression models are described in Table 1. For ease of interpretation we ran models on female and male participants separately given their systematic difference in timing of first birth and educational attainment. When model predictions are shown, average marginal effects were used (Bartus, 2005) and confidence intervals around the predicted values were estimated using the delta method.

3.3.1 Dependent variables:

To test hypotheses regarding timing of first births we ran analyses in two ways; first as linear regressions on age at first birth (AFB), and second as discrete-time event history analyses predicting probability of progressing to a first birth from age 16 onwards given that one had not already done so. The former was used for the mediation analysis.

To examine completed fertility outcomes for the index cohort we used zero-inflated Poisson models to predict number of children born given that they fit better than Poisson and negative binomial models. The zero-inflation was driven by men, who were more likely than women to be childless, but to facilitate comparison we use zero-inflated Poisson models for both sexes.

3.3.2 Independent variables:

As our primary predictor we considered any evidence of a parental absence within the first 20 years of life, including deaths and separations. Parents’ marital status was available from decadal censuses (from 1960 - 1990) so we could only get rough estimates of the timing of separations. From this we extracted any evidence of parental separation or non-cohabitation during the first 20 years of one’s life. This includes either parent being single, divorced, married but not living with the child’s parent, or cohabiting with someone other than one’s parent. We construct a single categorical variable of parental availability; parents alive and together (in tact), mother dead, father dead, and both parents alive but separated. There were too few individuals with both parents dead in the first 20 years of their life to be analyzed so these were excluded. Given the greater prevalence of separated parents than dead parents in this population, we focus our comparison of results on effect sizes rather than statistical significance.

3.3.3 Mediator:

To examine whether parental effects on reproductive outcomes are mediated by their investments in children’s education we considered university attendance as a mediator. Given that university education most directly trades off with onset of reproduction in post-industrial societies, and years of schooling is very left skewed, we used a binary variable of having ever attended college. For the mediation analyses we used linear regressions to model age at first birth as well as fertility, and binary mediation to accommodate the university education variable. We report bootstrapped percentile confidence intervals since sampling distributions of indirect effects tend to be skewed (Preacher & Hayes, 2008).

3.3.4 Covariates:

Given the importance of shared environmental and genetic effects between parents and children (Pettay, Kruuk, Jokela, & Lummaa, 2005), we included as many family background controls as possible to reduce confounding. We include the mean of parents’ disposable household income (as a linear and squared term), the maximum educational level of parents, and grandparental socio-
economic status as measured by occupational status in all models (with the exception of grandparental occupational status not being available for the child generation). Parents’ fertility was proxied by the mother’s when this data was available, and the father's number of children otherwise. Similarly, the mother's age at first birth was included in models. For the few individuals for whom this data was unavailable, we used the father's age at birth minus the cohort-specific mean age discrepancy between male and female ages at first birth. Additionally, to control for historical changes within each cohort we controlled for birth bands of roughly 5-year intervals. Finally, given the non-independence of observations within a family we use robust standard errors, clustered by shared mother, or shared father if mother identity was missing. In the mediation analyses we used the same control variables, but did not cluster by shared parent.

4. RESULTS

4.1 DO PARENTAL DEATHS OR SEPARATIONS IN CHILDHOOD AFFECT REPRODUCTIVE TIMING AND FERTILITY?

4.1.1 AGE AT FIRST BIRTH:
Focusing on the index generation for now, all forms of parental absences in the first 20 years of life expedite first births for sons and daughters (Figure 2). While many of these effects are not significant, even the smallest among them amounted to decreasing the individual's predicted age at first birth by a quarter of a year. The effects are generally larger for daughters than for sons. For example, a father’s death or parental separations are associated with an age at first birth that is nearly 1 year earlier for daughters. It is only a mother’s death which tends to decreases sons’ age at first birth more than it does daughters’ — although the effect of a mother's death in the first 20 years of life was not significant in either sex. Event history analysis of progression to first births generally replicates this pattern of sons’ progressions to first births being more affected by maternal deaths and separations, while daughters' tempo are more strongly affected by paternal deaths and separations (Figure S4).

Other family background parameters have comparable, or larger, effects on age at first birth. For example, having a parent who completed high school versus one who had at least 3 years of tertiary education is associated with a 0.87 year delay to daughters' age at first birth, and a 0.71 delay to sons'. Interestingly, grandparents SES and parents’ reproductive parameters have effects above and beyond those of parents' SES. See Supplement Section 3 for full models of AFB by cohort.

4.1.2 TOTAL FERTILITY
The effects of early parental absences on age at first birth, do not clearly translate to effects on total fertility. Models predicting fertility fit better without the parental availability measures than with them (see Supplementary Materials Section 4, Table S4 for full model). The largest, though non-significant, parental effect on fertility is that a mother's death in early life is predicted to result in 0.12 more children for her sons at the means of other covariates (poisson B=.06, SE=.06, p=0.27).

As previously documented in the UBCoS sample (Goodman & Koupil, 2009), family background variables are more reliably associated with both sons’ and daughters’ total fertility (Table S4). Parents’ reproductive strategies have similar effects on both daughters and sons – there are
intergenerational correlations in total fertility, and earlier ages of parents’ first births correspond to higher fertility in their children. A family’s socio-economic background, on the other hand, tends to have different effects on sons’ and daughters’ fertility. Generally, the higher one’s family’s socio-economic background the higher a male’s fertility, and the lower a female’s fertility, with this negative effect on females appearing to be mediated to a considerable degree by university attendance. Because we do not find strong effects of parents on fertility we do not consider it further in our mediation analysis.

Figure 2. Effect of parental absences on age at first birth (AFB) – Across generations. Family disruptions are documented in first 20 years of life. All effects are shown relative to having an intact family and are derived from separate models for each cohort. Tests for differences between cohorts are derived from models with interactions between parental absences and cohort. Robust 95% CIs are shown. *p<0.05. Note: the patterns are substantively the same when only analyzing individuals who reached 35 years of age (see Supplementary Materials).
4.2. Are Parental Effects on Age at First Birth Mediated via Educational Attainment, Specifically University Attendance?

Parental absences in the first two decades of life generally have negative effects on children’s likelihood of attending university (Figure 3). Focusing on the index cohort (G2) for now, parental separations result in the most reliable, and largest, decrements in the log odds of university attendance. The negative effects of early maternal deaths on daughters’ university attendance rival those of parental separation in size for this generation. Mothers’ and fathers’ deaths have roughly the same effect on sons, though neither is significant, while fathers’ deaths have effectively zero effect on a daughter’s university attendance in the index generation.

Figure 3. Effect of early family disruptions on education – Across generations. Family disruptions are documented in first 20 years of life. All effects are shown relative to having an intact family and are derived from separate models for each cohort. Tests between cohorts are derived from models with interactions between parental absences and cohort. Robust 95% CIs are shown. **p<0.01. Note: the patterns are substantively the same when only analyzing individuals who reached 35 years of age (see Supplement)
Mediation analyses show that these parental contributions to children’s university attendance partly explain parents’ effect on their ages at first birth. This indirect effect via education corresponds to lines $a \times b$ in Figure 4, while parents’ residual direct effect after controlling for university attendance is represented by line $c$. See Tables in Section 5 of Supplementary Materials for all effects used in mediation analyses, and standardized direct and indirect effects.

In the index generation parental absences expedite first births primarily through direct effects rather than indirectly via education (Figure 5). The main exception to this pattern is the effect of parental separations on sons’ AFB, for which the indirect and direct effects are equally large. We also find a significant indirect effect of similar strength of parental separation on daughters’ AFB via education. However, the overall effect of parental separations on daughters’ AFB is much larger, and this is driven by their direct effects. The partial mediations result from parental separations reducing the probability that children attend university, which in turn reduces their ages at first birth.

**Figure 4**

Schematic of mediation analyses run for each measure of parental absence (within first 20 years). The direction of effects is accurate for most models. Deviations from these directions are specified in Figure 5.
**Figure 5**

Standardized Direct and Indirect effects of early parental absences on age at first birth, by generation. Parental deaths and separations are those documented by age 20. Effects are relative to having an intact family. University attendance is used as a mediator. Only effects with solid outlines have bootstrapped percentile 95% confidence intervals that did not include zero. NB: the directions of effects deviate from the Figure 4 schema in that for sons in the child generation (G3) maternal deaths and parental separations have positive direct effects on age at first birth (c is +).

### a) Sons

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<thead>
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<td>maternal deaths and parental separations have positive direct effects on age at first birth (c is +).</td>
</tr>
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<td>mothers abs.</td>
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<td>separated</td>
<td>direct effect</td>
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### b) Daughters

<table>
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<th>Child (G3)</th>
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<td>mothers abs.</td>
<td>direct effect</td>
</tr>
<tr>
<td>separated</td>
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</tbody>
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---

4.3. **Are there historical changes in the pathways of parental influence?**

First we examine the changes in parental absence effects on AFB (Figure 3) and university attendance (Figure 4) across the two generations. Then we compare the mediation analyses across these cohorts (Figure 5).
Most parental absences in the first 20 years of life have similarly accelerating effects on age at first birth in the child generation as well (Figure 3). There are two exceptions; mothers’ deaths have a non-significant delaying effect on sons’ AFB in the child generation, and parental separations have no effect on sons’ first births. The only significant difference between the generations is that the effect of parental separation on daughters’ AFB becomes weaker. That is, there is a significant interaction between cohort and parental separation (B(SE)=0.44(0.2), p=0.03). However, the interaction effects with cohort are even larger for the effect of mothers’ deaths on a daughters’ AFB in the child generation, and parental separations have no effect on sons’ first births. The only significant interaction between cohort and parental separation (B(SE)=0.53(0.65), p=.41), mothers’ effects on sons (B(SE)=0.88(0.70), p=0.20) and father's effects on sons (B(SE)=0.60(0.46), p=0.19). This suggests that our analysis may be underpowered to detect historical changes in the effects of parental deaths given that these are so rare. Examining progressions to first birth to deal with censored individuals in the more recent cohort reveals similar patterns (Figure S4).

All kinds of parental absences are associated with lower chances of university attendance in the more recent child cohort (Figure 4). This stands in contrast to the null effect of a father’s death on daughter’s university attendance in the index generation. This is the only significant interaction between cohort and parental absence; i.e. a father’s death is more deleterious to a daughter’s higher educational prospect in the more recent cohort (B(SE)=0.51(0.19), p=0.008). Father presence also becomes a significant predictor of son’s university attendance in the more recent generation (interaction effect with cohort B(SE)=0.29(0.2), p=.15). On the other hand, the deleterious effects of parental separations on education become muted for both sons and daughters, though not significantly so.

There are several differences between the pathways of parental influence on age at first birth in the two generations. Unlike in the index generation, fathers’ deaths have very similar effects on daughters and sons in the more recent child generation (Figure 5). While the direct effects of a father’s death on AFB in the child generation are intermediate between those on sons and daughters in the index generation, their indirect negative effects via university attendance increase to similar levels for daughters and sons alike. On the other hand while mothers’ deaths had similar effects on their sons and daughters in the index generation, they have opposite direct effects in the child generation. In other words a mother’s death in the child generation expedites daughter’s first birth but delays her son’s after controlling for the fact that her death reduces their chances of attending university. Parental separations expedite first births less in the more recent generation, primarily due to reductions in the direct pathway. For sons this means that in the more recent index generation the effect that parental separations have on their first births is completely mediated by their effects on his university attendance. For daughters, this is not the case, as the direct effect of parental separations continues having a large expediting effect.

It is worth noting that the two generations’ samples are slightly different for two reasons. First, the former’s reproduction is censored. That is, individuals in the child generation who have reproduced are likely to represent young breeders. Second, we did not have access to the 2000 census from which we derived parental separation measures, meaning that more recently born might be incorrectly coded as coming from intact families when in fact a separation ensued by 2000. We conducted a sensitivity analysis restricting the mediation models to individuals who were at least 35 years of age when last seen, meaning that they are more likely to have undergone a first birth, and
would have been at least 20 by the 1990 census. Figure S5 shows the very similar patterns of direct and indirect effects for this restricted sample.

5. DISCUSSION
We show that parental absences in childhood have sex-specific effects on life history strategies, that some of the effects are partially mediated by parental effects on university attendance, and that these pathways change across the 20th century along with the democratization and feminization of higher education. This suggests that intergenerational genetic correlations or unmeasured socio-economic variance are unlikely to be the sole explanation for associations between childhood parental absences and reproductive outcomes (Comings & Muhleman, 2002; Surbey, 1998). We consider each of our research questions in more detail below and discuss how well the patterns fit predictions from the theoretical models.

5.1 PARENTAL ABSENCES EXPEDITE FIRST BIRTHS, BUT HAVE LITTLE EFFECT ON FERTILITY
The data suggest that parental absences expedite first births, but have relatively little effect on total fertility. Parental absence effects on reproductive timing rather than fertility are both theoretically more cogent and straightforward predictions from life history theory (Ellis, 2004; Quinlan, 2007), and possibly more likely to be detected in a population with low fertility norms where people do not take advantage of their full reproductive life span.

If we had only focused on effects in the index generation, we might have concluded that opposite-sex parental deaths have larger effects on AFB than same-sex parental absences. However, in the more recent generation mother’s effects on daughters’ ages at first birth are equivalent to those of father effects, and paternal deaths expedite sons’ AFB more than do maternal deaths. Most of the previous literature has focused on effects of father rather than mother absence, and some studies comparing fathers and mothers directly have suggested stronger developmental acceleration effects of father absence (Bogaert, 2005). We only partially confirm this trend for daughters in the index generation and sons in the child generation.

Similarly, the literature has primarily focused on female children and adolescents’ development for a series of methodological, policy, and theoretical reasons—menarche is easier to measure than adrenarche, female teen pregnancies are seen as a larger social problem (Card & Wise, 1978), and the tradeoffs between early reproduction, and somatic and educational investments seem starker for females (Ellis, 2004). However, direct comparisons are rare and generally there seems to be few clear patterns regarding the interaction of parent and child sex on developmental outcomes (Russell & Saebel, 1997). Our study shows that the developmental consequences of family disruptions on age at first birth tend to be larger for daughters, but can be as severe for sons as they are for daughters (e.g. mothers’ deaths expedited ages at first birth more for sons than for daughters in the index generation).

Parental separations—a commonly used metric of parental absence—seem to expedite daughters’ first births more than sons’ (Figure 2). This suggests caution in interpreting results from studies relying on parental separations since children in these situations are more likely to be reared by mothers, while son’s reproductive strategies might be more sensitive to maternal absences—at least in some social contexts (e.g. index generation). Unlike some previous work (Biblarz & Gottainer,
we find that the effects of parental separations on life history strategy are not particularly larger than those of parents’ deaths, especially in the more recent generation. This suggests that the social context has a large effect on the meaning of parental separations. In the recent generation separations were less likely to be stigmatized, represented less self-selected families, may have been less of a financial burden for the primary caretaker, or may have resulted in relatively more equal parenting by mothers and fathers.

5.2. Parental Effects on Age at First Birth Are Only Partially Mediated by University Attendance.

Most parental absences in childhood are associated with lower university attendance rates, which in turn reduces age at first birth. These indirect effects are relatively small compared to the direct effects of parental absence on age at first birth, especially in the index generation. Notably, a father’s death does not affect a daughters’ education in the earlier generation, and thus has no indirect effect on her AFB. Those indirect pathways which are observed via education are most consistent with Child Development Theory that proposes children delay their maturation when they get higher parental investments and can reap these benefits (Ellis, 2004). While parental investments in their children may improve their socio-economic success in ways not captured by university attendance, other theoretical models are likely to help explain the much larger direct effects of parental absence (Belsky, Steinberg, & Draper, 1991; Chisholm et al., 2005; Moya & Sear, 2014; Rickard et al., 2014).

Parental educational investments do not necessarily payoff in terms of total reproduction in post-demographic transition settings, and definitely do not in this society specifically (Goodman et al., 2012). Mechanisms promoting status seeking are likely at play motivating these parental contributions to education (Boyd & Richerson, 1985; Kaplan, Lancaster, Tucker, & Anderson, 2002). By this logic, children with higher parental investments in childhood may stand to benefit in terms of social status from university attendance more than children from family backgrounds where they received less parental investment, even though this does not improve their fitness.

5.3. Pathways of Parental Influence Change Across Time

Below we consider our hypotheses about the possible historical changes to parental influences on ages at first birth. First we discuss how total parental effects may have changed, and then we discuss the direct and indirect educational pathways of change.

If parental effects simply changed to reflect intergenerational changes in reproductive norms, parents would delay their children’s first births more in the more recent generation, given that the mean age at first birth increased for both men and women across these cohorts. While we do not find this pattern for all parent-offspring dyads, we do see that fathers delay their sons more and mothers delay their daughters more in the more recent child generation, though not significantly so. This may reflect the fact that children also are motivated to follow the reproductive norms of their generation leaving little room for parental social influence.

If the expansion of governmental programs facilitating reproduction changed parental effects on reproductive decision-making we would have expected parental effects to become weaker through time. More specifically, parents should have become less necessary to carry out reproduction resulting in less expediting effects of parents. It is difficult to assess whether this mechanism is at
play in the historical changes we see given that having parents around does not generally expedite reproduction. This means that we see little evidence that young adults are using their parents as alloparenatal resources that help them expedite their reproduction. The only pattern consistent with this is that maternal deaths delay their sons’ reproduction, but only in the more recent generation and not significantly so. If anything, this argues against more generous parenting policies in recent generations weakening parental effects.

Nor do we find that governmental policies supporting higher education reduced the effect of early parental absences on university attendance. The only kind of parental absence that had a smaller effect on education in the more recent cohort was that of parental separations. We believe it is more plausible that this is due to changes in the meaning, stigma and economic consequences of parental separation through time, than a reflection of policy changes improving educational access. In fact, the effect of parental separations on son’s age at first birth is completely mediated by their effect on education in the more recent cohort, suggesting that pathways via other psychological consequences are of decreasing importance.

In contrast we find that fathers’ deaths are more deleterious to childrens’ university prospects in the more recent generation, though only significantly so for daughters. This translates into larger effects of fathers on AFB for sons only, while for daughters it changes the fathers’ pathway of influence, but not his total effect. The fact that the direct and indirect effects of paternal deaths look similar for sons and daughters in the more recent generation suggests that changing gender norms around university attendance affect how fathers interact with, and invest in, their children. In other words the more recent fathers, who themselves belonged to a cohort with greater female than male college attendance, encouraged relatively similar educational and reproductive timing strategies for both sons and daughters. In contrast the index generations’ fathers, who belonged to a cohort with markedly higher university attendance for men than women, only increased university attendance for their sons. This interpretation does not explain why mothers had similar effects on their sons’ and daughters’ education across the generations. The larger paternal effects on education overall may also reflect a greater involvement of fathers in child-rearing in the more recent generation.

Finally, if peer and non-kin social networks were influencing reproductive timing more as university attendance increased, we would expect to have seen decreasing direct effects of parents through time. This is only the case for opposite-sex parents and parental separations. As discussed previously, we believe the decreasing direct effects of parental separations are better understood in light of the changing meaning and consequences of divorce. The direct effects of mothers on sons are actually nearly equivalently sized but in opposite directions across cohorts, and those of fathers on daughters are nearly the same as their effects on sons in the child cohort. This suggests that waning parental social influence might not account for these historical changes in pathways of effect either.

Consistency over time can also be of interest if it implies that more canalized mechanisms (i.e. those less susceptible to environmental changes) are at work. Interestingly, the reduction in the direct effect of parental separations across time seems to have been larger for sons than daughters. On the other hand, the indirect effects of parental separations on AFB via university attendance are consistent across time for both daughters and sons. In both generations daughters’ reproductive
timing is more susceptible to the effects of separations, suggesting that at least some of the mechanisms at work are robust to changing and more egalitarian gender norms.

8. Conclusions

We present evidence that parental absences in childhood affect children’s reproductive timing — even when their presence and investments are weakly approximated by their vital or marital status, and even in a society that provides much governmental support for reproduction, education and material well-being. We add to the growing literature showing that parental deaths and separations in the first two decades of a child’s life are associated with earlier reproductive outcomes in post-demographic transition societies. Parent absence effects are partly explained by their influence on university attendance that delays first births, but residual direct effects tend to be larger. Furthermore, we see that the historical context moderates the total effects and pathways of influence of parental absences. The effect of fathers’ death becomes more similar for daughters and sons in the more recent generation suggesting the importance of gendered education norms in how parents influence children. However, the effect of mothers’ becomes more differentiated by the sex of her children in the more recent generation. Fathers’ effects via education may also have increased through time due to greater male parental involvement. Parental separations expedite first births less in the more recent generation, suggesting that the social consequences of unconventional marital practices are becoming less severe. However, the fact that daughters’ ages at first birth are more affected by parental separations than sons’ ages at first birth remains is robust to historical changes. This suggests that the pathways of developmental influence differ depending on the kind of parental absence tested, and that some are more likely to change with changing gender norms.

We do not intend to make any prescriptive claims in this article and given the political sensitivity of the topic under investigation, it remains to remind readers that we are limited in our ability to make strong causal inferences with these analyses. For example, it is unclear that parental separations themselves have effects on a child’s life history, or whether separation is just an indicator of family tension. If the latter were the case, encouraging parents to stay together may have even larger impacts on a child’s development than having them separate. Furthermore, as the historical analyses suggests, parental absences can have different effects depending on the prevalence of the behavior or of the societal context suggesting that policy recommendations might be undertaken at the group, rather than at the individual, level. Finally, it is difficult to generalize our results to societies where biparental care is less common given that other alloparents tend to invest heavily in child rearing in many societies (Hrdy, 2009).

References


