Birth Spacing and Fertility in the Presence of Son Preference and Sex-Selective Abortions: India's Experience Over Four Decades*

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Abstract

Over the past four decades, the Hindu women in India most likely to use sex-selective abortions—well-educated women with no sons—had the most substantial lengthening of birth intervals and the most biased sex ratios. As a result, we now see cases that reverse the traditional spacing pattern, with some women with no sons having longer birth intervals than those with sons. Those least likely to use sex-selective abortions—less-educated women in rural areas—still follow the traditional pattern of short spacing when they have girls, with only limited evidence of sex selection. Because of the rapid lengthening in spacing, the standard fertility rates substantially overestimated how fast cohort fertility fell. Despite a convergence, cohort fertility is still 10%–20% higher than the fertility rate and above replacement level for all but the best-educated urban women. Infant mortality has declined substantially over time for all groups, with the fastest decline among the less educated. Short birth spacing is still associated with higher mortality, although considerably less so for the best-educated women. There is no evidence that repeated sex-selective abortions are associated with higher infant mortality for the child eventually born. Finally, it does not appear that the use of sex selection is declining.

JEL: J1, O12, I1

Keywords: India, prenatal sex determination, censoring, competing risk, nonproportional hazard

1 Introduction

India has experienced many positive changes over the past four decades: The economy has grown substantially, educational attainment has increased for males and females, and the total fertility rate has fallen to 2.2 children (Bosworth and Collins, 2008; Dharmalingam, Rajan and Morgan, 2014; International Institute for Population Sciences (IIPS) and ICF, 2017).

However, India also witnessed the advent of sex selection—the selective abortion of female fetuses based on prenatal sex determination—with the introduction of ultrasound in the mid-1980s. Combined with a strong continued preference for sons, the result was a dramatic increase in the male–female ratio at birth (Das Gupta and Bhat, 1997; Arnold, Kishor and Roy, 2002; Retherford and Roy, 2003; Guilmoto, 2012; Pörtner, 2015; Jayachandran, 2017).

The main question I address here is how birth spacing responded to these changes, especially the spread of sex selection. The motivation is twofold. First, researchers have failed to appreciate that each abortion increases the interval between births by 6–12 months.[1] Hence, the growing use of sex-selective abortions may substantially increase birth spacing, although we do not know to what extent. Second, greater educational attainment by women, higher household income, and the low and declining female labor force participation all likely influence birth spacing. Thus, the combined changes in birth spacing may outpace what we have observed in other countries.

Studying birth spacing contributes to our understanding of fertility decisions, but, equally important, birth spacing also affects the reliability of our fertility measures and may affect mortality. Therefore, I address two additional questions.

First, did changes in birth spacing bias the fertility estimates for India? With longer

[1] The increase consists of three parts. First, after an abortion, the uterus needs at least two menstrual cycles to recover, or the likelihood of spontaneous abortion increases substantially (Zhou, Olsen, Nielsen and Sabroe, 2000). Second, the waiting time to conception is one to six months. Finally, sex determination tests are reliable only from three months of gestation.

spacing, mothers will be older at each parity, and this tempo effect makes the total fertility rate a downward-biased estimate of cohort fertility (Hotz, Klerman and Willis, 1997; Bongaarts, 1999; Ní Bhrolcháin, 2011). Hence, if birth intervals increased substantially, then India's fertility may be higher than generally accepted.

Second, what is the relationship between infant mortality and the changes in birth spacing and sex selection? In India, birth intervals have traditionally been shorter with fewer sons, contributing to the higher mortality risk for girls (Whitworth and Stephenson, 2002; Bhalotra and van Soest, 2008; Maitra and Pal, 2008; Jayachandran and Kuziemko, 2011; Jayachandran and Pande, 2017). Therefore, longer birth spacing, whether from sex selection or secular changes, may reduce mortality (Conde-Agudelo, Rosas-Bermudez, Castaño and Norton, 2012; Molitoris, Barclay and Kolk, 2019). However, a counteracting effect is possible if longer birth intervals arise from multiple abortions because the short duration between pregnancies could increase mortality.

To investigate how birth spacing has changed, I use a competing risk hazard model with two exit states: The birth of a girl or the birth of a boy. I apply the model to the birth histories of Hindu women covering 1972–2016 using data from the four National Family and Health Surveys (NFHS).

The primary outcomes I examine are the 25th, 50th, and 75th percentile birth intervals; the sex ratio at birth; and the likelihood of giving birth. I estimate the model across four periods to capture the changing access and legality of sex selection. The key variables are maternal education, the sex of previous children, and the area of residence.

The empirical model allows me to predict cohort fertility. To examine whether tempo effects bias our standard fertility measures, I compare the predicted cohort fertility with fertility calculated from age-specific fertility rates.

I use the same data to study how infant mortality changed with birth spacing and the increasing use of sex selection. The key explanatory variables remain the same, except for the addition of birth spacing and the sex of the index child.

There are three main results.

First, birth intervals lengthened over the four decades, and the lengthening was longer, the higher the parity, the more educated the woman, and the higher the percentile. Women most likely to use sex selection—well-educated women with no sons—had the most substantial lengthening of birth intervals and the most biased sex ratios. As a result, we now see cases that reverse the traditional spacing pattern, with some women with no sons having *longer* birth intervals than those with sons. Those least likely to use sex selection—less-educated women in rural areas—still follow the traditional pattern of short spacing when they have girls, with only some evidence of sex selection. The likelihood of a very short birth interval changed little.

Second, the fertility rate substantially overestimated how fast cohort fertility fell in the 1990s and early 2000s as spacing began to increase. Although the two have lately been converging, the predicted cohort fertility is still 10%–20% higher than the fertility rate. Furthermore, predicted cohort fertility is still at or above replacement level for all but the best-educated urban women.

Finally, infant mortality has declined substantially over time for all groups, but fastest for the less educated, who are now close to the level of the best-educated women. However, mortality is still inversely related to education level, especially for very short birth intervals. There is no evidence that repeated sex-selective abortions are associated with higher mortality for the child eventually born.

2 Background and Conceptual Framework

To set the stage for the subsequent analyses and provide a conceptual framework for understanding birth spacing, I first discuss female education and labor force participation in India and relevant theories on birth spacing.

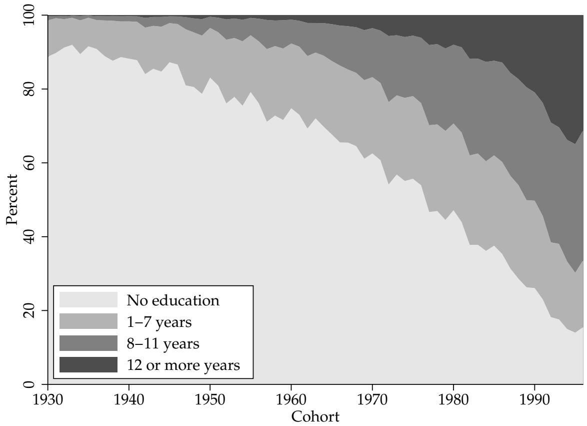
Female education is a crucial explanatory variable here for three reasons. First, higher female education is associated with lower fertility and increased use of sex selection (Das Gupta and Bhat, 1997; Dreze and Murthi, 2001; Bhat and Zavier, 2003; Retherford and Roy, 2003; Guilmoto, 2009; Pörtner, 2015; Jayachandran, 2017). Second, female labor force participation in India, as in other developing countries, first decreases and then increases with education (Klasen and Pieters, 2015; Fletcher, Pande and Moore, 2017; Afridi, Dinkelman and Mahajan, 2018; Bhargava, 2018; Chatterjee, Desai and Vanneman, 2018; Bhargava, 2019). Finally, child mortality decreases with maternal education (Rosenzweig and Schultz, 1982; Whitworth and Stephenson, 2002; Maitra and Pal, 2008).

I divide education levels into four groups: No education, 1–7 years, 8–11 years, and 12 and more years. The latter two correspond to having completed primary and secondary school, respectively.[2] To ensure that the results are comparable with the prior literature on fertility and mortality in India, I follow the NFHS reports, except that I combine the less than five years and 5–7 years of schooling completed and the 8–9 and 10–11 years of schooling completed. This grouping allows me to capture the differences across education levels discussed below, while also having groups large enough for the empirical method.

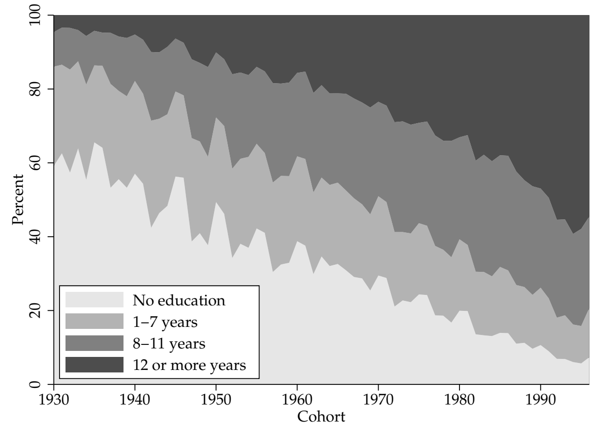
Female education has increased substantially over time in rural and urban areas but is still substantially higher in urban than in rural areas. Figure 1 shows the distribution of schooling by birth cohort for urban and rural women, 20 years or older, whether married or not, based on the four rounds of the NFHS. In rural areas, women with no education have gone from 90% for the 1930s cohorts to less than 20% for the 1990s cohorts. Women with eight or more years of education have gone from almost zero for the 1930 cohort to more than 60% for the 1990s cohorts, with about half in the 8–11 group and the other half in the 12 plus group. In urban areas, the proportions with no education or 1–7 years have each declined to just below 10%. Most of the increase in urban female education came from the 12 plus group, which now accounts for more than half of all urban women for

[2] Although there are variations by state, elementary education in India consists of a primary school covering grades one through five and an upper primary—or middle school—covering grades six through eight. Similarly, secondary education covers grades nine and tenth for "secondary education" and 11 and 12 for "upper secondary."

the most recent cohorts.



(a) Rural



(b) Urban

Figure 1: Distribution of education by cohort for women 20 years or older at survey

The standard economic argument for shorter spacing with increasing female education is that parents incur time costs when they have children (Hotz et al., 1997; Schultz, 1997). Suppose having children requires the mother to reduce her market work. Parents can then lower this cost of children by shortening birth spacing to take advantage of economies of scale in childrearing (Vijverberg, 1982).

However, even as the level of female education has increased, the female labor force participation in both urban and rural areas has stagnated or decreased (Klasen and Pieters, 2015; Fletcher et al., 2017; Afridi et al., 2018; Bhargava, 2018; Chatterjee et al., 2018; Bhargava, 2019). India's female labor force participation is now lower than that of most other countries and does not yet show any signs of increasing (Klasen and Pieters, 2015; Chatterjee et al., 2018). In line with previous research, the NFHS data show a U-shaped relationship between education and working for married women, with the highest percentage working being women with either no education or 12 or more years and the lowest being women with 8–11 years of education.[3]

The low and declining female labor force participation, especially for younger women, suggests that families face little incentive to space children more closely together for eco-

[3]See appendix Figures A.1 through A.3.

nomic reasons. One explanation is that household income has increased so substantially that the income effect dominates any substitution effect. Two findings speak to this effect. First, although real wages for both men and women have almost doubled between 1987 and 2011, the mean male wage is still close to 70% higher than the female wage (Klasen and Pieters, 2015; Bhargava, 2018). Second, women's labor supply appears to be more negatively elastic to husbands' wages than positively elastic to their own wages (Bhargava, 2018).

The introduction of sex selection allows parents to avoid giving birth to girls but increases the expected interval to the next birth. Theory suggests that sex selection increases with lower desired fertility and with higher parity for a given desired number of children (Pörtner, 2015). Sex selection is more widespread among better-educated than less-educated and among urban than rural women, which is consistent with lower desired fertility increasing the use of sex selection (Das Gupta and Bhat, 1997; Retherford and Roy, 2003; Guilmoto, 2009; Pörtner, 2015; Jayachandran, 2017). Better-educated and urban women also tend to live in households with higher income, which lowers the relative costs of using sex selection and having long birth intervals.

The combination of rising incomes and continued son preference may lead to even longer spacing than might be expected from the income effect alone. As women's education increases, their productivity in the production of offspring human capital also increases. With relatively more boys born because of increased access to sex-selective abortions and the increasing income potential for (male) offspring, demand for better-educated women can increase, even if they do not participate in the labor market (Behrman, Foster, Rosenzweig and Vashishtha, 1999).

If more and "better" parental attention per child results in higher child "quality," we should expect longer birth intervals (Zajonc and Markus, 1975; Zajonc, 1976; Razin, 1980). However, the evidence on spacing's effect on child quality measures such as IQ and education is mixed for developed countries and nonexisting for developing countries (Powell and Steelman, 1993; Pettersson-Lidbom and Thoursie, 2009; Buckles and Munnich, 2012; Barclay and Kolk, 2017). The exception is health and mortality, where longer spacing does lead to better outcomes, although this relationship weakens with maternal education (Whitworth and Stephenson, 2002; Conde-Agudelo et al., 2012; Molitoris et al., 2019).

The increases in female educational attainment imply that access to education has expanded beyond the higher castes. One possible effect of the associated change in the composition of better-educated women is that this group's behavior would change. However, "Sanskritization" implies that as lower-castes females gain access to education and their husbands' income increases, they adopt higher-caste norms such as stronger son preference and a retraction from the formal labor market (Srinivas, 1956; Chen and Dreze, 1995; Abraham, 2013; Chatterjee et al., 2018). The low and declining female labor force participation suggests that this process still operates.

In summary, with substantial increases in husbands' income and a declining female labor force participation, I expect a push toward longer birth spacing over time, independent of education levels, based on the income effects and the effects of spacing on child outcomes. Furthermore, I expect birth spacing to increase the most among the better educated because their household income increases the most—even with declining female labor participation—and because of their use of sex selection. Even with the substantial increase in the number of better-educated women, "Sanskritization" implies that the changing composition will not substantially change the use of sex selection.

3 Estimation Strategy

The standard approach in the birth spacing literature is to use proportional hazard models with a single exit—the birth of a child.[4] There are two problems with the standard approach in this setting.

[4]See Sheps, Menken, Ridley and Lingner (1970) and Newman and McCulloch (1984) for early discussions of why hazard models are the preferred way to deal with the censoring of birth intervals.

First and foremost, the use of sex selection means that the sex of the next child is no longer random and that the spacing to the birth of a boy will differ from the spacing to a girl. Therefore, I use a competing risk setup that captures both the non-randomness of the birth outcome and the differential spacing.[5]

Second, even without sex selection, it is unlikely that characteristics, such as the sex composition of previous births, have the same effects throughout the entire birth interval. The proportional hazard model requires that the hazard for any individual is a fixed proportion of the hazard for any other individual. Nonconstant effects violate that assumption, and the results from a proportional hazard model would, therefore, be biased. The proportionality assumption is especially problematic for higher-order birth intervals because there are substantial differences across groups in the likelihood of progressing to the next birth and how soon couples want their next child if they are going to have one (Whitworth and Stephenson, 2002; Bhalotra and van Soest, 2008; Kim, 2010).

The introduction of prenatal sex determination exacerbates any bias from the proportionality assumption for two reasons. First, different groups have different levels of sex-selective abortion use and, thereby, birth spacing. Second, within a birth interval, a household's use of sex selection may vary, and that means that the effects of covariates vary as well.

Therefore, I use a nonproportional hazard specification that allows the shape of the hazard functions to vary across groups. The use of a nonproportional specification also mitigates any potential effects of unobserved heterogeneity when used in conjunction with a flexible baseline hazard (Dolton and von der Klaauw, 1995).

The model is a discrete-time, nonproportional, competing risk hazard model with two exit states: Either a boy or a girl is born. The unit of analysis is a spell—the period from one parity birth to the following birth or censoring. For estimation purposes, the spells begin nine months after the previous birth because this is the earliest we should expect

[5] Merli and Raftery (2000) used a discrete hazard model to examine whether there was underreporting of births in rural China, although they estimated separate waiting time regressions for boys and girls.

to observe a new birth. Censoring can happen for three reasons: The survey takes place, sterilization of the woman or her husband, or imposed because of too few births for the method to work.

For each woman, $i = 1, \ldots, n$, the starting point for a spell is time $t = 1$, and the spell continues until time t_i, when either birth or censoring of the spell occurs. The time of censoring is assumed to be independent of the hazard rate, as is standard in the literature. The two exit states are the birth of a boy, $j = 1$, or a girl, $j = 2$.

The discrete-time hazard rate h_{ijt} is

$$h_{ijt} = \frac{\exp(D_j(t) + \alpha'_{jt}\mathbf{Z}_{it} + \beta'_j\mathbf{X}_i)}{1 + \sum_{l=1}^{2}\exp(D_j(t) + \alpha'_{lt}\mathbf{Z}_{it} + \beta'_l\mathbf{X}_i)} \quad j = 1, 2. \tag{1}$$

$D_j(t)$ is the piece-wise constant baseline hazard for outcome j, captured by dummies and the associated coefficients,

$$D_j(t) = \gamma_{j1}D_1 + \gamma_{j2}D_2 + \ldots + \gamma_{jT}D_T, \tag{2}$$

with $D_m = 1$ if $t = m$ and zero otherwise. This approach to modeling the baseline hazard is flexible and does not restrict the baseline hazard unnecessarily. $\mathbf{Z}$ is the nonproportional part, which includes the interactions between $D_j(t)$ and a set of explanatory variables and the interactions of those. The remaining explanatory variables, $\mathbf{X}$, enter proportionally.

Equation 1 is equivalent to the logistic hazard model and has the same likelihood function as the multinomial logit model (Allison, 1982; Jenkins, 1995). Hence, splitting spells into smaller intervals—here equal to three months—and treating them as observations, I can estimate the model using a standard multinomial logit model.

I use the model to predict birth interval measures, parity progression probabilities, and the sex ratio rather than present coefficients because the interpretation of competing risk model coefficients is challenging (Thomas, 1996). The predicted parity progression probability is the likelihood of giving birth by the imposed censoring based on standard survival curve calculations averaged across all women in a given sample.

For birth intervals, I estimate a set of percentile birth intervals. I first calculate for each woman when there is a given percentage chance that she will have given birth, conditional on the probability of giving birth in the spell. For example, with an 80% parity progression probability, the median birth interval is the predicted number of months before a woman passes the 60% mark on her survival curve. I then add nine months to account for the start of the spell. The reported statistic is the average of a given percentile interval across all women in a given sample using the individual progression probabilities as weights.

The predicted sex ratio is the weighted average of individual predicted sex ratios, using parity progression probabilities as weights. To find the individual sex ratio, I estimate the percentage of births that are boys at t, conditional on not having had a child before t. Weighting the percent boys with the likelihood of exiting the spell with a birth across all t gives the predicted percentage of boys over the entire spell for an individual.[6]

4 Data

The data come from the four rounds of the NFHS collected in 1992–1993, 1998–1999, 2005–2006, and 2015–2016. The surveys are large: 89,777, 90,303, 124,385, and 699,686 women, respectively. NFHS-1 and NFHS-2 surveyed only ever-married women, while the two later surveys included never-married.

I focus on the three spells starting from the first birth and ending with the fourth birth. I exclude the interval from marriage to the first birth because many are imputed and the higher-order intervals because few women had five or more births, especially among the better-educated.

I restrict the sample to Hindus for two reasons. First, Hindus are the majority population group, about 80% of India's population. Second, the prior literature shows that

[6] Imagine $T = 2$. If 54% and 66% of births are boys and the likelihood of giving birth 20% and 40%, then the predicted sex ratio is $\frac{54*0.2+66*0.4}{0.2+0.4} = 62\%$ boys.

son preference and use of sex selection vary substantially between Hindus and the second largest group, Muslims. Combining them and assuming that the baseline hazard is the same would lead to biased results. Because of space constraints and the relatively small number of observations once split by education and periods, I do not provide separate results for Muslims or any of the remaining groups, such as Sikhs, Jains, and Christians.

Finally, I exclude visitors and women in any of the following categories: Never married; no gauna yet; married more than once; divorced; not living with husband; inconsistent age at marriage; or education information missing. The same goes for women who had at least one multiple births, reported giving birth before age 12, had a birth before marriage, or had an interval between births of less than nine months.

In addition to a large number of women surveyed and the long period covered, a significant benefit of the NFHS over other surveys is that enumerators pay careful attention to the spacing between births and probe for "missed" births. For India, the main concern is underreporting of deceased children, especially a systematic recall error where respondents' likelihood of reporting the birth of a deceased child depends on the sex of that child. Unreported deceased children inflate the birth intervals and, with declining mortality, make changes over time appear too small. In the online appendix, I provide a detailed analysis of systematic recall error, which shows that recall error depends heavily on how long ago a woman was married. I, consequently, drop women married 22 years or more.[7]

To ensure that there are enough births for the method to work, I censor spells at 96 months (eight years) after a woman can first give birth, equivalent to 105 months after the birth of the prior child. Less than 1% of observed births occur after the cutoff. The final sample consists of 395,695 women, with 815,360 parity one through four births.

Direct information on the use of sex selection is not available, so I compare periods

[7] Recall error is likely behind the designation of the first two rounds of NFHS as "moderate quality" in an analysis of the quality of birth histories in DHS surveys and its impact on fertility estimates (Schoumaker, 2014).

based on the changes in access and legality of prenatal sex determination in India. Abortion has been legal in India since 1971. Reports of sex determination appeared around 1982–1983, and the number of clinics quickly increased (Sudha and Rajan, 1999; Bhat, 2006; Grover and Vijayvergiya, 2006). In 1994, the Prenatal Diagnostic Techniques Act made determining and communicating the sex of a fetus illegal.[8] Finally, although sex selection increased even after 1994, we may have passed a turning point in its use in the mid-2000s (Das Gupta, Chung and Shuzhuo, 2009; Kumar and Sathyanarayana, 2012; Bongaarts, 2013; Diamond-Smith and Bishai, 2015).

I use four periods: 1972–1984, 1985–1994, 1995–2004, and 2005–2016. The first covers the period before sex selection became available and the second from when sex selection became available until the Prenatal Diagnostic Techniques Act. I have split the period from 1995 until 2016 into two to examine if there was support for the prior literature's hypothesized reversal in child sex ratios and son preference in India.

The allocation of spells into periods is determined by when conception, and, therefore, decisions on sex selection can begin. Hence, some spells cover two periods, which may bias downward the differences between the periods. Most sterilizations take place soon after giving birth. These spells, therefore, do not show up in the samples used. Furthermore, sterilization depends strongly on the sex composition of prior children with lower probabilities, the fewer boys. The effect is to bias downward the differences in parity progression probabilities.

I divide the explanatory variables into two groups, nonproportional and proportional. The first group consists of characteristics shown in the prior literature to affect the spacing choice and the use of sex selection: Mother's education, sex composition of previous children, and area of residence. To minimize any potential bias from including proportional variables, I estimate a separate model for each birth interval, education group, and period combination, rather than including education as a variable. I capture sex composi-

[8]There is little evidence that the ban significantly affected sex ratios (Das Gupta, 2019).

tion with dummy variables for the possible combinations, ignoring the ordering of births.[9] Area of residence is a dummy variable for living in an urban area.

The second group of variables consists of those expected to have an approximately proportional effect on the hazard. These include the mother's age when the spell begins, the household's land ownership, and whether it belongs to a scheduled tribe or caste. Appendix Tables D.1 and D.2 present descriptive statistics.

5 How Birth Spacing Changed

The first question I address is how birth spacing responded to the significant changes in India. Figures 2 through 7 show the 25th, 50th, and 75th percentile birth intervals in months, the sex ratio, and the probability of having a birth for each spell by education levels and area of residence.[10] The sex ratio graphs also show the natural sex ratio, approximately 51.2% boys (Ben-Porath and Welch, 1976; Jacobsen, Moller and Mouritsen, 1999; Pörtner, 2015). The underlying values with bootstrapped standard errors are available in the online appendix.

The parity progression and the sex ratio show two broad trends. First, in line with the falling total fertility rate, the likelihood of a next birth has decreased over time. The likelihood of a next birth fell more rapidly, the higher the education, the higher the parity, and with at least one son. Within a given spell and period, parity progressions are lower in urban than rural areas, if at least one son is present, and the more educated the mother.

Second, the spread of sex selection shows clearly in the sex ratios of next births, which has become more male-dominated for women with no sons. The percentage of births that were boys increased more quickly, the higher the education and the higher the parity.

[9] With sex selection, the composition of prior children is, in principle, endogenous. It is beyond the scope of this paper to develop a method for dealing with this issue.

[10] Results for urban women without education, rural women with 12 or more years of education, and the fourth spell for women with 12 or more years of education are in the online appendix because of relatively small samples.

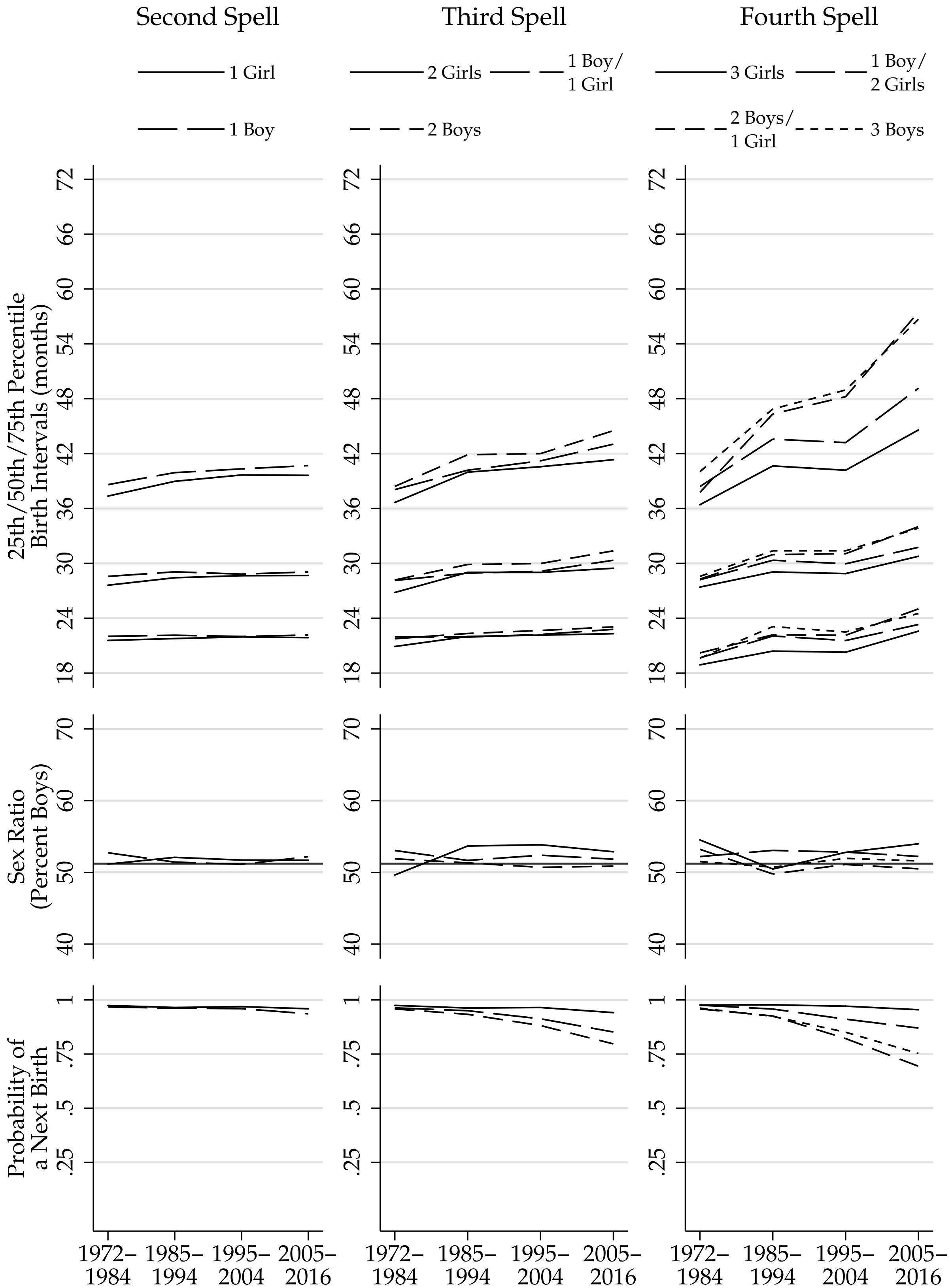


Figure 2: Percentile birth intervals, sex ratios, and parity progression for rural women with no education by spell, sex composition, and period

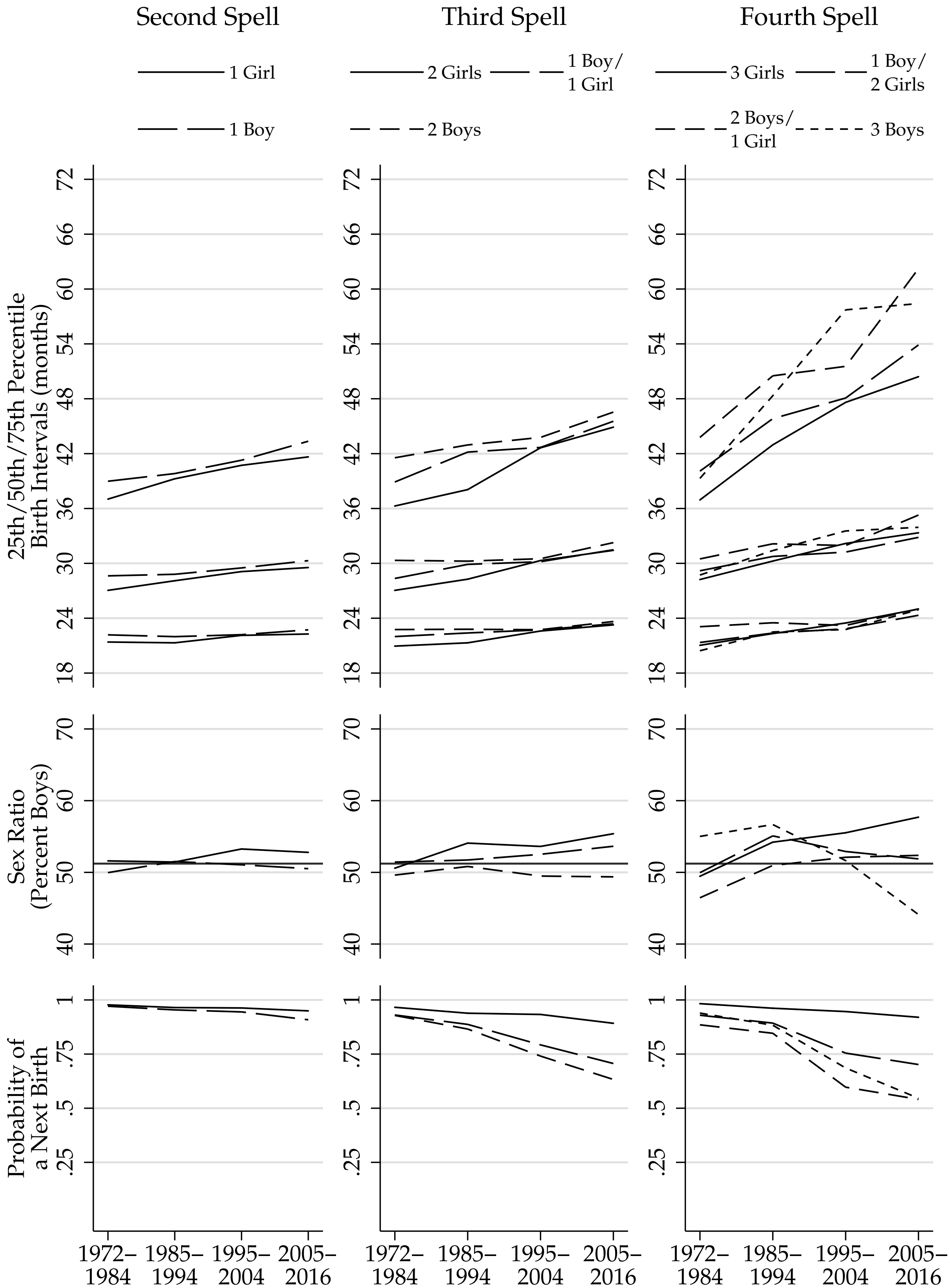


Figure 3: Percentile birth intervals, sex ratios, and parity progression for rural women with 1–7 years of education by spell, sex composition, and period

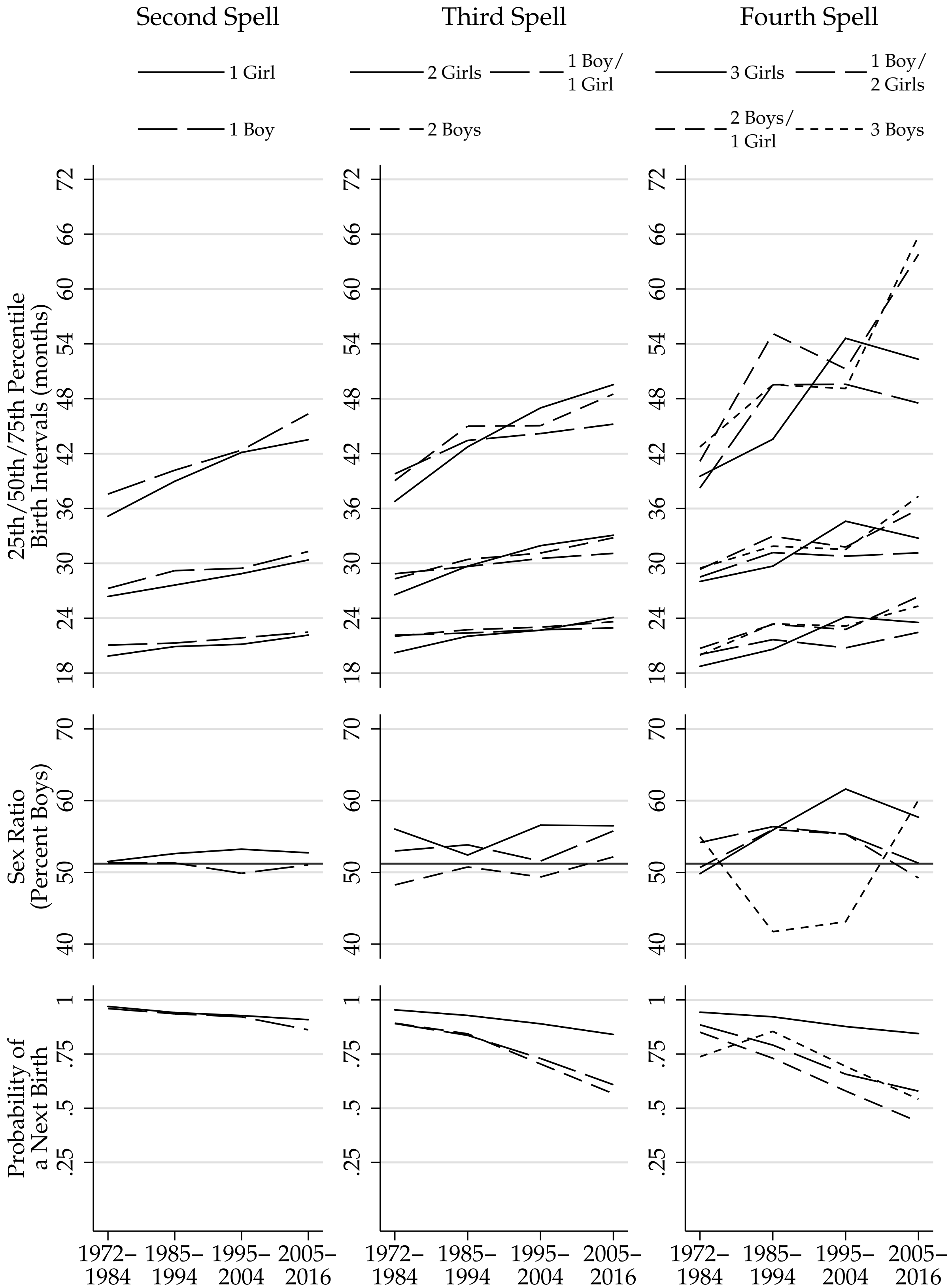


Figure 4: Percentile birth intervals, sex ratios, and parity progression for urban women with 1–7 years of education by spell, sex composition, and period

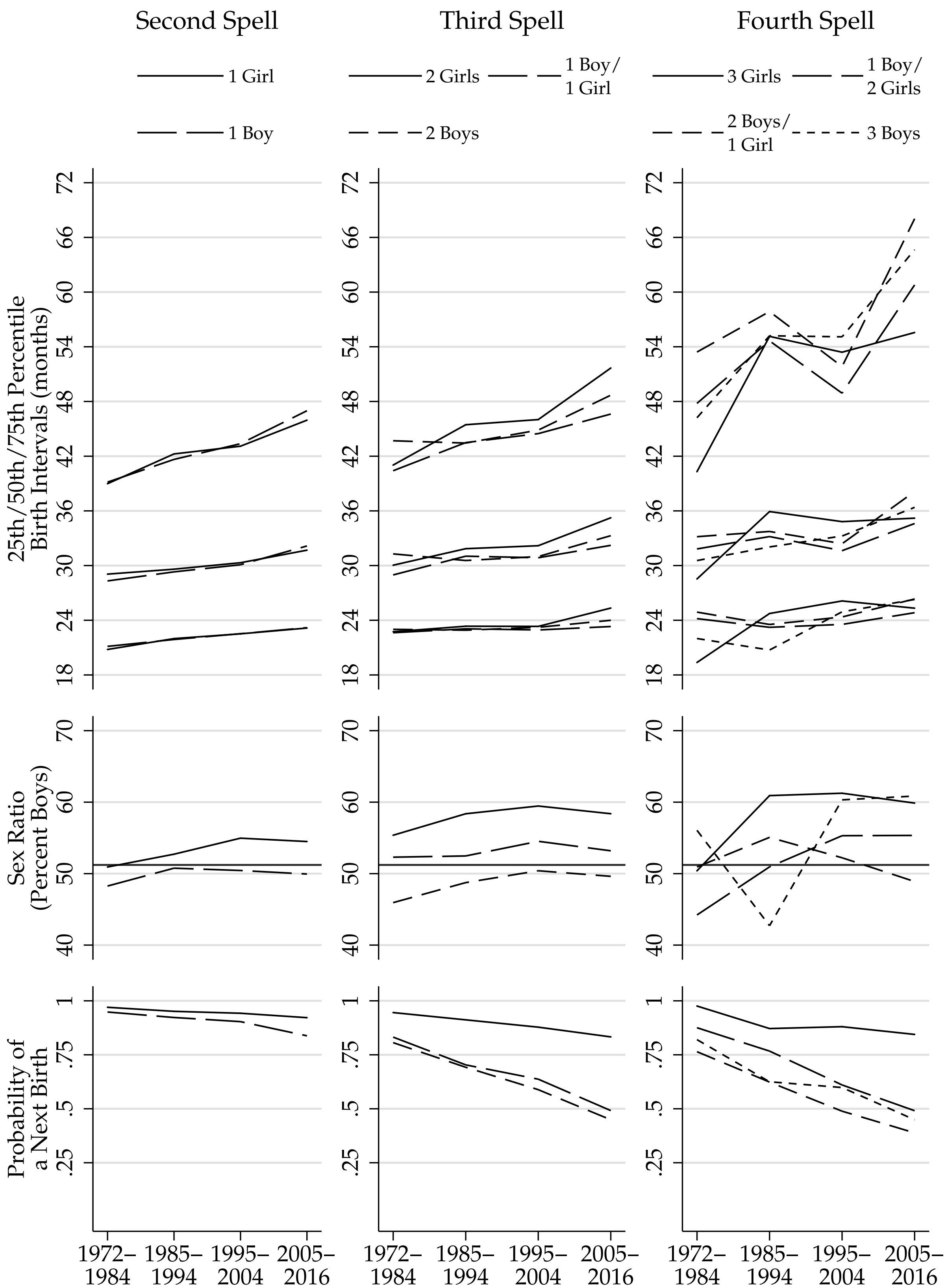


Figure 5: Percentile birth intervals, sex ratios, and parity progression for rural women with 8–11 years of education by spell, sex composition, and period

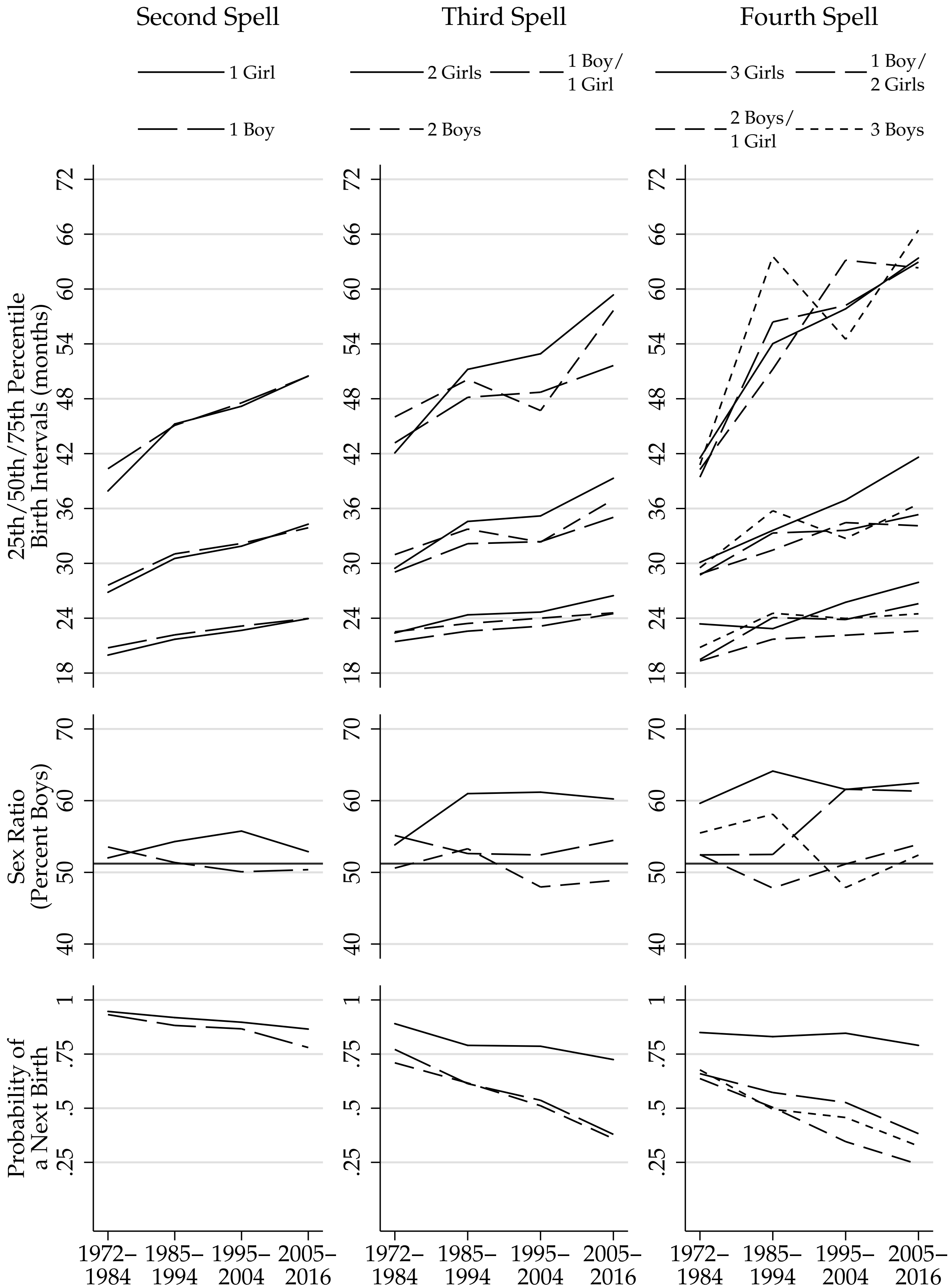


Figure 6: Percentile birth intervals, sex ratios, and parity progression for urban women with 8–11 years of education by spell, sex composition, and period

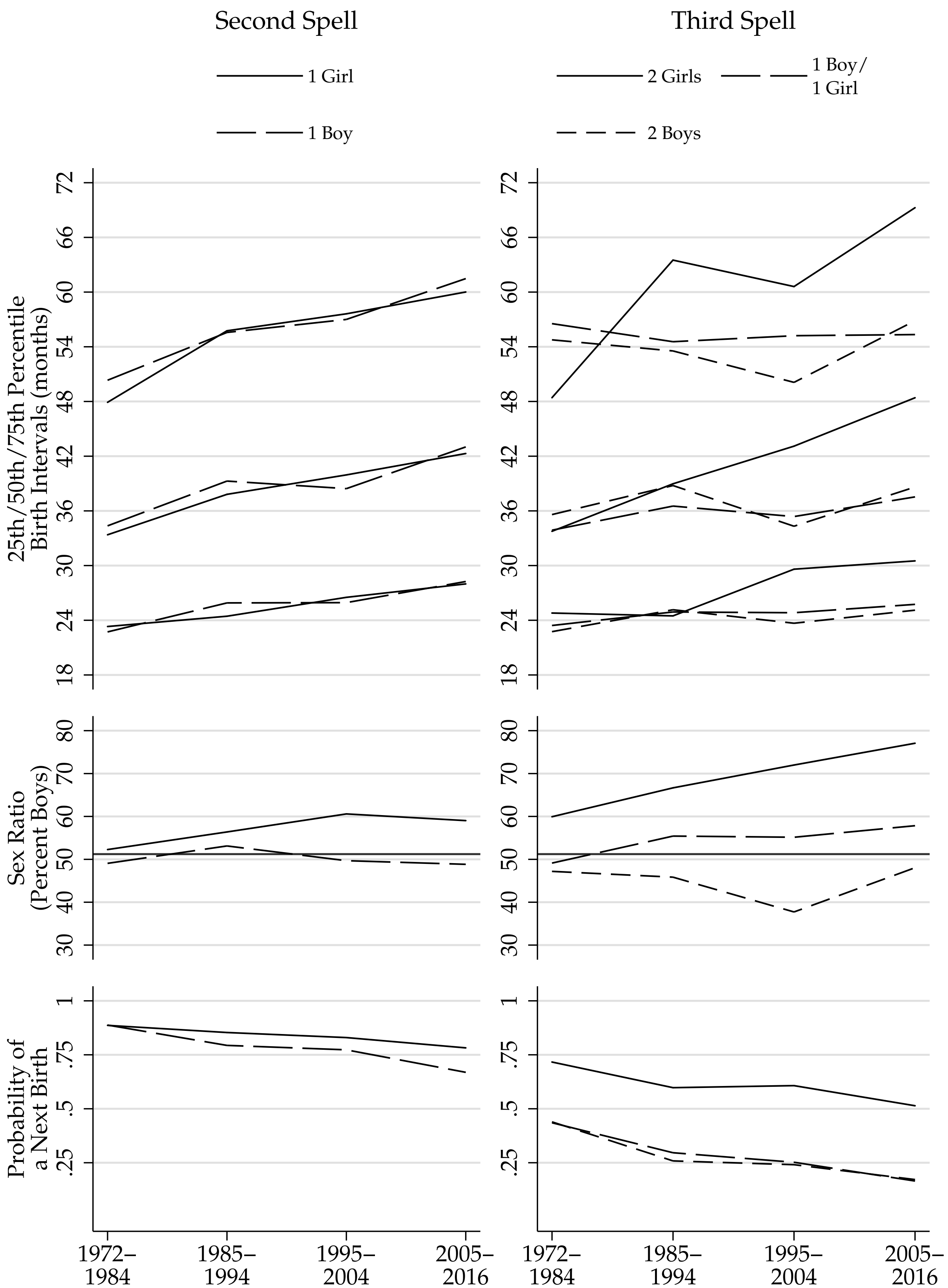


Figure 7: Percentile birth intervals, sex ratios, and parity progression for urban women with 12 or more years of education by spell, sex composition, and period

There are no clear trends for the other sex compositions. Within a given spell and period combination and in the absence of a son, sex ratios are higher the more educated the mother is and with higher parity. Sex ratios are also higher in urban than in rural areas. Some women with one son also show an unnaturally high percentage of boys, although the failing fertility makes these estimates noisy.

5.1 When Sex Selection Is Less Used

To separate the effects of the introduction of sex selection and the other changes in India, I first discuss how birth intervals have changed in situations where sex selection is less used. The group broadly covers women with no education, regardless of the sex composition of their children, and women with any education who have one or two sons already. Despite the lower level of sex selection, son preference is still evident with the shortest spacing when they have only girls. Notably, for those least likely to use sex selection—rural women with no education—the difference in birth intervals across sex compositions has grown over time as spacing when sons are present has increased.

A remarkably high proportion of birth intervals are still very short. For all but the most educated, 25% or more have their second and third child within 24 months of the previous birth. These intervals are substantially below the 24 months between *pregnancies* the WHO recommends. Furthermore, despite higher parities' more substantial increases in birth intervals, even the 25th percentile birth intervals for the fourth spell are around 24 months for women with less than eight years of education.

Median birth intervals have also increased relatively little—only three to six months over the four decades—compared to around 3.5 months *per decade* in other countries with declining fertility (Rutstein, 2011; Casterline and Odden, 2016).[11] The result is that most of the median birth intervals are still at 36 months or below, with the shortest only 29 months.

[11] The NFHS reports show median closed birth intervals of approximately 31 months, which have barely moved over time, underscoring the importance of accounting for censoring when examining birth spacing.

Birth intervals appeared to lengthen the most for women the least likely to work. For example, from lowest to highest education, the average third-spell birth intervals for urban women with one boy and one girl increased by 2.7, 3.4, 5.8, and 1.8 months over the four decades.[12] Hence, women with the lowest labor force participation—those with 8–11 years of education—also saw the largest increases in average spacing, possibly driven by the substantial improvement in household income for this group from economic growth.

The most substantial changes occurred in the 75th percentile birth intervals, where the more the parity progression probabilities declined, the more the birth interval lengthened. For example, the probability of a fourth birth for urban women with 8–11 years of education and two sons and a girl has declined by almost 40 percentage points as the 75th percentile birth interval increased by 22 months. Compare this with rural women of no education with a boy as their first child, for whom the probability of a third birth declined by fewer than six percentage points while the birth interval increased only slightly over two months.

These results are in line with prior research showing that falling fertility is associated with increases in longer spacing, although why is still an unresolved question (Casterline and Odden, 2016). The exception to this trend suggests one possible answer. For the most educated women who already have a son, the probability of a third birth declined rapidly, but the birth intervals changed little. These women both have better access to modern contraceptives and are better at using traditional contraceptive methods (Rosenzweig and Schultz, 1989).

5.2 Sex Selection and Birth Spacing

A clear illustration of how the combination of son preference and the introduction of sex selection affected birth spacing comes from the third spell of the best-educated urban

[12]For women with two sons, the numbers were 4.3, 6.3, 7.0, and 3.0. See the online appendix tables for the average birth intervals.

women. With two girls, almost 80% of the third births are boys, and the 75th percentile birth interval is close to 70 months. This interval is about 13 months longer than if they had at least one son and represents an increase of almost 21 months over the four decades.

Even more striking is that most of the change took place right at the introduction of sex selection. The 75th percentile birth interval with two girls increased from 48 months to 64 months in a decade, while the other sex compositions showed a slight decrease from around 55 months to 54 months. These changes in birth spacing may even be an underestimate because this particular group appears to have had access to sex selection even before it became widespread, as shown by the unequal sex ratio for the 1972–1984 period for women with two girls.

The 75th percentile changes are the most dramatic, but sex selection also affects the 25th and median birth intervals. For the best-educated urban women with two girls, the 25th percentile birth interval increased by six months, or 23%, while the median percentile birth interval increased by 15 months (43%).

Not surprisingly, given these effects of sex selection, the third spell for the best-educated women shows the clearest reversal in the spacing pattern; the birth intervals with two girls are consistently longer than the intervals with one or two boys, no matter the percentile used. A similar reversal, although more muted, occurred for the third spell for urban women with 1–7 years of education and both urban and rural women with 8–11 years of education.

Did the predictions of declining use of sex selection come true? There is no clear evidence for or against a reversal in the use of sex selection, with some cases showing increases in sex ratios between the last two periods, others little change, and some a decline. The best-educated women are again a good illustration. The sex ratio for women with two girls continued to increase over the last two periods, but the likelihood of a third birth declined. Furthermore, if the first child was a girl, the sex ratio for the second birth dropped slightly, as did the probability of having a second birth. However, there are also cases where there is no abatement in the increasing use of sex selection. For example, for rural women with 1–7 years of education, the sex ratios in the absence of girls continued to increase while the likelihood of an additional birth remained high.

In summary, over the four decades, birth intervals lengthened with improving economic conditions and falling fertility. These increases are larger with higher parity and higher percentile measure. Furthermore, when sex selection is less used, it appears that the women least likely to work are also those with the most substantial increases.

Sex selection, however, is behind the most substantial increases in birth spacing. The best-educated women with two girls had the most biased sex ratio and the most significant increase in birth intervals. Over the four decades, the median birth interval for this group increased by almost 15 months, and the 75th percentile birth interval increased by a staggering 21 months, most of that within a decade.

6 What Happened to Fertility?

The tempo effect from longer birth intervals means that the total fertility rate may underestimate cohort fertility. The next question I address is, therefore, to what extent did the changes bias the fertility estimates for India? To this end, I compare fertility based on a variation of the total fertility rate with predicted cohort fertility from the hazard model. Table 1 shows the two fertility measures by area of residence and education.

The fertility rate follows the same procedure as in the Demographic and Health Survey reports: I use the births from 36 to 1 month before the survey month to calculate age-specific fertility rates for five-year age groups and then sum the age-specific fertility rates multiplied by five (Croft, Marshall and Allen, 2018). However, because the hazard model predictions only use births up to parity four, I use the same set of births for the fertility rate and label it the "four-parity" fertility rate. Hence, the presented fertility rates are not directly comparable to those in the NFHS reports.

Table 1: Four-parity fertility rate versus predicted cohort fertility based on hazard model

	NFHS–1		NFHS–2	NFHS–3	NFHS–4
Fertility Rate Period	1987–1988	1992–1993	1998–1999	2005–2006	2015–2016
Hazard Model Period	1972–1984		1985–1994	1995–2004	2004–2016
			Urban		
			No Education		
Fertility Rate[a]	3.55	3.06	2.80	2.54	2.45
Hazard Model[b]	3.44		3.29	3.06	2.79
			1–7 Years of Education		
Fertility Rate[a]	2.85	2.29	2.09	1.99	2.04
Hazard Model[b]	3.18		2.88	2.62	2.42
			8–11 Years of Education		
Fertility Rate[a]	2.43	2.04	1.84	1.81	1.87
Hazard Model[b]	2.72		2.41	2.28	2.07
			12 or More Years of Education		
Fertility Rate[a]	2.05	1.68	1.57	1.55	1.51
Hazard Model[b]	2.29		2.06	1.94	1.80
			Rural		
			No Education		
Fertility Rate[a]	3.57	2.93	2.63	2.74	2.81
Hazard Model[b]	3.55		3.38	3.26	3.09
			1–7 Years of Education		
Fertility Rate[a]	3.01	2.52	2.39	2.25	2.37
Hazard Model[b]	3.29		3.08	2.83	2.70
			8–11 Years of Education		
Fertility Rate[a]	2.56	2.21	2.22	2.16	2.19
Hazard Model[b]	2.93		2.68	2.49	2.31
			12 or More Years of Education		
Fertility Rate[a]	1.95	1.68	2.13	2.08	1.96
Hazard Model[b]	2.64		2.39	2.25	2.11

Note. All predictions based on births up to and including parity four births for both fertility rate and model predictions. NFHS-1 was collected in 1992–1993, and model results for 1972–1984 were applied for the predictions. NFHS-2 was collected in 1998–1999, and model results for 1985–1994 were applied for the predictions. NFHS-3 was collected in 2005–2006, and model results for 1995–2004 were applied for the predictions. NFHS-4 was collected in 2015–2016, and model results for 2005–2016 were applied for the predictions.

[a] The fertility rate is based on five-year age groups, counting births that occurred 1–36 months before the survey months. For NFHS-1 and NFHS-2, the total number of women in the five-year age groups is based on the household roster because only ever-married women are in the individual recode sample. For NFHS-3 and NFHS-4, the total number of women is based on the individual recode sample because all women were interviewed.

[b] The model predictions for fertility are the average predicted fertility across all women in a given sample, using their age of marriage as the starting point and adding three years for each spell. Observed births are not taken into account for the predictions. For each spell, the predicted probability is the likelihood of having a next birth given sex composition multiplied with the probability of that sex composition and the likelihood of getting to the spell, corrected for the probability of sterilization.

Because NFHS-1 was after the introduction of sex selection, I cannot calculate a fertility rate in precisely the same manner for a period before sex selection was widely available. Instead, I calculate the fertility rates for women between 15 and 39 years of age five years before the survey month, again using the number of births three years before. This rate is shown as "1987–1988" in the table. Given the relatively low number of births to women 40–45 years of age, this approach provides the best estimate of the fertility rate when sex selection still was not widespread.

To predict cohort fertility based on the hazard models, I estimate the parity progression probability for each spell. Because parity progression depends on the sex composition of prior children, I estimate the probability for each sex composition and weigh the probabilities with the likelihood of the sex compositions. The survey rounds do not coincide directly with the periods used for the hazard model. Therefore, I compare the model results for 1972–1984, 1985–1994, 1995–2004, and 2005–2016 with rounds 1 through 4 of the NFHS, respectively.

I include the spell from marriage to first birth, despite the problems capturing the exact timing of marriages because the estimated progression probabilities should not be affected by this problem. I begin with the age of marriage for each woman and predict the likelihood of progressing to each parity, assuming three-years increases in age between births. Shorter assumed increases in age lead to slightly higher predicted fertility.

Sterilizations are not incorporated into the hazard model because most occur immediately after giving birth. To compensate, I estimate the probability of sterilization using a Logit model and use that to scale down the parity progression probability when predicting cohort fertility.

The predicted cohort fertility based on the hazard model is higher than the four-parity fertility rate in almost all cases. Only women with no education in the first period show little difference between the two fertility measures, a situation where fertility is high, spacing very short, and likely unchanged for an extended period.

Consistent with a more substantial bias in the fertility rate when the age of marriage and the length of birth intervals increase, the absolute bias is least in the first and the last period and highest in the middle two periods. Hence, the fertility rate declined too fast from the mid-1980s to the century's end. Only recently, as the rate of increase for the birth intervals has slowed, have the two fertility measures begun to converge again. Even with the convergence, the predicted 2005–2016 cohort fertility is still above the 1992–1993 fertility rate for every group, except urban women with no education. Furthermore, for the last period, the predicted cohort fertility remains at least 10%–20% higher than the fertility rate.

Another indication of how tempo effects bias the fertility rate bias is that the fertility rate *increases* for some groups. For example, for urban women with 8–11 years of education, the fertility rates were 1.84, 1.81, and 1.87 over the last three surveys. This pattern likely arises from the stabilization of the age of first birth and the spacing between births.

Finally, even with the declines in the predicted cohort fertility, it is still mostly above replacement. Only for urban women with 12 or more years of education is the predicted cohort fertility clearly below 2.1 children. Even then, cohort fertility is still more than 0.3 children higher than the fertility rate estimate of 1.5. Furthermore, the predicted cohort fertility numbers are likely too low because I use only the first four births and births before the imposed 105-month birth interval censoring.

7 Mortality and the Changing Birth Spacing

The final question I address is whether there is an association between infant mortality and increases in birth spacing and sex selection. Starting with the sample used for estimating birth spacing, I select children born more than 12 months before the survey month. I restrict the analyses to parities two and three because of the small number of births and deaths for parity four. Furthermore, I do not show the results for women with 12 or more years of education for the 1972–1984 period because of the small number of women.

The dependent variable is whether the child died within the first 12 months of life. The main set of explanatory variables consists of dummies for the spacing from the prior birth. The birth interval dummies cover 12-month periods, starting nine months after the prior birth, until the 57-month dummy, which covers until 105 months after the prior birth. I use dummies for sex of the index child and the sex composition of the prior children. The birth spacing dummies, the sex of index child, and the sex composition dummies are all interacted. Because the actual number of abortions is unobserved, the interactions between the sex composition of prior children and the sex of the index child serve as proxies for the use of sex selection. The other explanatory variables are the same as above, and estimations are done separately by education level and parity.

I estimate the probability of infant mortality using a Logit model. Figures 8 and 9 show the predicted probability of the second child dying within the first year at the possible combinations of index child sex, sex composition of prior children, and birth spacing, with all other variables at their average values.[13] The graphs do not show confidence intervals to improve legibility.

An important caveat is that the estimations do not address potential selection problems. For example, suppose women who have difficulties conceiving or carrying a pregnancy to term also have a higher mortality risk for their offspring. In that case, a spurious correlation between long birth spacing and mortality may arise (Kozuki and Walker, 2013). Unfortunately, methods to address selection, such as family fixed effects, do not work well when the number of births is as low as for better-educated women (Kozuki and Walker, 2013; Molitoris et al., 2019). However, the fixed effects and linear probability results did not deviate substantially in prior research.

There has been substantial convergence in mortality risk across groups over time. For intervals 21 months or longer, there is now little difference across the education groups,

[13]The online appendix shows the corresponding graphs for the third child.

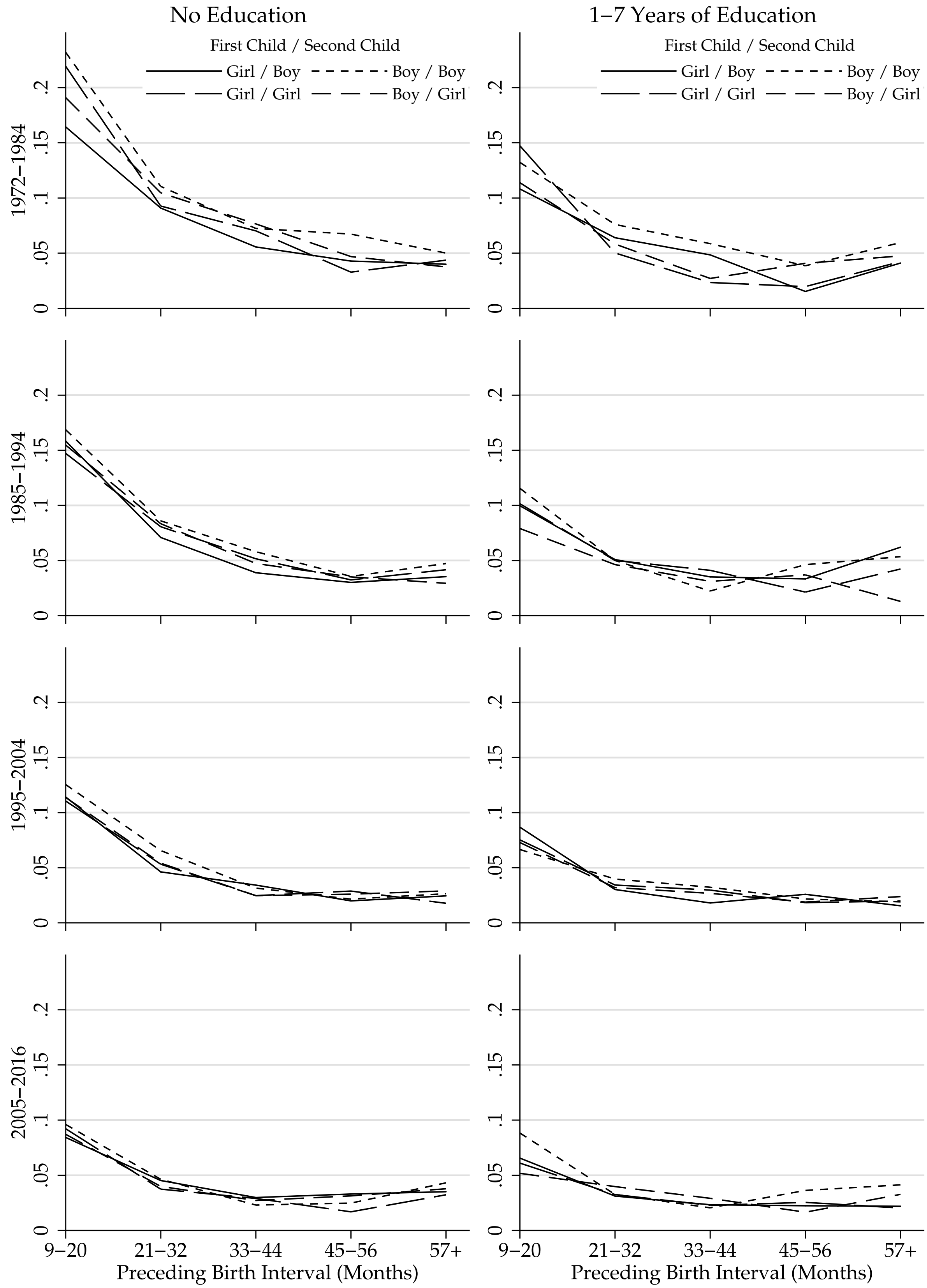


Figure 8: Infant mortality by preceding birth interval across periods for second child of women with no education and women with 1–7 years of education

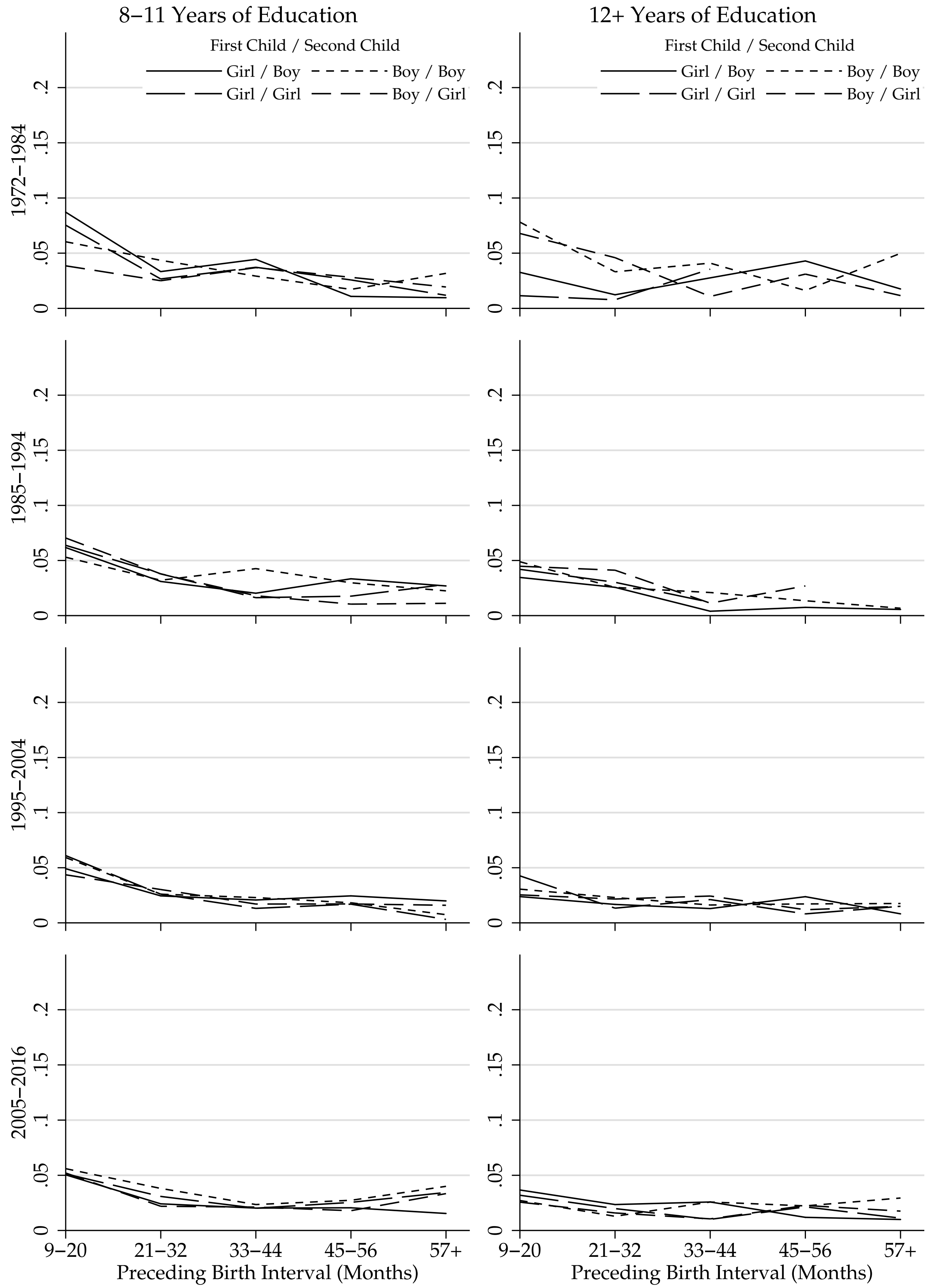


Figure 9: Infant mortality by preceding birth interval across periods for second child of women with 8–11 and 12 and above years of education

with even the no-education group showing an infant mortality risk below 5%.

Very short birth intervals still exhibit a higher mortality risk, although the effect declines with education level. For the best-educated women, the mortality risk is 3%–4%, whereas women with no education still show a risk that is close to 10%.

Despite the prior findings of differential mortality by sex, there is little evidence that girls have substantially higher mortality risk. There is some weak evidence that a boy born after a girl has a lower mortality risk in the earliest periods. However, this difference disappears with the general decline in mortality risk.

Despite the concern that multiple abortions might increase mortality risk by shortening the interval between pregnancies, there is no evidence for this effect. Suppose sex-selective abortions lead to higher mortality risk. In that case, boys born after a girl—the solid lines—should have an increased risk with longer spacing for the two highest education groups in the last two periods. However, there are no apparent consistent differences between these groups and the other potential combinations. The same holds for the third spell.

The raw numbers for women with the most uneven sex ratio also suggest that even with very high use of sex selection, there is no impact on mortality. A total of 1,004 women with 12 or more years of education and no boys at the start of the third spell in the last period had a third child, of which 685 were boys. Of these 685 boys, only six died within the first year of life. Half of those who died were born in the 9–32-month interval, and none in the 57-month+ interval.

8 Conclusion

Over the past four decades, India saw a dramatic increase in the male-to-female sex ratio at birth as access to sex selection spread and son preference remained high. Simultaneously, economic growth was strong, schooling increased, and the total fertility rate fell to close to the replacement level.

The main question I address in this paper is how birth spacing responded to the significant changes in India between 1972 and 2016, particularly the spread of sex selection. I also examine two related questions. First, did the changes in birth spacing bias the standard fertility estimates for India? Second, what is the relationship between infant mortality and the changes in birth spacing and sex selection?

The most substantial lengthening of birth intervals came from the best-educated women because of their substantial use of sex selection combined with falling fertility. Take, for example, women with 12 or more years of education who had two girls. As the sex ratio increased to close to 80% boys, the expected median birth interval increased by almost 15 months, and the 75th percentile interval increased by 21 months. Most of the increase in the long intervals came immediately after the introduction of sex selection in India.

Some of these increases are so large that we even observed a reversal of the traditional spacing pattern for some groups; when there are no sons, we now see the longest, rather than the shortest, birth intervals because of sex selection. The women who are the least likely to use sex selection still show the traditional spacing pattern with short spacing in the absence of sons.

Son preference continues to show in fertility decisions. Fertility has declined for all groups, but the likelihood of having an additional child still depends strongly on the number of sons, with women with no sons having the highest parity progression probabilities.

Birth intervals also lengthened in cases when sex selection is less likely to be used. However, compared to other countries with similar declines in fertility, the median spacing increases were smaller at three to six months over the period. Most of the median intervals when sex selection is less used are still short at 36 months or below. Furthermore, many women still have very short birth intervals. In many cases, more than 25% have their next child within 24 months of the previous birth.

Despite predictions that the use of sex selection would decline, there is no clear evidence of this. The original users of sex selection continue to show substantial male-biased sex ratios, although there may be some leveling off. More concerning, sex selection appears to be spreading to less educated women as their fertility is falling.

The increases in spacing make the total fertility rate a more biased measure of cohort fertility. This bias was most prominent early in the spread of sex selection when the fertility rate was up to one child lower than the predicted cohort fertility. However, it is still present, with the predicted cohort fertility 10%–20% higher than the fertility rate. At 1.8 children, the best-educated urban women are the only group for whom the predicted cohort fertility is below replacement.

Tempo effects are studied extensively in the literature (see, for example, Bongaarts, 1999). Still, there are, to my knowledge, no other cases where there has been as substantial an increase in birth intervals and associated bias in fertility rates as for India. It is conceivable that we might see increases in the total fertility rate as birth spacing stabilizes or even shortens again if interventions against sex selection are successful.

There has been a substantial reduction in infant mortality over time, and the size of the reductions is inversely related to the mother's education. Hence, there is now little difference in mortality risk across education groups if the birth took place more than 21 months from the prior birth. Short birth spacing is still associated with higher mortality, although the effect is small for the best-educated women. There is no evidence that repeated abortions are associated with higher infant mortality for the child eventually born.

The results here paint a less rosy picture of India's prospects for a continued reduction in population growth than generally accepted. With predicted cohort fertility still substantially higher than the fertility rate, India's total fertility rate will likely stabilize or even increase as birth intervals slow their lengthening. The more successful the attempts at combatting sex selection are, the more likely an increase in the total fertility rate will be. Furthermore, the rapid decline in infant mortality risk, combined with likely future declines as the proportion of very short birth intervals falls, may also slow the reduction in population growth.

There are two critical questions that future research should address. First, sex selection means that girls-only families are less likely to have very short birth intervals, which may reduce sibling competition. Hence, better health outcomes for girls with sex selection could be an unintended side-effect, rather than the result of girls becoming more valued as is often assumed (Hu and Schlosser, 2015). Comparing prior children's outcomes across sex composition and the sex of the next child could be a way to understand why girls' health outcomes improve in the presence of sex selection.

Second, what is the relationship between female labor force participation and sex selection? Women may be staying out of the labor market precisely because sex selection makes them more likely to have a boy and increases the expected birth spacing. Better job opportunities for women would affect sex selection for two reasons. First, it makes it more expensive to be out of the labor market for long periods. Second, it would moderate the differential in potential earnings between husband and wife and make it more attractive to invest in daughters' human capital. This approach could, however, be a double-edged sword. If better job opportunities further lower fertility, the use of sex selection may increase, everything else being equal. Understanding the trade-off between long-term benefits from improvements in women's labor force participation and short-term costs from potential increases in sex selection is of paramount importance.

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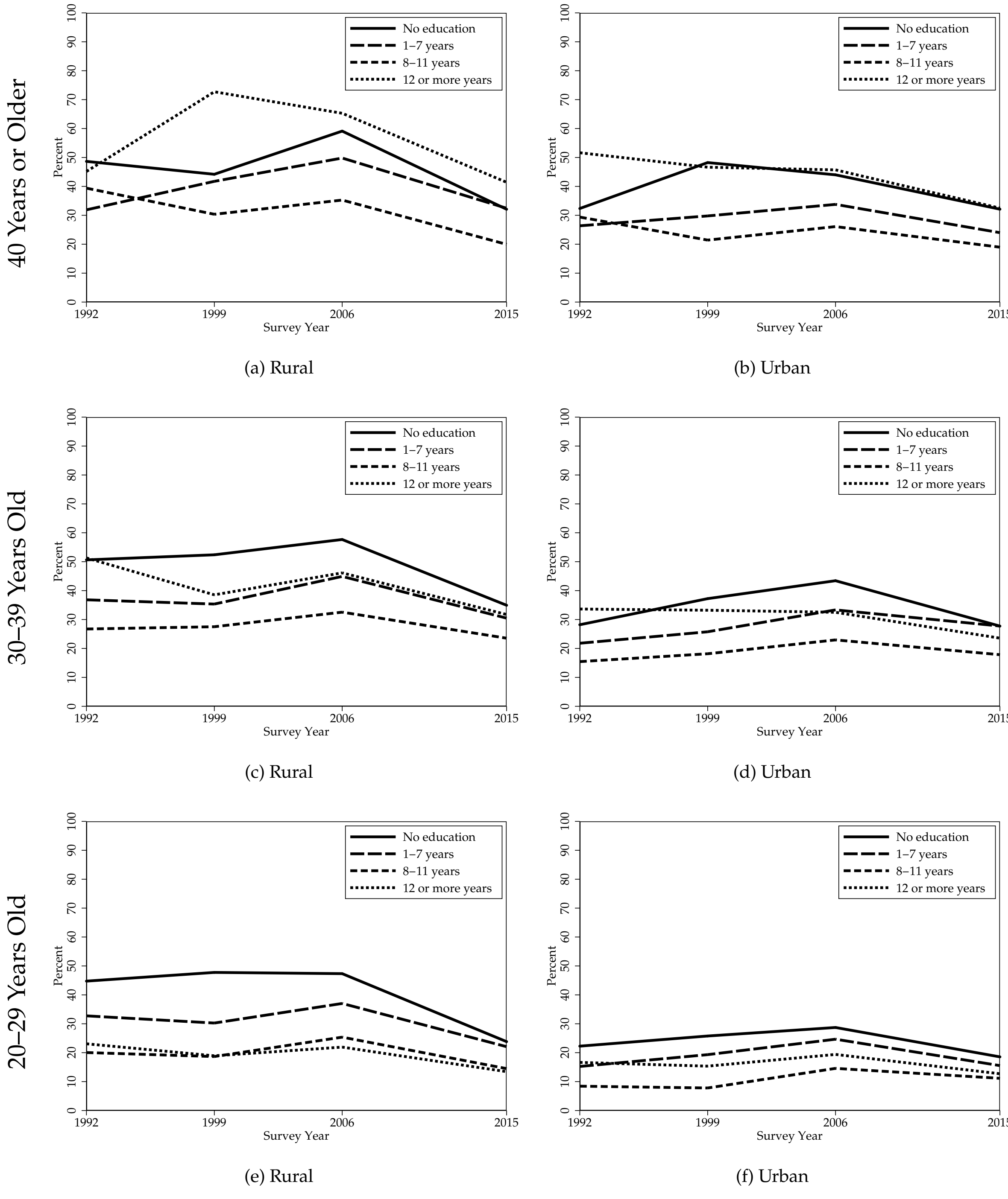
Appendices for Online Publication

These appendices are intended for online publication. They provide the descriptive statistics, additional estimated duration tables, and graphs for all education groups and spells.

A Characteristics of Women's Work Experiences

Figure A.1 shows the percent of married women who are currently working at the time of the survey by age group and education level. No other labor force participation question is consistently available across all four surveys. Because the question refers to currently working, the percentages are lower in previous studies.

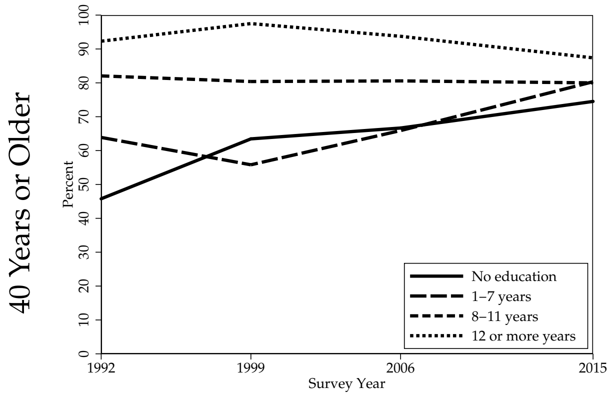


(a) Rural (b) Urban

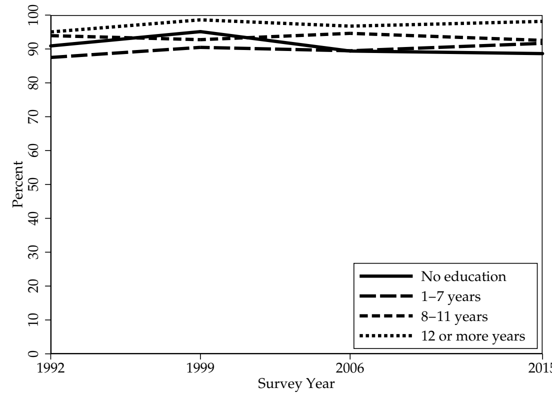
(c) Rural (d) Urban

(e) Rural (f) Urban

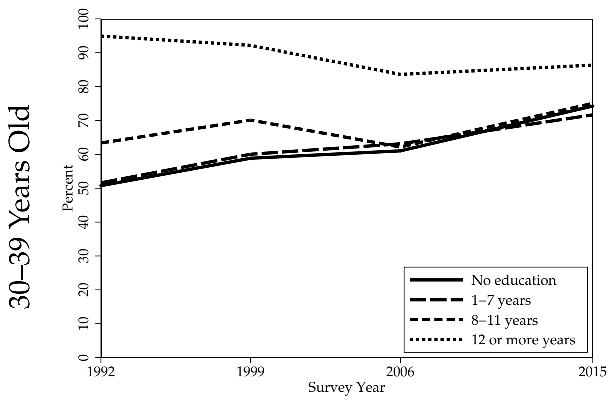
Figure A.1: Percentage of married women who were working at the time of the survey by age group and area of residence



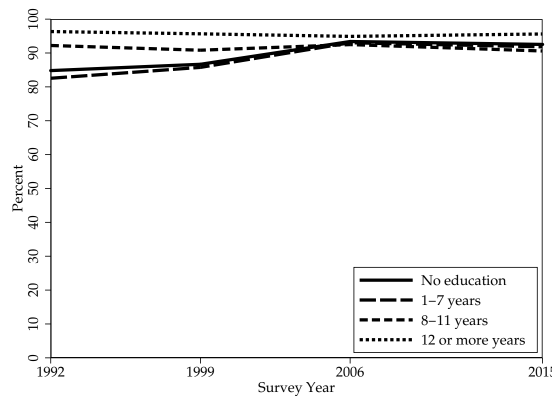
(a) Rural



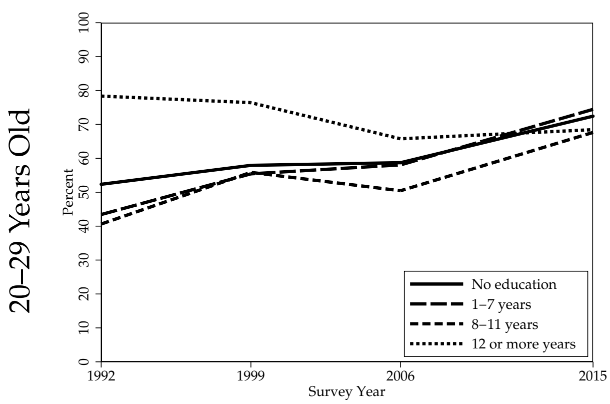
(b) Urban



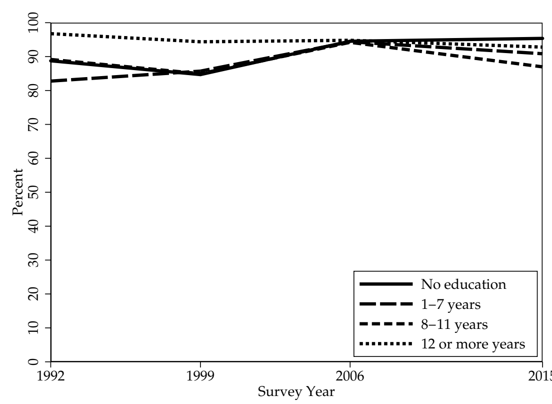
(c) Rural



(d) Urban

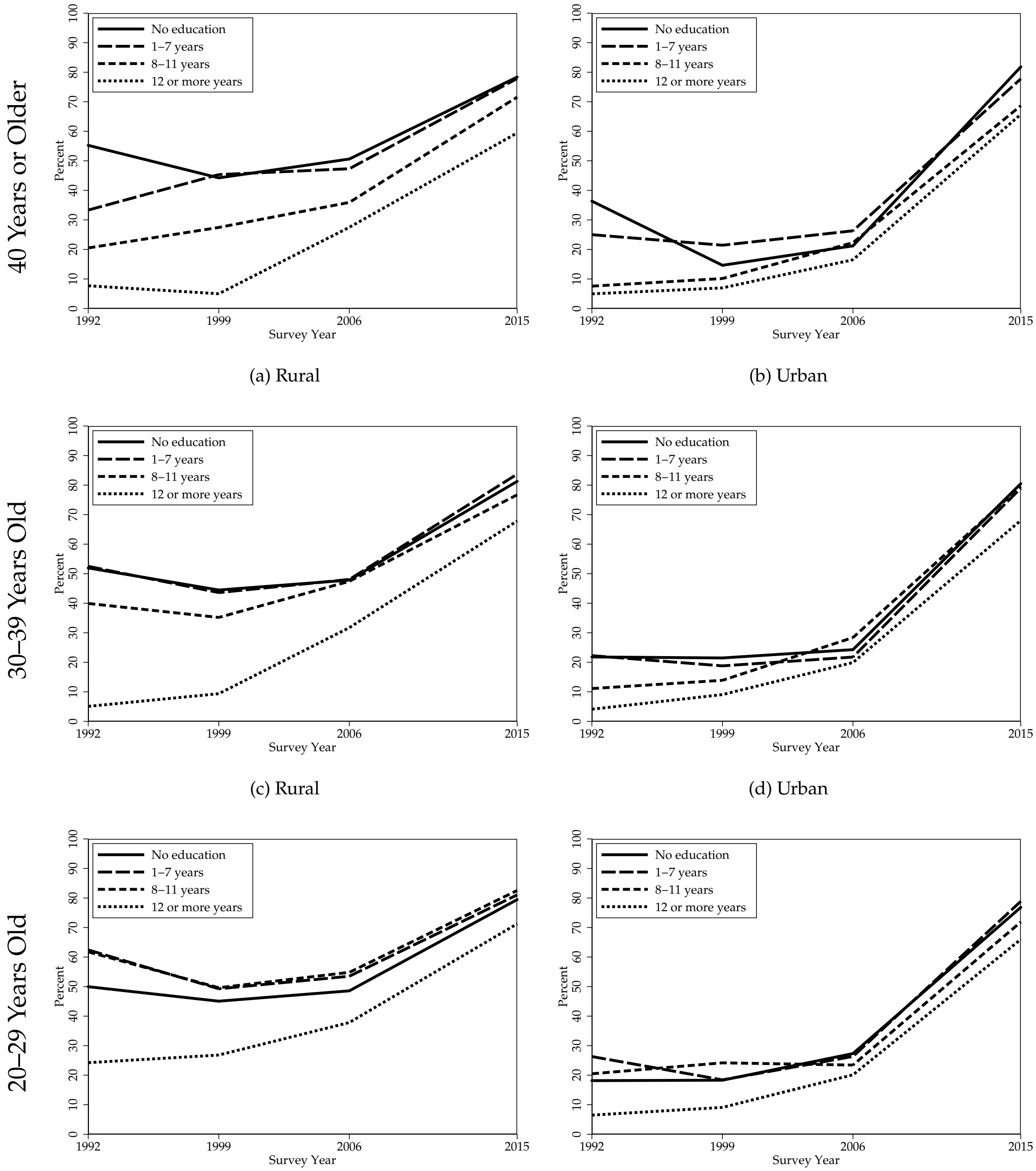


(e) Rural



(f) Urban

Figure A.2: Percentage of women paid cash or cash and in-kind of those women who were working at the time of the survey by age group and area of residence



(a) Rural (b) Urban

(c) Rural (d) Urban

(e) Rural (f) Urban

Figure A.3: Percentage women who worked for a family member of those working at the time of the survey, by age group and area of residence

B Empirical Model Details

The model is a discrete time, nonproportional, competing risk hazard model with two exit states: Either a boy or a girl is born. The unit of analysis is a spell, the period from nine months after one birth to the next. For each woman, $i = 1, \dots, n$, the starting point for a spell is time $t = 1$, and the spell continues until time t_i, when either a birth occurs or the spell is censored.[14] There are two exit states: The birth of a boy, $j = 1$, or the birth of a girl, $j = 2$, and J_i is a random variable indicating which event took place. The discrete time hazard rate h_{ijt} is

$$h_{ijt} = \frac{\exp(D_j(t) + \alpha'_{jt}\mathbf{Z}_{it} + \beta'_j\mathbf{X}_i)}{1 + \sum_{l=1}^{2} \exp(D_j(t) + \alpha'_{lt}\mathbf{Z}_{it} + \beta'_l\mathbf{X}_i)} \quad j = 1, 2 \tag{3}$$

where the explanatory variable vectors, $\mathbf{Z}_{it}$ and $\mathbf{X}_i$, capture individual, household, and community characteristics, and $D_j(t)$ is the piece-wise linear baseline hazard for outcome j, captured by dummies and the associated coefficients,

$$D_j(t) = \gamma_{j1}D_1 + \gamma_{j2}D_2 + \dots + \gamma_{jT}D_T, \tag{4}$$

with $D_m = 1$ if $t = m$ and zero otherwise. This approach to modeling the baseline hazard is flexible and does not place overly strong restrictions on the baseline hazard.

The explanatory variables in **Z**, and the interactions between them, constitute the nonproportional part of the model, which means that they are interacted with the baseline hazard:

$$\mathbf{Z}_{it} = D_j(t) \times (\mathbf{Z}_1 + Z_2 + \mathbf{Z}_1 \times Z_2), \tag{5}$$

where $D_j(t)$ is the piece-wise linear baseline hazard, $\mathbf{Z}_1$ captures sex composition of previous children, if any, and Z_2 captures area of residence. The remaining explanatory variables, **X**, enter proportionally, but to further minimize any potential bias from assuming proportionality, estimations are done separately for different levels of mothers' education and different periods.

Equation (3) is equivalent to the logistic hazard model and has the same likelihood function as the multinomial logit model (Allison, 1982; Jenkins, 1995). Hence, transforming the data, so each observation is an interval—here equal to three months—the model can be estimated using a standard multinomial logit model.

The distribution of spacing is captured by the survival curve, which shows the prob-

[14] The time of censoring is assumed independent of the hazard rate, as is standard in the literature.

ability of not having had a birth yet by spell duration, for a given set of explanatory variables. The survival curve at time t is

$$S_t = \prod_{d=1}^{t} \left(\frac{1}{1 + \sum_{l=2}^{2} \exp(D_j(t) + \alpha'_{ld}\mathbf{Z}_{kd} + \beta'_l \mathbf{X}_k)} \right). \tag{6}$$

Interpretation of the model coefficients is challenging (Thomas, 1996). It is, however, possible to calculate the predicted probabilities of having a boy, b, and of having a girl, g, in period t, conditional on a set of explanatory variables and not having had a child before that period, as

$$P(b_t|\mathbf{X}_k, \mathbf{Z}_{kt}, t) = \frac{\exp(D_j(t) + \alpha'_{1t}\mathbf{Z}_{kt} + \beta'_1 \mathbf{X}_k)}{1 + \sum_{l=1}^{2} \exp(D_j(t) + \alpha'_{lt}\mathbf{Z}_{kt} + \beta'_l \mathbf{X}_k)} \tag{7}$$

$$P(g_t|\mathbf{X}_k, \mathbf{Z}_{kt}, t) = \frac{\exp(D_j(t) + \alpha'_{2t}\mathbf{Z}_{kt} + \beta'_2 \mathbf{X}_k)}{1 + \sum_{l=2}^{2} \exp(D_j(t) + \alpha'_{lt}\mathbf{Z}_{kt} + \beta'_l \mathbf{X}_k)} \tag{8}$$

It is then straightforward to calculate the estimated percentage of children born that are boys, $\hat{Y}$, at each t:

$$\hat{Y}_t = \frac{P(b_t|\mathbf{X}_k, \mathbf{Z}_{kt}, t)}{P(b_t|\mathbf{X}_k, \mathbf{Z}_{kt}, t) + P(g_t|\mathbf{X}_k, \mathbf{Z}_{kt}, t)} \times 100. \tag{9}$$

Combining the percentage boys and the likelihood of exiting the spell across all t gives the predicted percent boys born over the entire spell.[15]

[15] Imagine $T = 2$. If 54% and 66% of births are boys and the likelihood of giving birth 20% and 40%, then the predicted sex ratio is $\frac{54*0.2+66*0.4}{0.2+0.4} = 62\%$ boys.

C Recall Error and the Sex Ratio

The reliability of the results depends on the correctness of the birth histories provided by the respondents. A significant concern here is underreporting of child mortality, especially a systematic recall error where respondents' likelihood of reporting a deceased child depends on the sex of that child. This appendix section assesses the degree of recall error across the surveys and discusses methods to address it.

NFHS enumerators probe for any missed births, although the method depends on the survey. NFHS-1 probe for each calendar birth interval that is four or more years. NFHS-2 asked for stillbirths, spontaneous and induced abortions and also probed for each calendar birth interval four or more years. NFHS-3 and NFHS-4 did not directly use birth intervals, but asked whether there were any other live births between (name of previous birth) and (name), including any children who died after birth, and asked for births before the birth listed as first birth and after the last birth listed as the last birth.

Probing catches many initially missed births, but systematic recall error based on son preference may still be a problem. First, son preference leads to significantly higher mortality for girls than boys. Secondly, son preference makes it more likely that parents will remember deceased boys than deceased girls. Finally, in the absence of sex-selective abortions, parents with a preference for sons may have the next birth sooner if the last child was a girl than if it was a boy. If this girl subsequently dies, she is more likely to be missed if probing for missed births is only done for long intervals as in NFHS-1 and NFHS-2.

I use two approaches to examine the degree of recall error. The first approach is to test whether the observed sex ratio is significantly different from the natural sex ratio. The natural sex ratio is approximately 105 boys to 100 girls or 51.2% (Ben-Porath and Welch, 1976; Jacobsen et al., 1999; Pörtner, 2015). Prenatal sex determination techniques did not become widely available until the mid-1980s, so any significant deviation from the natural sex ratio before that time is likely the result of recall error. The second approach is to compare births that took place during the same period but where captured in different surveys. Recall error is likely to increase with time, so births and deaths that took place earlier are more likely to be subject to recall error than more recent events.

Table C.1 shows the sex ratios of children recorded as first-born by year of birth, together with tests for whether the observed sex ratio is significantly higher than the natural sex ratio and whether more recent surveys have a higher sex ratio for the cohort than earlier surveys for the same period births. Births are combined into five-year cohorts to achieve sufficient power.

The "first-born" sex ratios illustrate the systematic recall error problem well. In all four

Table C.1: Observed Ratio of Boys for Children Listed as First-born by Year of Birth in Five-Year Cohorts

	NFHS-1 1992–1993	NFHS-2 1998–1999	NFHS-3 2005–2006	NFHS-4 2015–2016	Diff. test[a]
1960–1964	0.5430***	.	.	.	
	(0.0007)	(.)	(.)	(.)	
	[2,744]	[.]	[.]	[.]	
1965–1969	0.5295***	0.5500***	.	.	A
	(0.0052)	(0.0004)	(.)	(.)	
	[5,551]	[2,011]	[.]	[.]	
1970–1974	0.5365***	0.5329***	0.5432*	.	
	(0.0000)	(0.0011)	(0.0851)	(.)	
	[7,898]	[5,543]	[521]	[.]	
1975–1979	0.5206*	0.5151	0.5257*	.	
	(0.0577)	(0.3126)	(0.0512)	(.)	
	[8,913]	[7,455]	[3,738]	[.]	
1980–1984	0.5213**	0.5240**	0.5271***	0.5567***	CEF
	(0.0272)	(0.0104)	(0.0048)	(0.0000)	
	[11,241]	[9,618]	[7,646]	[4,135]	
1985–1989	0.5180	0.5134	0.5121	0.5562***	CEF
	(0.1095)	(0.4060)	(0.5080)	(0.0000)	
	[11,293]	[10,912]	[9,345]	[22,243]	
1990–1994	0.5197	0.5193*	0.5176	0.5481***	CEF
	(0.1150)	(0.0643)	(0.1357)	(0.0000)	
	[6,523]	[11,457]	[10,475]	[41,624]	
1995–1999	.	0.5237**	0.4980	0.5322***	EF
	(.)	(0.0171)	(0.9986)	(0.0000)	
	[.]	[8,514]	[10,996]	[50,480]	
2000–2004	.	.	0.5123	0.5214***	F
	(.)	(.)	(0.4924)	(0.0000)	
	[.]	[.]	[10,743]	[56,853]	
2005–2009	.	.	0.5171	0.5182***	
	(.)	(.)	(0.3160)	(0.0017)	
	[.]	[.]	[2,537]	[59,383]	
2010–2016	.	.	.	0.5197***	
	(.)	(.)	(.)	(0.0000)	
	[.]	[.]	[.]	[73,474]	

Note. Sample consists of Hindu women only. First number in cell is ratio of boys to children. Second number, in parentheses, is p-value for the hypothesis that observed sex ratio is greater than 105/205 using a binomial probability test (bitest in Stata 13) with significance levels: * sign. at 10%; ** sign. at 5%; *** sign. at 1%. Third number, in square brackets, is number of observations.

[a] Test (prtest in Stata 13) whether recall error increases with time passed, which would manifest itself in a higher sex ratio for a more recent survey than an earlier for the same cohort. A: Cohort sex ratio significantly larger in NFHS-2 than NFHS-1 at the 10% level. B: Cohort sex ratio significantly larger in NFHS-3 than NFHS-1 at the 10% level. C: Cohort sex ratio significantly larger in NFHS-4 than NFHS-1 at the 10% level. D: Cohort sex ratio significantly larger in NFHS-3 than NFHS-2 at the 10% level. E: Cohort sex ratio significantly larger in NFHS-4 than NFHS-2 at the 10% level. F: Cohort sex ratio significantly larger in NFHS-4 than NFHS-3 at the 10% level.

surveys around 55% of children reported as first-born are boys for the first cohort of births observed. Given that these cohorts cover from 1960-1964 to 1980-1984, which is before sex selection techniques became available in India, the most likely explanation for the skewed sex ratio is that some children listed as first-borns were not, in fact, the first children born in their families. Instead, for a substantial proportion of families, their first-born was a girl who died and went unreported when enumerators asked about birth history.

As expected, the difference between the observed sex ratio and the natural sex ratio is less pronounced the closer to the survey date the cohort is. The observed sex ratio for children born just before the NFHS-1 survey and listed as first-born is 0.517, which is not statistically significantly different from the natural sex ratio. The same general pattern holds for the other three surveys, with cohorts further away from the survey date more likely to have a sex ratio skewed male.

Finally, across surveys, the same cohort tends to show a higher sex ratio the more recent the survey (births in the cohort took place earlier relative to the survey date). Despite this, few cohorts show significantly different sex ratios across surveys, most likely because of a lack of power. The exception is that comparisons involving NFHS-4 are mostly statistically significant since the number of surveyed households in NFHS-4 were much larger than in prior surveys.

The problem with the above approach is that the year of birth is affected by recall error; a second born child listed as first-born is born later than the real first born child. Year of marriage should, however, be affected neither by parental recall error nor the use of sex-selective abortions. Tables C.2 and C.3, therefore, shows sex ratios of children recorded as first-born and second-born by year of parents' marriage, together with tests for whether the observed sex ratio is significantly higher than the natural sex ratio and whether more recent surveys show a higher sex ratio for the cohort than earlier surveys. The basic recall error pattern remains, with women married longer ago more likely to report that their first-born is a boy. Similarly, comparing women married in the same five-year period across surveys shows that women married longer ago are more likely to report having a son.

The relationship between the length of marriage and recall error can also be seen in Figures C.1 and C.2, which show the observed sex ratio for children reported as first born as a function of the duration of marriage at the time of the survey. The solid line is the sex ratio of children reported as first-born by the number of years between the survey and marriage, while the dashed lines indicate the 95% confidence interval and the horizontal line the natural sex ratio (approximately 0.512). To ensure sufficient cell sizes I group years into twos. In line with the results from Tables C.2 and C.3, the observed ratio of boys is increasingly above the expected value the longer ago the parents were married.

Table C.2: Observed Ratio of Boys for Children Listed as First-born by Year of Parents' Marriage in Five-Year Cohorts

	NFHS-1 1992–1993	NFHS-2 1998–1999	NFHS-3 2005–2006	NFHS-4 2015–2016	Diff. test[a]
1960–1964	0.5364***	.	.	.	
	(0.0001)	(.)	(.)	(.)	
	[6,298]	[.]	[.]	[.]	
1965–1969	0.5357***	0.5431***	.	.	
	(0.0001)	(0.0000)	(.)	(.)	
	[6,801]	[4,279]	[.]	[.]	
1970–1974	0.5242**	0.5223*	0.5269	.	
	(0.0150)	(0.0526)	(0.1010)	(.)	
	[8,274]	[6,527]	[1,953]	[.]	
1975–1979	0.5269***	0.5203*	0.5314***	0.5617***	CDEF
	(0.0017)	(0.0666)	(0.0019)	(0.0005)	
	[9,956]	[8,602]	[5,749]	[1,127]	
1980–1984	0.5152	0.5133	0.5192	0.5512***	CEF
	(0.2658)	(0.4166)	(0.1023)	(0.0000)	
	[10,894]	[9,805]	[8,237]	[12,033]	
1985–1989	0.5176	0.5210**	0.5094	0.5530***	CEF
	(0.1409)	(0.0339)	(0.7148)	(0.0000)	
	[10,017]	[10,825]	[9,620]	[33,241]	
1990–1994	0.5237	0.5196*	0.5119	0.5405***	CEF
	(0.1460)	(0.0663)	(0.5315)	(0.0000)	
	[2,198]	[10,464]	[10,458]	[45,940]	
1995–1999	.	0.5257**	0.5019	0.5254***	F
	(.)	(0.0292)	(0.9846)	(0.0000)	
	[.]	[5,007]	[10,863]	[52,679]	
2000–2004	.	.	0.5166	0.5207***	
	(.)	(.)	(0.2022)	(0.0000)	
	[.]	[.]	[9,119]	[56,143]	
2005–2009	.	.	.	0.5204***	
	(.)	(.)	(.)	(0.0000)	
	[.]	[.]	[.]	[58,511]	
2010–2016	.	.	.	0.5176***	
	(.)	(.)	(.)	(0.0091)	
	[.]	[.]	[.]	[48,481]	

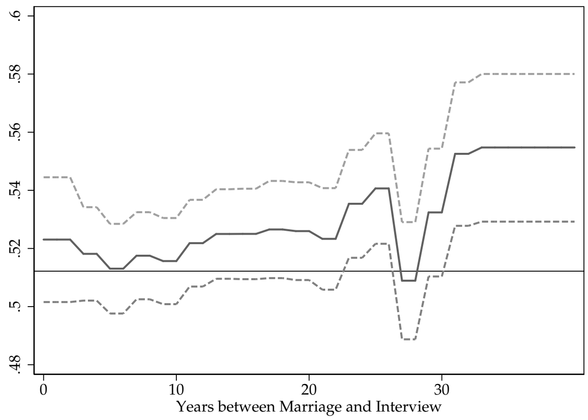
Note. Sample consists of Hindu women only. First number in cell is ratio of boys to children. Second number, in parentheses, is p-value for the hypothesis that observed sex ratio is greater than 105/205 using a binomial probability test (bitest in Stata 13) with significance levels: * sign. at 10%; ** sign. at 5%; *** sign. at 1%. Third number, in square brackets, is number of observations. [a] Test (prtest in Stata 13) whether recall error increases with time passed, which would manifest itself in a higher sex ratio for a more recent survey than an earlier for the same cohort. A: Cohort sex ratio significantly larger in NFHS-2 than NFHS-1 at the 10% level. B: Cohort sex ratio significantly larger in NFHS-3 than NFHS-1 at the 10% level. C: Cohort sex ratio significantly larger in NFHS-4 than NFHS-1 at the 10% level. D: Cohort sex ratio significantly larger in NFHS-3 than NFHS-2 at the 10% level. E: Cohort sex ratio significantly larger in NFHS-4 than NFHS-2 at the 10% level. F: Cohort sex ratio significantly larger in NFHS-4 than NFHS-3 at the 10% level.

Table C.3: Observed Ratio of Boys for Children Listed as Second-born by Year of Parents' Marriage' in Five-Year Cohorts

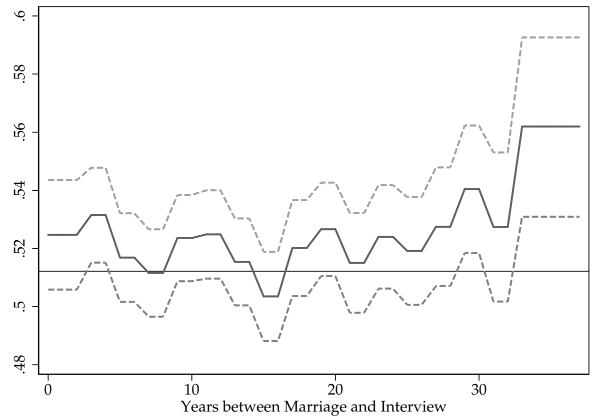
	NFHS-1 1992–1993	NFHS-2 1998–1999	NFHS-3 2005–2006	NFHS-4 2015–2016	Diff. test[a]
1960–1964	0.5264**	.	.	.	
	(0.0135)	(.)	(.)	(.)	
	[6,113]	[.]	[.]	[.]	
1965–1969	0.5269***	0.5378***	.	.	
	(0.0090)	(0.0005)	(.)	(.)	
	[6,571]	[4,163]	[.]	[.]	
1970–1974	0.5192	0.5220*	0.5374**	.	B
	(0.1085)	(0.0619)	(0.0148)	(.)	
	[7,984]	[6,307]	[1,898]	[.]	
1975–1979	0.5147	0.5198*	0.5287***	0.5453**	BCE
	(0.3143)	(0.0850)	(0.0072)	(0.0172)	
	[9,469]	[8,288]	[5,582]	[1,049]	
1980–1984	0.5213**	0.5173	0.5170	0.5346***	CEF
	(0.0348)	(0.1650)	(0.1984)	(0.0000)	
	[9,932]	[9,343]	[7,866]	[11,513]	
1985–1989	0.5133	0.5178	0.5251***	0.5301***	BCE
	(0.4376)	(0.1312)	(0.0074)	(0.0000)	
	[5,901]	[10,036]	[9,035]	[31,639]	
1990–1994	0.4362	0.5197*	0.5256***	0.5274***	ABC
	(0.9737)	(0.0926)	(0.0045)	(0.0000)	
	[149]	[7,918]	[9,555]	[43,344]	
1995–1999	.	0.5630***	0.5312***	0.5230***	
	(.)	(0.0007)	(0.0002)	(0.0000)	
	[.]	[1,016]	[8,940]	[49,053]	
2000–2004	.	.	0.5252*	0.5199***	
	(.)	(.)	(0.0688)	(0.0003)	
	[.]	[.]	[3,307]	[50,804]	
2005–2009	.	.	.	0.5231***	
	(.)	(.)	(.)	(0.0000)	
	[.]	[.]	[.]	[46,164]	
2010–2016	.	.	.	0.5218**	
	(.)	(.)	(.)	(0.0110)	
	[.]	[.]	[.]	[14,370]	

Note. Sample consists of Hindu women only. First number in cell is ratio of boys to children. Second number, in parentheses, is p-value for the hypothesis that observed sex ratio is greater than 105/205 using a binomial probability test (bitest in Stata 13) with significance levels: * sign. at 10%; ** sign. at 5%; *** sign. at 1%. Third number, in square brackets, is number of observations.

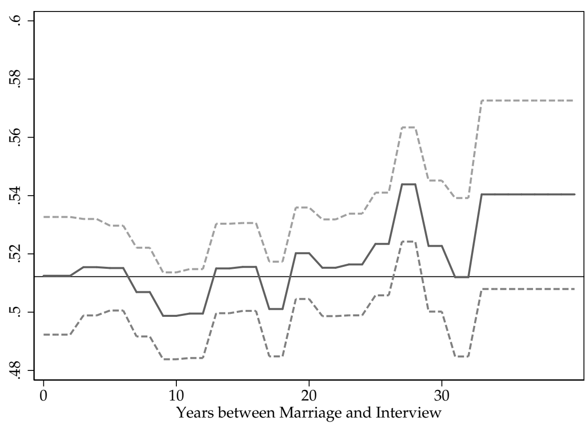
[a] Test (prtest in Stata 13) whether recall error increases with time passed, which would manifest itself in a higher sex ratio for a more recent survey than an earlier for the same cohort. A: Cohort sex ratio significantly larger in NFHS-2 than NFHS-1 at the 10% level. B: Cohort sex ratio significantly larger in NFHS-3 than NFHS-1 at the 10% level. C: Cohort sex ratio significantly larger in NFHS-4 than NFHS-1 at the 10% level. D: Cohort sex ratio significantly larger in NFHS-3 than NFHS-2 at the 10% level. E: Cohort sex ratio significantly larger in NFHS-4 than NFHS-2 at the 10% level. F: Cohort sex ratio significantly larger in NFHS-4 than NFHS-3 at the 10% level.



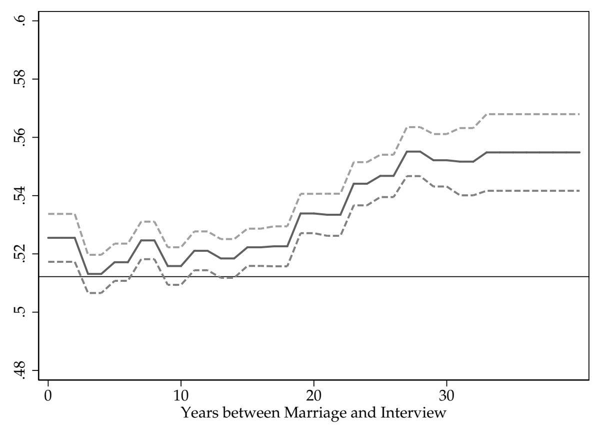
(a) NFHS-1



(b) NFHS-2



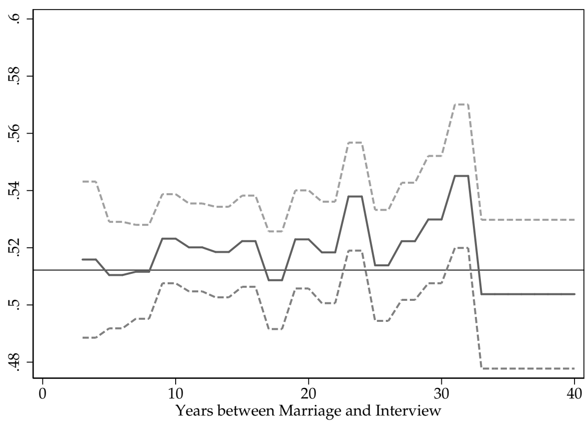
(c) NFHS-3



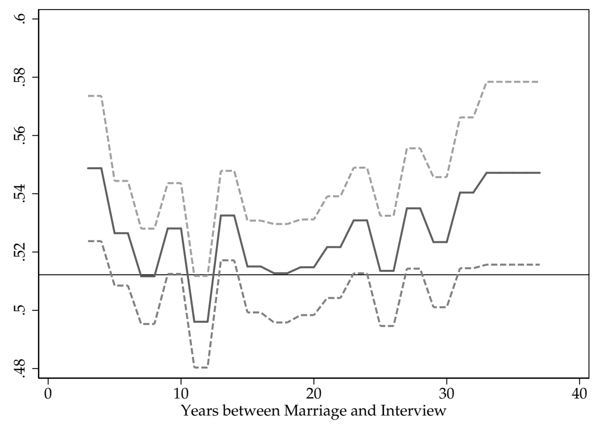
(d) NFHS-4

Figure C.1: Ratio of Boys for "First" Births by Survey Round

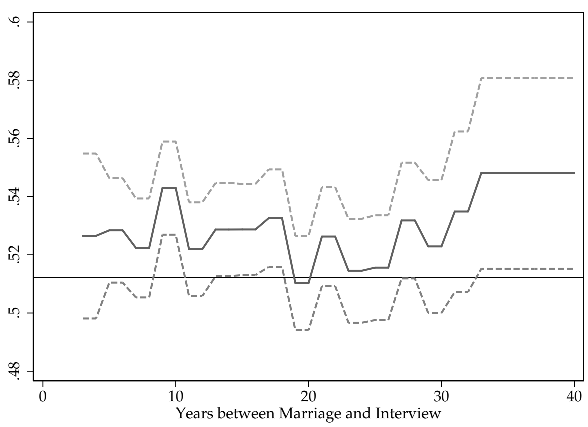
The increasingly unequal sex ratio with increasing marriage duration suggests that a solution to the recall error problem is to drop observations for women who were married "too far" from the survey year. The main problem is establishing what the best cut-off point should be, with the trade-off between retaining enough observations and the correctness of the information. As Tables C.2 and C.3 show, there are differences in recall error across the three surveys and between the two birth orders, although this may be the result of differences in the number of observations across surveys. Furthermore, the recall error pattern is not entirely consistent across observed birth orders. Since most of the surveys start showing significantly biased sex ratio from around 22 years of marriage on, I drop all observations where the marriage took place 22 years or more.



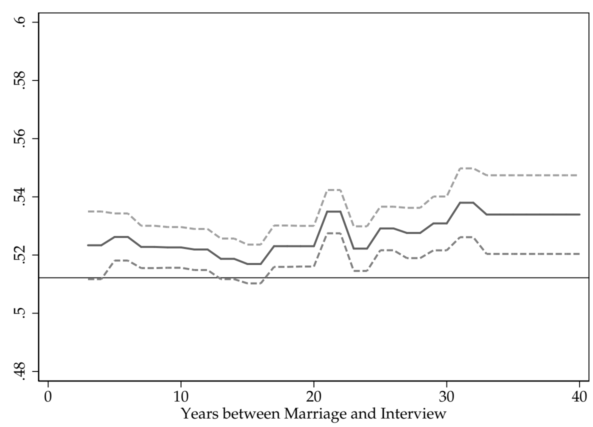
(a) NFHS-1



(b) NFHS-2



(c) NFHS-3



(d) NFHS-4

Figure C.2: Ratio of Boys for “Second” Births by Survey Round

D Descriptive Statistics

Table D.1: Descriptive Statistics by Education Level and Beginning of Spell For Two Lowest Education Levels

		No Education				1–7 Years of Education			
		1972–1984	1985–1994	1995–2004	2005–2016	1972–1984	1985–1994	1995–2004	2005–2016
Second Spell	Boy born	0.504	0.452	0.468	0.413	0.493	0.450	0.460	0.380
		(0.500)	(0.498)	(0.499)	(0.492)	(0.500)	(0.498)	(0.498)	(0.485)
	Girl born	0.464	0.421	0.440	0.380	0.474	0.423	0.426	0.353
		(0.499)	(0.494)	(0.496)	(0.485)	(0.499)	(0.494)	(0.494)	(0.478)
	Censored	0.032	0.127	0.092	0.207	0.032	0.127	0.114	0.266
		(0.175)	(0.333)	(0.289)	(0.405)	(0.177)	(0.333)	(0.317)	(0.442)
	1 boy	0.523	0.515	0.518	0.516	0.521	0.514	0.522	0.519
		(0.499)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)
	1 girl	0.477	0.485	0.482	0.484	0.479	0.486	0.478	0.481
		(0.499)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)
	Urban	0.169	0.175	0.155	0.122	0.350	0.341	0.259	0.192
		(0.375)	(0.380)	(0.362)	(0.327)	(0.477)	(0.474)	(0.438)	(0.394)
	Age	17.773	18.274	19.432	20.740	18.637	19.141	19.485	20.527
		(2.739)	(3.005)	(3.410)	(3.520)	(2.889)	(3.176)	(3.284)	(3.271)
	Owns land	0.602	0.573	0.510	0.482	0.506	0.493	0.474	0.468
		(0.509)	(0.503)	(0.500)	(0.500)	(0.500)	(0.500)	(0.499)	(0.499)
	Sched. caste/tribe	0.347	0.391	0.444	0.486	0.154	0.219	0.337	0.416
		(0.476)	(0.488)	(0.497)	(0.500)	(0.361)	(0.414)	(0.473)	(0.493)
	3 months periods	163,580	232,552	392,924	244,364	59,182	106,165	255,925	229,242
	Women	18,650	27,563	43,952	29,527	6,889	12,191	27,225	26,446
Third Spell	Boy born	0.492	0.428	0.421	0.341	0.464	0.397	0.356	0.273
		(0.500)	(0.495)	(0.494)	(0.474)	(0.499)	(0.489)	(0.479)	(0.445)
	Girl born	0.455	0.398	0.386	0.314	0.437	0.360	0.325	0.236
		(0.498)	(0.489)	(0.487)	(0.464)	(0.496)	(0.480)	(0.469)	(0.424)
	Censored	0.053	0.174	0.193	0.345	0.100	0.243	0.319	0.492
		(0.224)	(0.379)	(0.395)	(0.475)	(0.300)	(0.429)	(0.466)	(0.500)
	2 boys	0.275	0.256	0.251	0.249	0.251	0.246	0.241	0.239
		(0.447)	(0.436)	(0.434)	(0.432)	(0.434)	(0.431)	(0.427)	(0.426)
	1 boy, 1 girl	0.489	0.502	0.504	0.499	0.506	0.502	0.509	0.505
		(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)
	2 girls	0.235	0.243	0.245	0.252	0.243	0.252	0.251	0.256
		(0.424)	(0.429)	(0.430)	(0.434)	(0.429)	(0.434)	(0.434)	(0.436)
	Urban	0.173	0.171	0.159	0.121	0.365	0.341	0.263	0.192
		(0.379)	(0.376)	(0.365)	(0.326)	(0.482)	(0.474)	(0.440)	(0.394)
	Age	19.987	20.593	21.641	23.055	20.839	21.367	21.735	22.821
		(2.896)	(3.150)	(3.490)	(3.665)	(2.954)	(3.228)	(3.372)	(3.441)
	Owns land	0.607	0.581	0.523	0.489	0.507	0.509	0.493	0.475
		(0.506)	(0.497)	(0.499)	(0.500)	(0.500)	(0.500)	(0.500)	(0.499)
	Sched. caste/tribe	0.339	0.392	0.444	0.479	0.154	0.218	0.334	0.410
		(0.473)	(0.488)	(0.497)	(0.500)	(0.361)	(0.413)	(0.472)	(0.492)
	3 months periods	105,997	194,166	295,808	267,436	42,088	84,124	182,266	209,481
	Women	12,119	22,858	31,218	29,446	4,384	8,785	16,346	20,850
Fourth Spell	Boy born	0.483	0.390	0.357	0.286	0.414	0.358	0.293	0.222
		(0.500)	(0.488)	(0.479)	(0.452)	(0.493)	(0.479)	(0.455)	(0.416)
	Girl born	0.424	0.367	0.327	0.266	0.405	0.305	0.254	0.199
		(0.494)	(0.482)	(0.469)	(0.442)	(0.491)	(0.461)	(0.435)	(0.400)
	Censored	0.093	0.243	0.316	0.448	0.180	0.337	0.453	0.578
		(0.290)	(0.429)	(0.465)	(0.497)	(0.385)	(0.473)	(0.498)	(0.494)
	3 boys	0.136	0.123	0.115	0.105	0.110	0.107	0.099	0.087
		(0.343)	(0.329)	(0.319)	(0.307)	(0.312)	(0.310)	(0.299)	(0.281)
	2 boys, 1 girl	0.372	0.355	0.352	0.335	0.343	0.329	0.327	0.314
		(0.483)	(0.478)	(0.478)	(0.472)	(0.475)	(0.470)	(0.469)	(0.464)
	1 boys, 2 girls	0.362	0.392	0.397	0.407	0.400	0.407	0.413	0.423
		(0.481)	(0.488)	(0.489)	(0.491)	(0.490)	(0.491)	(0.492)	(0.494)
	3 girls	0.130	0.130	0.137	0.153	0.147	0.157	0.162	0.176
		(0.337)	(0.336)	(0.343)	(0.360)	(0.354)	(0.363)	(0.368)	(0.381)
	Urban	0.168	0.168	0.159	0.114	0.358	0.330	0.258	0.189
		(0.374)	(0.374)	(0.365)	(0.318)	(0.479)	(0.470)	(0.438)	(0.392)
	Age	21.948	22.777	23.583	25.284	22.644	23.444	23.821	24.893
		(3.019)	(3.296)	(3.497)	(3.799)	(2.910)	(3.385)	(3.455)	(3.523)
	Owns land	0.615	0.594	0.542	0.497	0.522	0.537	0.508	0.480
		(0.509)	(0.496)	(0.498)	(0.500)	(0.500)	(0.499)	(0.500)	(0.500)
	Sched. caste/tribe	0.333	0.402	0.451	0.481	0.148	0.219	0.339	0.414
		(0.471)	(0.490)	(0.498)	(0.500)	(0.355)	(0.413)	(0.473)	(0.493)
	3 months periods	55,942	140,909	162,841	217,023	20,121	46,646	75,858	110,944
	Women	6,421	16,278	17,105	22,496	2,008	4,771	6,496	10,620

Note. Means without parentheses and standard deviation in parentheses. Interactions between variables and baseline hazard dummies not shown.

Table D.2: Descriptive Statistics by Education Level and Beginning of Spell for Two Highest Education Levels

		8–11 Years of Education				12+ Years of Education			
		1972–1984	1985–1994	1995–2004	2005–2016	1972–1984	1985–1994	1995–2004	2005–2016
Second Spell	Boy born	0.486	0.432	0.441	0.325	0.452	0.392	0.400	0.268
		(0.500)	(0.495)	(0.497)	(0.468)	(0.498)	(0.488)	(0.490)	(0.443)
	Girl born	0.458	0.392	0.395	0.300	0.438	0.328	0.336	0.229
		(0.498)	(0.488)	(0.489)	(0.458)	(0.496)	(0.469)	(0.472)	(0.421)
	Censored	0.056	0.175	0.164	0.375	0.110	0.280	0.265	0.503
		(0.231)	(0.380)	(0.370)	(0.484)	(0.313)	(0.449)	(0.441)	(0.500)
	1 boy	0.521	0.520	0.521	0.518	0.512	0.519	0.526	0.519
		(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.499)	(0.500)
	1 girl	0.479	0.480	0.479	0.482	0.488	0.481	0.474	0.481
		(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.499)	(0.500)
	Urban	0.608	0.524	0.385	0.266	0.865	0.811	0.659	0.469
		(0.488)	(0.499)	(0.487)	(0.442)	(0.342)	(0.391)	(0.474)	(0.499)
	Age	20.340	20.630	20.528	21.117	22.803	23.312	23.099	23.170
		(3.203)	(3.318)	(3.405)	(3.349)	(3.330)	(3.499)	(3.712)	(3.704)
	Owns land	0.364	0.426	0.456	0.495	0.217	0.264	0.349	0.453
		(0.481)	(0.495)	(0.498)	(0.500)	(0.413)	(0.441)	(0.477)	(0.498)
	Sched. caste/tribe	0.076	0.138	0.231	0.309	0.030	0.065	0.124	0.195
		(0.266)	(0.345)	(0.422)	(0.462)	(0.172)	(0.246)	(0.330)	(0.396)
	3 months periods	45,828	106,296	334,766	372,999	25,305	71,602	230,155	297,850
	Women	4,850	10,823	31,512	40,204	2,034	5,605	17,314	28,198
Third Spell	Boy born	0.410	0.309	0.299	0.196	0.267	0.188	0.181	0.120
		(0.492)	(0.462)	(0.458)	(0.397)	(0.443)	(0.391)	(0.385)	(0.325)
	Girl born	0.366	0.261	0.244	0.163	0.233	0.137	0.139	0.078
		(0.482)	(0.439)	(0.429)	(0.370)	(0.423)	(0.344)	(0.346)	(0.268)
	Censored	0.224	0.430	0.457	0.640	0.499	0.674	0.680	0.802
		(0.417)	(0.495)	(0.498)	(0.480)	(0.500)	(0.469)	(0.467)	(0.398)
	2 boys	0.267	0.247	0.240	0.227	0.279	0.237	0.246	0.225
		(0.443)	(0.431)	(0.427)	(0.419)	(0.449)	(0.425)	(0.431)	(0.418)
	1 boy, 1 girl	0.482	0.508	0.517	0.513	0.495	0.515	0.535	0.538
		(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.499)	(0.499)
	2 girls	0.251	0.245	0.242	0.260	0.226	0.248	0.219	0.237
		(0.433)	(0.430)	(0.429)	(0.439)	(0.419)	(0.432)	(0.414)	(0.425)
	Urban	0.623	0.547	0.385	0.277	0.877	0.827	0.652	0.484
		(0.485)	(0.498)	(0.487)	(0.447)	(0.329)	(0.378)	(0.476)	(0.500)
	Age	22.322	22.882	22.751	23.537	25.085	25.810	25.524	25.963
		(3.126)	(3.390)	(3.429)	(3.577)	(3.463)	(3.743)	(3.945)	(4.116)
	Owns land	0.361	0.426	0.482	0.500	0.215	0.268	0.371	0.461
		(0.480)	(0.495)	(0.500)	(0.500)	(0.411)	(0.443)	(0.483)	(0.499)
	Sched. caste/tribe	0.074	0.132	0.234	0.291	0.034	0.058	0.127	0.186
		(0.262)	(0.339)	(0.423)	(0.454)	(0.181)	(0.234)	(0.333)	(0.389)
	3 months periods	36,611	81,074	222,974	296,060	18,805	51,144	134,925	185,578
	Women	2,897	6,637	16,314	25,328	973	2,995	7,494	13,774
Fourth Spell	Boy born	0.344	0.259	0.252	0.170	0.226	0.164	0.172	0.105
		(0.475)	(0.438)	(0.434)	(0.375)	(0.419)	(0.371)	(0.378)	(0.307)
	Girl born	0.319	0.224	0.190	0.132	0.246	0.129	0.127	0.077
		(0.466)	(0.417)	(0.392)	(0.338)	(0.432)	(0.335)	(0.333)	(0.266)
	Censored	0.337	0.517	0.558	0.699	0.528	0.707	0.701	0.818
		(0.473)	(0.500)	(0.497)	(0.459)	(0.500)	(0.455)	(0.458)	(0.386)
	3 boys	0.109	0.104	0.092	0.076	0.101	0.086	0.069	0.063
		(0.312)	(0.305)	(0.289)	(0.264)	(0.301)	(0.281)	(0.254)	(0.243)
	2 boys, 1 girl	0.363	0.305	0.317	0.291	0.337	0.314	0.331	0.282
		(0.481)	(0.461)	(0.465)	(0.454)	(0.474)	(0.464)	(0.471)	(0.450)
	1 boys, 2 girls	0.385	0.438	0.439	0.449	0.427	0.430	0.450	0.494
		(0.487)	(0.496)	(0.496)	(0.497)	(0.496)	(0.495)	(0.498)	(0.500)
	3 girls	0.142	0.152	0.153	0.185	0.136	0.170	0.151	0.162
		(0.349)	(0.360)	(0.360)	(0.388)	(0.343)	(0.376)	(0.358)	(0.369)
	Urban	0.639	0.534	0.359	0.253	0.824	0.769	0.574	0.395
		(0.481)	(0.499)	(0.480)	(0.434)	(0.382)	(0.421)	(0.495)	(0.489)
	Age	23.962	24.856	24.546	25.475	25.950	27.494	26.888	27.638
		(3.026)	(3.456)	(3.486)	(3.618)	(3.434)	(3.899)	(4.228)	(4.347)
	Owns land	0.353	0.444	0.502	0.523	0.271	0.338	0.455	0.506
		(0.478)	(0.497)	(0.500)	(0.499)	(0.446)	(0.473)	(0.498)	(0.500)
	Sched. caste/tribe	0.089	0.127	0.244	0.310	0.045	0.054	0.165	0.201
		(0.285)	(0.333)	(0.430)	(0.463)	(0.208)	(0.226)	(0.371)	(0.401)
	3 months periods	13,964	32,921	67,194	107,345	3,347	11,076	22,292	38,203
	Women	1,043	2,656	4,852	9,116	199	707	1,288	2,770

Note. Means without parentheses and standard deviation in parentheses. Interactions between variables and baseline hazard dummies not shown.

E Additional Results Figures and Tables

Figures E.1 and E.2 show 25th, 50th, and 75th percentile birth intervals, the sex ratio, and the probability of parity progression by spell for urban women with no education and rural women with 12 or more years of education, respectively.

The first set of tables, Tables E.1, E.2, E.3, and E.4 show 25th, 50th, and 75th percentile birth intervals together with their standard errors. The standard errors for all measures are based on bootstrapping, where the model is repeatedly estimated using resampling with replacement.

The second set of tables, Tables E.5, E.6, E.7, and E.8, show predicted average birth intervals, sex ratios, and probabilities of having a birth by decade, spell, and sex composition for the four education levels separated by the area of residence, together with bootstrapped standard errors for all three outcomes. To find the average birth interval, I calculate, for each woman, the probability of giving birth in each t, and her expected spell length from these probabilities. I then average the individual expected spell lengths across women using their parity progression probabilities as weights. Finally, I add nine months because spells begin nine months after the previous birth.

I also show whether durations for sex composition other than only girls are statistically significantly different from the duration with only girls based on bootstrapped differences. The cleanest test is comparing durations after only boys with durations after only girls, but the number of births to women with only sons becomes small in the later periods. Hence, it is possible to have substantial differences in spacing that are not statistically significant because of low power, especially for the third and fourth spell.

Each predicted percent of boys is tested against the natural percentage of boys using the bootstrapped standard errors. The natural sex ratio is approximately 105 boys to 100 girls or 51.2% (Ben-Porath and Welch, 1976; Jacobsen et al., 1999; Pörtner, 2015). The predicted percentage boys may differ from the natural rate because of natural variation, any remaining recall error not corrected for, or sex selection.

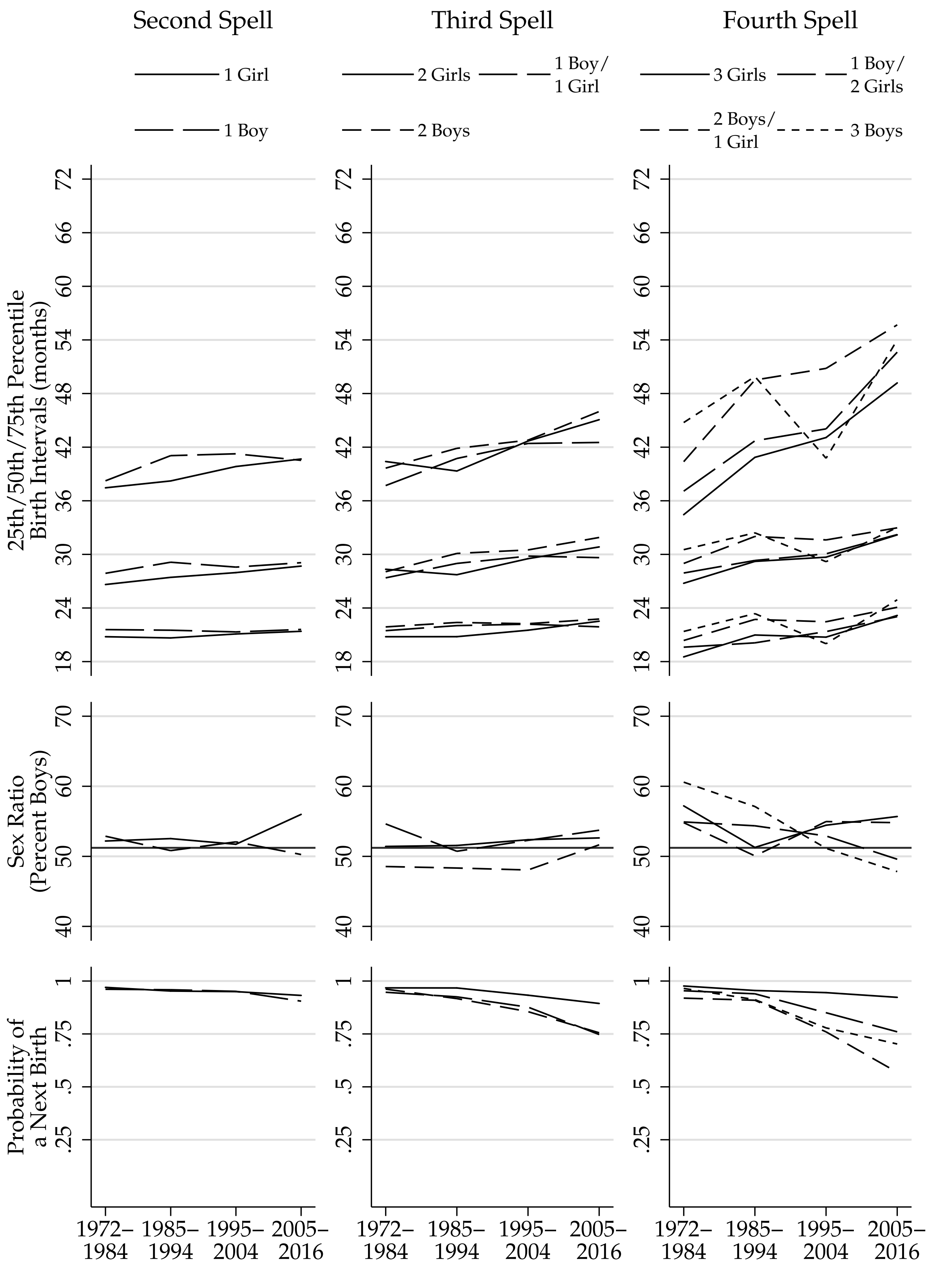


Figure E.1: Percentile birth intervals, sex ratios, and parity progression for urban women with no education by spell, sex composition, and period

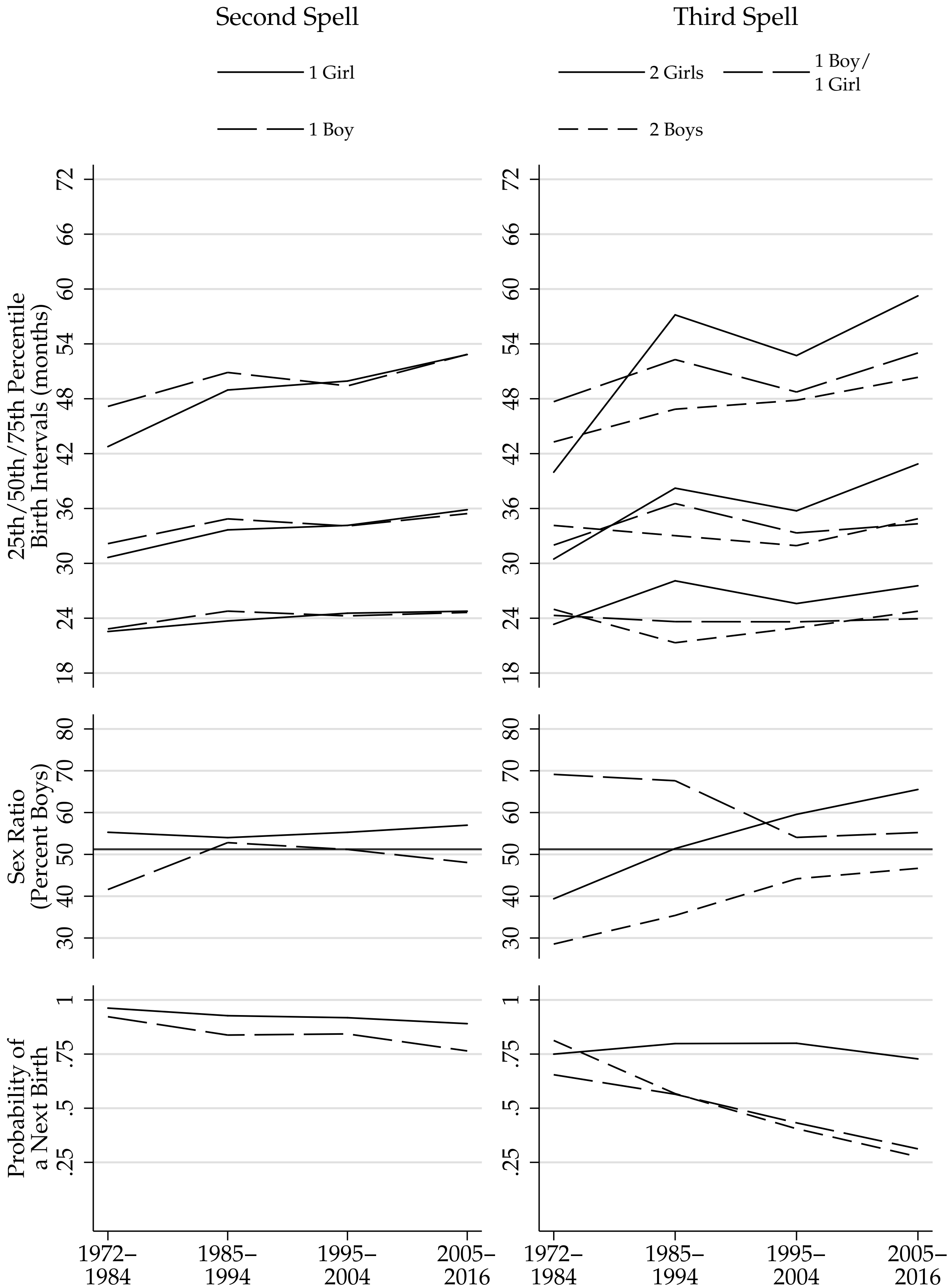


Figure E.2: Percentile birth intervals, sex ratios, and parity progression for rural women with 12 or more years of education by spell, sex composition, and period

Table E.1: Estimated 25th, 50th, and 75th Percentile Birth Intervals for Women with No Education

		1972–1984			1985–1994			1995–2004			2005–2016		
		Interval (Months)[a] Percentile			Interval (Months)[a] Percentile			Interval (Months)[a] Percentile			Interval (Months)[a] Percentile		
Spell	Composition of Prior Children	25th	50th	75th	25th	50th	75th	25th	50th	75th	25th	50th	75th
						Urban							
2	1 girl	20.8	26.6	37.5	20.7	27.4	38.2	21.1	28.0	39.8	21.4	28.7	40.7
		(0.4)	(0.3)	(0.6)	(0.3)	(0.4)	(0.5)	(0.2)	(0.3)	(0.5)	(0.4)	(0.5)	(0.8)
	1 boy	21.6*	27.9***	38.2	21.5**	29.1***	41.1***	21.3	28.6	41.3**	21.6	29.1	40.5
		(0.3)	(0.4)	(0.5)	(0.3)	(0.4)	(0.7)	(0.2)	(0.3)	(0.5)	(0.3)	(0.5)	(0.8)
3	2 girls	20.8	28.3	40.4	20.8	27.7	39.3	21.5	29.5	42.7	22.5	30.8	45.1
		(0.6)	(0.7)	(1.0)	(0.5)	(0.6)	(1.0)	(0.3)	(0.5)	(0.8)	(0.4)	(0.7)	(1.5)
	1 boy, 1 girl	21.5	27.4	37.7*	22.0**	29.0*	40.7	22.2*	29.8	42.4	21.9	29.6	42.5
		(0.3)	(0.4)	(0.9)	(0.2)	(0.4)	(0.6)	(0.2)	(0.3)	(0.7)	(0.4)	(0.5)	(1.2)
	2 boys	21.9	28.1	39.7	22.4***	30.1**	41.9*	22.2	30.5	42.8	22.8	31.9	46.0
		(0.4)	(0.6)	(1.1)	(0.4)	(0.7)	(0.9)	(0.3)	(0.6)	(0.8)	(0.5)	(0.8)	(1.6)
4	3 girls	18.5	26.8	34.4	21.0	29.2	40.9	20.7	29.7	43.1	23.2	32.2	49.2
		(1.2)	(0.8)	(1.7)	(0.9)	(0.6)	(1.7)	(1.1)	(0.8)	(2.1)	(1.0)	(1.0)	(2.1)
	1 boy, 2 girls	19.6	27.9	37.1	20.1	29.3	42.7	21.4	30.1	44.1	23.0	32.2	52.6
		(0.9)	(0.6)	(1.3)	(0.6)	(0.5)	(1.4)	(0.7)	(0.5)	(2.2)	(0.8)	(0.7)	(2.4)
	2 boys, 1 girl	20.4	29.0**	40.4**	22.7	32.0***	49.5***	22.5	31.6*	50.8**	24.1	33.0	55.7
		(1.1)	(0.7)	(2.0)	(0.7)	(0.6)	(1.3)	(0.9)	(0.6)	(2.4)	(0.9)	(0.9)	(3.5)
	3 boys	21.4	30.5**	44.8***	23.4*	32.4***	49.9***	20.0	29.2	40.8	24.9	33.0	54.0
		(1.8)	(1.5)	(2.9)	(0.9)	(1.0)	(2.1)	(1.3)	(1.0)	(3.5)	(1.3)	(1.5)	(5.8)
						Rural							
2	1 girl	21.6	27.6	37.4	21.8	28.4	39.0	22.0	28.7	39.7	21.9	28.7	39.6
		(0.1)	(0.2)	(0.3)	(0.1)	(0.1)	(0.2)	(0.1)	(0.1)	(0.2)	(0.1)	(0.1)	(0.2)
	1 boy	22.0**	28.6***	38.6***	22.1**	29.1***	39.9***	22.0	28.8	40.3***	22.2*	29.1*	40.7***
		(0.1)	(0.2)	(0.2)	(0.1)	(0.2)	(0.2)	(0.1)	(0.1)	(0.2)	(0.1)	(0.2)	(0.3)
3	2 girls	20.9	26.8	36.7	22.0	29.0	40.0	22.2	29.0	40.6	22.3	29.5	41.3
		(0.3)	(0.3)	(0.5)	(0.2)	(0.3)	(0.4)	(0.1)	(0.2)	(0.3)	(0.1)	(0.2)	(0.3)
	1 boy, 1 girl	22.0***	28.1***	38.1**	21.9	28.9	40.2	22.2	29.1	41.2*	22.8***	30.3***	43.0***
		(0.1)	(0.2)	(0.3)	(0.1)	(0.2)	(0.3)	(0.1)	(0.1)	(0.2)	(0.1)	(0.2)	(0.3)
	2 boys	21.8***	28.2***	38.4***	22.3	29.9**	41.9***	22.7***	30.0***	42.0***	23.0***	31.4***	44.5***
		(0.2)	(0.3)	(0.4)	(0.1)	(0.3)	(0.4)	(0.1)	(0.2)	(0.3)	(0.2)	(0.3)	(0.5)
4	3 girls	18.9	27.4	36.4	20.4	29.1	40.7	20.3	28.9	40.2	22.6	30.8	44.6
		(0.7)	(0.4)	(0.8)	(0.4)	(0.3)	(0.7)	(0.4)	(0.3)	(0.7)	(0.4)	(0.2)	(0.6)
	1 boy, 2 girls	19.7	28.2*	38.4*	22.1***	30.3***	43.6***	21.6***	30.0***	43.2***	23.3	31.8***	49.2***
		(0.3)	(0.3)	(0.7)	(0.3)	(0.2)	(0.5)	(0.3)	(0.2)	(0.7)	(0.3)	(0.2)	(0.7)
	2 boys, 1 girl	20.2*	28.3*	37.8	22.2***	31.0***	46.3***	22.1***	31.1***	48.2***	25.0***	34.0***	57.5***
		(0.4)	(0.2)	(0.6)	(0.3)	(0.3)	(0.7)	(0.4)	(0.2)	(0.9)	(0.2)	(0.3)	(0.8)
	3 boys	19.6	28.6*	40.0**	23.1***	31.4***	46.9***	22.5***	31.4***	49.0***	24.5***	33.9***	56.7***
		(0.6)	(0.5)	(1.3)	(0.6)	(0.5)	(1.2)	(0.6)	(0.6)	(1.8)	(0.5)	(0.6)	(1.4)

Note. The statistics for each spell/period combination are calculated based on the hazard model for that combination as described in the main text, using bootstrapping to find the standard errors shown in parentheses. For bootstrapping, the original sample is resampled, the hazard model run on the resampled data, and the statistics calculated. This process is repeated 100 times and the standard errors calculated.

[a] Percentile birth intervals calculated as follows. For each woman in a given spell/period combination sample, I calculate the time point at which there is a given percent chance that she will have given birth, conditional on the probability that she will eventually give birth in that spell. For example, if there is an 80% chance that a woman will give birth by the end of the spell, her median birth interval is the predicted number of months before she passes the 60% mark on her survival curve plus nine months to account for spell start. The reported statistics is the average of a given percentile interval across all women in a given sample using the individual predicted probabilities of having had a birth by the end of the spell as weights. Birth intervals for sex compositions other than all girls are tested against the duration for all girls, with *** indicating significantly different at the 1% level, ** at the 5% level, and * at the 10% level.

Table E.2: Estimated 25th, 50th, and 75th Percentile Birth Intervals for Women with 1–7 Years of Education

		1972–1984			1985–1994			1995–2004			2005–2016		
		Interval (Months)[a] Percentile			Interval (Months)[a] Percentile			Interval (Months)[a] Percentile			Interval (Months)[a] Percentile		
Spell	Composition of Prior Children	25th	50th	75th	25th	50th	75th	25th	50th	75th	25th	50th	75th
							Urban						
	1 girl	19.9	26.4	35.2	20.9	27.6	39.0	21.2	28.9	42.1	22.2	30.4	43.5
2		(0.4)	(0.3)	(0.6)	(0.3)	(0.4)	(0.6)	(0.2)	(0.3)	(0.5)	(0.3)	(0.4)	(0.8)
	1 boy	21.1**	27.3	37.6***	21.3	29.2***	40.2	21.9**	29.5	42.4	22.5	31.3*	46.3**
		(0.3)	(0.5)	(0.7)	(0.3)	(0.4)	(0.7)	(0.3)	(0.3)	(0.5)	(0.3)	(0.5)	(1.0)
	2 girls	20.2	26.6	36.8	22.0	29.7	42.7	22.7	31.9	47.0	24.1	33.1	49.5
		(0.7)	(0.7)	(1.2)	(0.4)	(0.7)	(1.3)	(0.4)	(0.7)	(1.4)	(0.4)	(0.7)	(1.6)
3	1 boy, 1 girl	22.1***	28.9***	39.8**	22.4	29.7	43.4	22.7	30.5	44.2	22.9**	31.1**	45.2**
		(0.3)	(0.5)	(0.9)	(0.3)	(0.5)	(1.1)	(0.2)	(0.5)	(0.9)	(0.4)	(0.6)	(1.3)
	2 boys	22.0**	28.3	39.0	22.7	30.4	45.0	23.0	31.1	45.1	23.6	32.8	48.5
		(0.5)	(0.8)	(1.2)	(0.4)	(0.8)	(1.4)	(0.4)	(0.8)	(1.3)	(0.6)	(1.1)	(1.8)
	3 girls	18.7	28.0	39.5	20.6	29.7	43.6	24.2	34.6	54.6	23.5	32.8	52.3
		(1.5)	(1.4)	(3.3)	(1.3)	(1.0)	(2.6)	(1.2)	(1.5)	(2.1)	(1.1)	(1.3)	(3.2)
	1 boy, 2 girls	20.0	28.5	38.2	21.7	31.2	49.5	20.8**	30.8**	49.6	22.5	31.2	47.5
4		(1.1)	(0.7)	(2.1)	(1.0)	(0.8)	(2.5)	(1.0)	(0.8)	(3.1)	(1.1)	(0.7)	(3.8)
	2 boys, 1 girl	20.7	29.3	41.2	23.3	33.0**	55.1***	22.8	31.8	51.3	26.4**	35.9	63.8**
		(1.3)	(0.9)	(3.5)	(1.0)	(1.1)	(2.9)	(1.1)	(0.9)	(3.8)	(0.9)	(1.8)	(3.6)
	3 boys	20.0	29.5	42.7	23.4	31.9	49.5	23.1	31.5	49.1	25.3	37.3	65.8**
		(2.4)	(2.5)	(7.7)	(1.4)	(1.3)	(3.9)	(1.8)	(1.6)	(6.1)	(2.3)	(4.5)	(5.4)
							Rural						
	1 girl	21.4	27.0	37.0	21.3	28.1	39.2	22.1	29.1	40.7	22.3	29.5	41.6
2		(0.2)	(0.3)	(0.5)	(0.2)	(0.3)	(0.4)	(0.1)	(0.2)	(0.3)	(0.1)	(0.2)	(0.4)
	1 boy	22.2***	28.6***	39.0***	22.0***	28.8*	39.8	22.2	29.5	41.3	22.7**	30.3**	43.4***
		(0.2)	(0.3)	(0.4)	(0.2)	(0.3)	(0.4)	(0.1)	(0.2)	(0.3)	(0.1)	(0.2)	(0.4)
	2 girls	20.9	27.0	36.3	21.3	28.3	38.1	22.6	30.3	42.6	23.3	31.4	44.9
		(0.5)	(0.4)	(0.7)	(0.3)	(0.4)	(0.6)	(0.2)	(0.3)	(0.5)	(0.2)	(0.3)	(0.6)
3	1 boy, 1 girl	22.0**	28.4**	38.9***	22.4***	29.9***	42.2***	22.7	30.2	42.7	23.4	31.5	45.5
		(0.2)	(0.4)	(0.7)	(0.2)	(0.3)	(0.5)	(0.1)	(0.2)	(0.4)	(0.1)	(0.3)	(0.6)
	2 boys	22.8***	30.3***	41.5***	22.8***	30.2**	43.0***	22.7	30.5	43.8	23.6	32.3	46.5
		(0.4)	(0.6)	(1.0)	(0.3)	(0.6)	(1.0)	(0.2)	(0.4)	(0.7)	(0.2)	(0.5)	(0.9)
	3 girls	21.0	28.2	36.9	22.3	30.3	43.0	23.5	32.2	47.6	25.0	33.3	50.4
		(1.3)	(0.7)	(1.6)	(0.7)	(0.6)	(1.5)	(0.6)	(0.6)	(1.2)	(0.4)	(0.4)	(1.0)
	1 boy, 2 girls	21.3	29.2	40.1	22.4	30.8	45.8	22.8	31.2	48.1	24.3	32.8	53.9**
4		(1.0)	(0.6)	(1.6)	(0.6)	(0.5)	(1.4)	(0.5)	(0.4)	(1.8)	(0.3)	(0.4)	(1.4)
	2 boys, 1 girl	23.1	30.5**	43.8**	23.5	32.1**	50.5***	23.2	31.9	51.5	25.0	35.3**	62.2***
		(0.9)	(0.7)	(2.4)	(0.6)	(0.7)	(1.9)	(0.7)	(0.6)	(2.8)	(0.5)	(0.6)	(1.3)
	3 boys	20.4	28.7	39.3	22.5	31.4	48.3*	22.8	33.5	57.7***	24.9	33.9	58.4**
		(1.3)	(0.9)	(2.8)	(1.2)	(1.1)	(2.7)	(1.3)	(1.4)	(3.0)	(0.8)	(1.1)	(3.5)

Note. The statistics for each spell/period combination are calculated based on the hazard model for that combination as described in the main text, using bootstrapping to find the standard errors shown in parentheses. For bootstrapping, the original sample is resampled, the hazard model run on the resampled data, and the statistics calculated. This process is repeated 100 times and the standard errors calculated.

[a] Percentile birth intervals calculated as follows. For each woman in a given spell/period combination sample, I calculate the time point at which there is a given percent chance that she will have given birth, conditional on the probability that she will eventually give birth in that spell. For example, if there is an 80% chance that a woman will give birth by the end of the spell, her median birth interval is the predicted number of months before she passes the 60% mark on her survival curve plus nine months to account for spell start. The reported statistics is the average of a given percentile interval across all women in a given sample using the individual predicted probabilities of having had a birth by the end of the spell as weights. Birth intervals for sex compositions other than all girls are tested against the duration for all girls, with *** indicating significantly different at the 1% level, ** at the 5% level, and * at the 10% level.

Table E.3: Estimated 25th, 50th, and 75th Percentile Birth Intervals for Women with 8–11 Years of Education

		1972–1984			1985–1994			1995–2004			2005–2016		
		Interval (Months)[a] Percentile			Interval (Months)[a] Percentile			Interval (Months)[a] Percentile			Interval (Months)[a] Percentile		
Spell	Composition of Prior Children	25th	50th	75th	25th	50th	75th	25th	50th	75th	25th	50th	75th
							Urban						
2	1 girl	20.0	26.8	37.9	21.7	30.5	45.2	22.7	31.9	47.2	24.0	34.3	50.5
		(0.4)	(0.3)	(0.7)	(0.3)	(0.4)	(0.7)	(0.2)	(0.3)	(0.5)	(0.3)	(0.4)	(0.9)
	1 boy	20.8	27.6	40.4**	22.2	31.0	45.1	23.1*	32.2	47.6	24.0	33.9	50.5
		(0.4)	(0.5)	(0.9)	(0.3)	(0.5)	(0.7)	(0.2)	(0.3)	(0.5)	(0.2)	(0.4)	(0.7)
3	2 girls	22.4	29.5	42.1	24.4	34.6	51.2	24.7	35.2	52.9	26.5	39.3	59.4
		(0.4)	(0.8)	(1.6)	(0.6)	(0.9)	(1.6)	(0.5)	(0.8)	(1.3)	(0.5)	(1.0)	(1.6)
	1 boy, 1 girl	21.4	29.0	43.2	22.6**	32.2*	48.2	23.1***	32.4***	48.7**	24.5***	35.0***	51.6***
		(0.4)	(0.7)	(1.3)	(0.4)	(0.7)	(1.2)	(0.3)	(0.6)	(1.0)	(0.5)	(0.9)	(1.7)
	2 boys	22.5	31.0	46.0*	23.4	33.7	50.1	24.0	32.3***	46.7***	24.6***	37.0	57.7
		(0.5)	(1.0)	(1.4)	(0.7)	(1.0)	(2.1)	(0.4)	(0.7)	(1.1)	(0.5)	(1.8)	(2.7)
4	3 girls	23.4	30.1	41.5	22.9	33.6	54.0	25.7	36.9	57.8	27.9	41.6	63.4
		(1.7)	(1.2)	(4.1)	(1.2)	(1.8)	(3.0)	(1.3)	(2.1)	(2.4)	(1.0)	(1.9)	(1.5)
	1 boy, 2 girls	19.5*	28.7	39.4	24.1	33.3	56.4	23.9	33.6	58.2	25.6*	35.3***	63.0
		(1.4)	(1.0)	(3.6)	(1.0)	(1.0)	(3.1)	(1.0)	(1.2)	(3.0)	(0.8)	(1.2)	(3.1)
	2 boys, 1 girl	19.3*	28.8	40.3	21.7	31.5	51.2	22.1	34.5	63.2	22.6***	34.1**	62.3
		(1.5)	(1.2)	(4.0)	(1.4)	(1.3)	(5.6)	(1.7)	(2.1)	(4.1)	(1.7)	(2.4)	(6.5)
	3 boys	20.8	29.5	40.8	24.5	35.8	63.6	24.0	32.7	54.5	24.5	36.5	66.4
		(2.3)	(2.0)	(7.3)	(2.3)	(3.9)	(6.4)	(1.7)	(2.0)	(8.0)	(2.9)	(5.6)	(7.8)
							Rural						
2	1 girl	20.8	29.1	39.0	22.0	29.6	42.2	22.5	30.3	43.1	23.1	31.7	46.0
		(0.4)	(0.5)	(0.8)	(0.2)	(0.3)	(0.6)	(0.1)	(0.2)	(0.3)	(0.1)	(0.2)	(0.5)
	1 boy	21.1	28.3	39.2	21.9	29.3	41.6	22.5	30.1	43.4	23.2	32.2	47.0
		(0.4)	(0.5)	(1.1)	(0.3)	(0.4)	(0.8)	(0.1)	(0.2)	(0.3)	(0.1)	(0.2)	(0.5)
3	2 girls	22.7	30.0	41.0	23.3	31.9	45.5	23.3	32.2	46.0	25.3	35.2	51.7
		(0.7)	(0.9)	(1.5)	(0.4)	(0.9)	(1.5)	(0.2)	(0.4)	(0.7)	(0.2)	(0.4)	(0.8)
	1 boy, 1 girl	22.6	29.0	40.4	23.1	31.0	43.5	22.9	30.9**	44.5*	23.3***	32.2***	46.6***
		(0.4)	(0.7)	(1.1)	(0.3)	(0.5)	(0.9)	(0.2)	(0.3)	(0.6)	(0.2)	(0.4)	(0.6)
	2 boys	23.0	31.3	43.7	22.9	30.6	43.4	23.2	31.0*	44.9	24.0***	33.3***	48.7*
		(0.7)	(1.2)	(1.8)	(0.5)	(0.8)	(1.8)	(0.3)	(0.5)	(1.0)	(0.3)	(0.6)	(1.2)
4	3 girls	19.4	28.5	40.3	24.7	35.9	55.1	26.1	34.8	53.4	25.3	35.2	55.6
		(2.2)	(2.2)	(4.1)	(1.2)	(2.0)	(2.3)	(0.5)	(1.1)	(1.7)	(0.4)	(0.8)	(1.2)
	1 boy, 2 girls	24.2*	31.8	47.8	23.2	33.2	54.6	23.5***	31.6***	48.9	24.8	34.6	60.8***
		(1.3)	(1.5)	(3.5)	(1.0)	(1.0)	(2.1)	(0.6)	(0.5)	(2.5)	(0.5)	(0.7)	(1.8)
	2 boys, 1 girl	24.9**	33.2*	53.4**	23.5	33.7	57.9	24.4*	32.4*	51.8	26.3	38.1	68.1***
		(1.3)	(1.7)	(5.0)	(1.3)	(1.6)	(3.7)	(0.8)	(0.8)	(4.1)	(0.8)	(1.8)	(1.6)
	3 boys	22.0	30.6	46.2	20.7*	32.0	55.2	24.9	33.2	55.1	26.3	36.4	64.6**
		(2.4)	(2.8)	(7.7)	(2.1)	(3.0)	(7.0)	(1.2)	(1.3)	(5.0)	(1.1)	(2.3)	(3.3)

Note. The statistics for each spell/period combination are calculated based on the hazard model for that combination as described in the main text, using bootstrapping to find the standard errors shown in parentheses. For bootstrapping, the original sample is resampled, the hazard model run on the resampled data, and the statistics calculated. This process is repeated 100 times and the standard errors calculated.

[a] Percentile birth intervals calculated as follows. For each woman in a given spell/period combination sample, I calculate the time point at which there is a given percent chance that she will have given birth, conditional on the probability that she will eventually give birth in that spell. For example, if there is an 80% chance that a woman will give birth by the end of the spell, her median birth interval is the predicted number of months before she passes the 60% mark on her survival curve plus nine months to account for spell start. The reported statistics is the average of a given percentile interval across all women in a given sample using the individual predicted probabilities of having had a birth by the end of the spell as weights. Birth intervals for sex compositions other than all girls are tested against the duration for all girls, with *** indicating significantly different at the 1% level, ** at the 5% level, and * at the 10% level.

Table E.4: Estimated 25th, 50th, and 75th Percentile Birth Intervals for Women with 12 or More Years of Education

		1972–1984			1985–1994			1995–2004			2005–2016		
		Interval (Months)[a] Percentile			Interval (Months)[a] Percentile			Interval (Months)[a] Percentile			Interval (Months)[a] Percentile		
Spell	Composition of Prior Children	25th	50th	75th	25th	50th	75th	25th	50th	75th	25th	50th	75th
							Urban						
	1 girl	23.3	33.4	47.9	24.4	37.8	55.8	26.5	39.9	57.6	28.0	42.3	60.0
2		(0.6)	(0.7)	(1.3)	(0.5)	(0.6)	(1.1)	(0.3)	(0.5)	(0.7)	(0.3)	(0.5)	(0.7)
	1 boy	22.7	34.4	50.3	25.9**	39.3	55.6	25.9	38.4**	57.0	28.3	43.0	61.5
		(0.6)	(0.8)	(1.2)	(0.5)	(0.7)	(0.8)	(0.3)	(0.4)	(0.6)	(0.4)	(0.7)	(0.9)
	2 girls	24.8	33.8	48.4	24.5	39.0	63.5	29.6	43.1	60.6	30.5	48.4	69.3
		(1.0)	(1.4)	(2.6)	(1.2)	(1.8)	(3.5)	(1.0)	(1.2)	(1.6)	(1.1)	(1.8)	(2.5)
3	1 boy, 1 girl	23.4	33.9	56.5**	24.9	36.5	54.6**	24.8***	35.4***	55.2**	25.7***	37.5***	55.3***
		(0.8)	(2.1)	(2.9)	(0.8)	(1.6)	(2.8)	(0.6)	(1.0)	(2.1)	(0.8)	(1.5)	(3.1)
	2 boys	22.8	35.6	54.8	25.2	38.8	53.5*	23.7***	34.3***	50.1***	25.1***	38.6***	56.9**
		(1.6)	(2.7)	(3.6)	(1.3)	(2.3)	(3.9)	(0.8)	(1.3)	(2.4)	(1.2)	(2.2)	(5.6)
							Rural						
	1 girl	22.5	30.6	42.8	23.7	33.7	49.0	24.6	34.2	49.9	24.8	35.9	52.8
2		(1.1)	(1.7)	(2.9)	(0.6)	(0.9)	(2.1)	(0.3)	(0.5)	(0.7)	(0.2)	(0.4)	(0.7)
	1 boy	22.8	32.2	47.2	24.8	34.9	50.9	24.3	34.1	49.4	24.6	35.4	52.9
		(1.0)	(2.0)	(2.9)	(0.7)	(1.0)	(2.2)	(0.3)	(0.5)	(0.7)	(0.3)	(0.4)	(0.8)
	2 girls	23.3	30.5	40.0	28.1	38.2	57.2	25.6	35.7	52.7	27.6	40.9	59.3
		(2.5)	(3.5)	(3.6)	(1.6)	(2.4)	(4.5)	(0.7)	(1.1)	(1.8)	(0.6)	(1.0)	(1.5)
3	1 boy, 1 girl	24.3	32.0	47.7	23.6**	36.5	52.3	23.6**	33.3	48.7	23.9***	34.3***	53.0**
		(1.6)	(3.1)	(6.1)	(1.0)	(2.5)	(3.9)	(0.5)	(1.0)	(1.8)	(0.4)	(0.8)	(2.2)
	2 boys	25.0	34.2	43.3	21.3***	33.0	46.9	22.9**	31.9**	47.8	24.8**	34.9***	50.3**
		(2.9)	(2.6)	(5.3)	(2.1)	(3.7)	(6.0)	(0.9)	(1.4)	(3.0)	(0.8)	(1.5)	(3.0)

Note. The statistics for each spell/period combination are calculated based on the hazard model for that combination as described in the main text, using bootstrapping to find the standard errors shown in parentheses. For bootstrapping, the original sample is resampled, the hazard model run on the resampled data, and the statistics calculated. This process is repeated 100 times and the standard errors calculated.

[a] Percentile birth intervals calculated as follows. For each woman in a given spell/period combination sample, I calculate the time point at which there is a given percent chance that she will have given birth, conditional on the probability that she will eventually give birth in that spell. For example, if there is an 80% chance that a woman will give birth by the end of the spell, her median birth interval is the predicted number of months before she passes the 60% mark on her survival curve plus nine months to account for spell start. The reported statistics is the average of a given percentile interval across all women in a given sample using the individual predicted probabilities of having had a birth by the end of the spell as weights. Birth intervals for sex compositions other than all girls are tested against the duration for all girls, with *** indicating significantly different at the 1% level, ** at the 5% level, and * at the 10% level.

Table E.5: Estimated Average Birth Interval in Months, Sex Ratio, and Probability of Parity Progression for Women with No Education

Spell	Composition of prior Children	1972–1984 Inter-val[a] (Mos)	1972–1984 Per-cent[b] boys	1972–1984 Proba-bility birth[c]	1985–1994 Inter-val[a] (Mos)	1985–1994 Per-cent[b] boys	1985–1994 Proba-bility birth[c]	1995–2004 Inter-val[a] (Mos)	1995–2004 Per-cent[b] boys	1995–2004 Proba-bility birth[c]	2005–2016 Inter-val[a] (Mos)	2005–2016 Per-cent[b] boys	2005–2016 Proba-bility birth[c]
							Urban						
	1 girl	30.7	52.2	0.970	31.5	52.5	0.953	32.8	51.7	0.950	33.1	56.0***	0.932
2		(0.4)	(1.3)	(0.004)	(0.3)	(1.1)	(0.005)	(0.3)	(0.8)	(0.004)	(0.5)	(1.2)	(0.009)
	1 boy	32.2***	52.9	0.961	33.3***	50.8	0.959	33.4	52.1	0.951	33.1	50.3	0.905
		(0.4)	(1.3)	(0.005)	(0.4)	(1.2)	(0.004)	(0.3)	(0.9)	(0.004)	(0.5)	(1.2)	(0.008)
	2 girls	32.3	51.4	0.968	32.0	51.6	0.967	34.4	52.4	0.933	36.2	52.6	0.894
		(0.7)	(2.1)	(0.009)	(0.7)	(1.6)	(0.009)	(0.5)	(1.6)	(0.008)	(0.9)	(2.0)	(0.015)
3	1 boy, 2 girl	31.4	54.6**	0.947	33.4*	50.7	0.925	34.7	52.3	0.877	34.1*	53.7*	0.747
		(0.5)	(1.5)	(0.007)	(0.4)	(1.3)	(0.007)	(0.4)	(1.2)	(0.008)	(0.7)	(1.5)	(0.014)
	2 boys	32.4	48.6	0.962	33.9*	48.3	0.917	34.5	48.1*	0.855	36.7	51.6	0.756
		(0.7)	(2.1)	(0.008)	(0.7)	(1.9)	(0.013)	(0.6)	(1.7)	(0.012)	(1.1)	(2.2)	(0.020)
	3 girls	29.9	57.2	0.977	34.0	51.3	0.955	35.1	54.4	0.945	38.2	55.7	0.923
		(1.3)	(4.1)	(0.016)	(0.9)	(2.6)	(0.015)	(0.9)	(2.7)	(0.017)	(1.0)	(3.1)	(0.016)
	1 boy, 2 girls	32.3	54.9	0.954	34.7	54.4*	0.940	36.5	52.9	0.850	39.8	49.6	0.760
4		(0.8)	(2.4)	(0.011)	(0.6)	(1.7)	(0.009)	(0.7)	(1.8)	(0.014)	(0.9)	(2.1)	(0.018)
	2 boys, 1 girl	34.5***	54.8	0.919	38.3***	50.1	0.909	39.0***	55.0*	0.760	41.2*	54.8	0.569
		(0.9)	(2.6)	(0.017)	(0.6)	(2.2)	(0.013)	(0.8)	(2.2)	(0.018)	(1.3)	(2.8)	(0.023)
	3 boys	35.6***	60.6**	0.965	38.6***	57.1	0.912	35.5	51.2	0.779	40.9	47.8	0.703
		(1.6)	(3.7)	(0.018)	(1.0)	(3.7)	(0.020)	(1.5)	(3.5)	(0.031)	(2.1)	(4.1)	(0.037)
							Rural						
	1 girl	31.4	51.2	0.974	32.4	52.1*	0.965	33.0	51.7	0.969	33.0	51.7	0.959
2		(0.2)	(0.6)	(0.002)	(0.2)	(0.5)	(0.003)	(0.1)	(0.4)	(0.001)	(0.2)	(0.5)	(0.003)
	1 boy	32.1***	52.7**	0.968	33.1***	51.4	0.962	33.3*	51.1	0.960	33.5**	52.2*	0.936
		(0.2)	(0.6)	(0.002)	(0.2)	(0.5)	(0.002)	(0.1)	(0.4)	(0.002)	(0.2)	(0.5)	(0.003)
	2 girls	30.2	49.6	0.975	32.8	53.7***	0.963	33.1	53.9***	0.965	33.8	52.9**	0.942
		(0.3)	(1.1)	(0.003)	(0.3)	(0.8)	(0.004)	(0.2)	(0.7)	(0.002)	(0.2)	(0.7)	(0.005)
3	1 boy, 2 girl	31.7***	53.0**	0.963	32.9	51.7	0.951	33.6**	52.4**	0.913	35.1***	51.8	0.852
		(0.2)	(0.7)	(0.003)	(0.2)	(0.6)	(0.003)	(0.2)	(0.5)	(0.003)	(0.2)	(0.6)	(0.004)
	2 boys	31.7***	51.9	0.958	34.0***	51.3	0.934	34.4***	50.7	0.882	36.0***	50.9	0.797
		(0.3)	(1.0)	(0.004)	(0.3)	(0.8)	(0.005)	(0.2)	(0.7)	(0.005)	(0.3)	(0.7)	(0.008)
	3 girls	31.1	54.5	0.977	33.2	50.5	0.977	33.4	52.8	0.971	36.0	54.0***	0.955
		(0.6)	(2.0)	(0.006)	(0.3)	(1.2)	(0.004)	(0.4)	(1.2)	(0.004)	(0.3)	(1.0)	(0.005)
	1 boy, 2 girls	32.3*	52.2	0.976	35.4***	53.1**	0.958	35.8***	52.8*	0.911	38.5***	52.2	0.870
4		(0.4)	(1.1)	(0.004)	(0.2)	(0.9)	(0.003)	(0.3)	(0.9)	(0.005)	(0.3)	(0.8)	(0.005)
	2 boys, 1 girl	32.7**	53.2*	0.958	36.8***	49.8	0.926	38.0***	51.1	0.822	42.2***	50.5	0.694
		(0.4)	(1.2)	(0.006)	(0.3)	(0.9)	(0.005)	(0.3)	(0.9)	(0.007)	(0.4)	(0.9)	(0.009)
	3 boys	33.3**	51.5	0.962	37.3***	50.7	0.924	38.2***	52.0	0.851	41.7***	51.6	0.753
		(0.6)	(2.1)	(0.009)	(0.5)	(1.3)	(0.009)	(0.7)	(1.5)	(0.014)	(0.7)	(1.7)	(0.015)

Note. The statistics for each spell/period combination are calculated based on the competing risk hazard model for that combination as described in the main text, using bootstrapping to find the standard errors shown in parentheses. For bootstrapping, the original sample is resampled, the hazard model run on the resampled data, and the statistics calculated. This process is repeated 100 times and the standard errors calculated.

[a] Average birth interval is calculated as follows. For each woman in a given spell/period combination sample, I calculate the probability of that she will give birth for each period, conditional on the likelihood that she will eventually give birth in that spell, and use these probabilities as weights to calculated the expected spell duration. The reported statistics is the average of these intervals across all women in a given sample using the individual predicted probabilities of having had a birth by the end of the spell as weights with nine months added to account for spell start. Birth intervals for sex compositions other than all girls are tested against the duration for all girls, with *** indicating significantly different at the 1% level, ** at the 5% level, and * at the 10% level.

[b] Percent boys is calculated as follows. For each woman in a given spell/period combination sample, I calculate the predicted percent boys for each month and sum this across the length of the spell using the likelihood of having a child in each month as the weight. The percent boys is then averaged across all women in the given sample using the individual predicted probabilities of having had a birth by the end of the spell as weights. The result is the predicted percent boys that will be born to women in the sample once child bearing for that spell is over. The predicted percent boys is tested against the natural percentage boys, 105 boys per 100 girls, with *** indicating significantly different at the 1% level, ** at the 5% level, and * at 10% level.

[c] Probability of giving birth by the end of the spell period.

Table E.6: Estimated Average Birth Interval in Months, Sex Ratio, and Probability of Parity Progression for Women with 1–7 Years of Education

Spell	Composition of prior Children	1972–1984 Inter-val[a] (Mos)	1972–1984 Per-cent[b] boys	1972–1984 Proba-bility birth[c]	1985–1994 Inter-val[a] (Mos)	1985–1994 Per-cent[b] boys	1985–1994 Proba-bility birth[c]	1995–2004 Inter-val[a] (Mos)	1995–2004 Per-cent[b] boys	1995–2004 Proba-bility birth[c]	2005–2016 Inter-val[a] (Mos)	2005–2016 Per-cent[b] boys	2005–2016 Proba-bility birth[c]
								Urban					
	1 girl	29.4	51.5	0.970	32.4	52.6	0.942	33.9	53.2**	0.928	35.3	52.7	0.909
2		(0.4)	(1.5)	(0.005)	(0.4)	(1.2)	(0.006)	(0.3)	(0.9)	(0.005)	(0.5)	(1.3)	(0.009)
	1 boy	31.4***	51.3	0.961	33.4	51.3	0.936	34.2	49.9	0.922	36.7**	51.0	0.862
		(0.5)	(1.6)	(0.006)	(0.5)	(1.3)	(0.006)	(0.3)	(0.9)	(0.006)	(0.6)	(1.2)	(0.009)
	2 girls	30.6	56.0*	0.954	34.7	52.4	0.928	37.2	56.6***	0.890	39.5	56.5**	0.841
		(0.8)	(2.7)	(0.012)	(0.9)	(2.1)	(0.012)	(0.8)	(1.5)	(0.011)	(0.8)	(2.2)	(0.017)
3	1 boy, 2 girl	33.2**	53.0	0.891	35.2	53.8*	0.837	35.7	51.6	0.730	36.6**	55.8***	0.609
		(0.6)	(1.8)	(0.011)	(0.7)	(1.6)	(0.012)	(0.6)	(1.4)	(0.013)	(0.9)	(1.7)	(0.017)
	2 boys	32.0	48.2	0.893	36.2	50.8	0.844	35.9	49.4	0.704	38.3	52.2	0.567
		(0.8)	(2.4)	(0.016)	(0.9)	(2.1)	(0.016)	(0.9)	(2.4)	(0.016)	(1.3)	(2.5)	(0.020)
	3 girls	33.1	49.8	0.944	35.3	55.9	0.922	40.9	61.6***	0.877	39.7	57.7*	0.845
		(1.8)	(5.1)	(0.030)	(1.2)	(3.7)	(0.021)	(1.2)	(3.7)	(0.029)	(1.3)	(3.6)	(0.029)
	1 boy, 2 girls	33.9	54.2	0.885	38.3*	56.4**	0.792	38.3*	55.3	0.657	38.4	51.3	0.579
4		(1.1)	(3.0)	(0.021)	(1.0)	(2.5)	(0.022)	(1.0)	(2.6)	(0.023)	(1.1)	(2.7)	(0.023)
	2 boys, 1 girl	35.4	50.7	0.851	40.7***	56.0	0.731	39.5	55.3	0.580	45.2**	49.2	0.437
		(1.4)	(3.6)	(0.031)	(1.2)	(3.3)	(0.027)	(1.2)	(3.0)	(0.024)	(1.8)	(4.1)	(0.027)
	3 boys	36.2	55.0	0.738	38.7*	41.7**	0.855	38.9	43.1	0.693	45.8*	60.1	0.542
		(3.5)	(6.7)	(0.068)	(1.6)	(4.2)	(0.033)	(2.1)	(5.5)	(0.043)	(3.2)	(6.7)	(0.053)
								Rural					
	1 girl	30.9	51.6	0.977	32.3	51.4	0.965	33.5	53.3***	0.963	34.4	52.8**	0.950
2		(0.3)	(1.1)	(0.003)	(0.3)	(0.9)	(0.004)	(0.2)	(0.5)	(0.002)	(0.3)	(0.7)	(0.004)
	1 boy	32.4***	50.0	0.971	33.0*	51.5	0.954	33.9	51.1	0.945	35.3***	50.5	0.908
		(0.3)	(1.0)	(0.004)	(0.3)	(0.8)	(0.004)	(0.2)	(0.5)	(0.002)	(0.2)	(0.6)	(0.004)
	2 girls	29.5	50.6	0.966	31.4	54.1**	0.939	34.6	53.6**	0.933	36.5	55.4***	0.892
		(0.5)	(1.9)	(0.007)	(0.4)	(1.4)	(0.008)	(0.4)	(1.0)	(0.005)	(0.4)	(1.0)	(0.007)
3	1 boy, 2 girl	32.4***	51.4	0.931	34.4***	51.7	0.887	34.9	52.5*	0.793	37.1	53.6**	0.707
		(0.5)	(1.3)	(0.007)	(0.4)	(1.2)	(0.007)	(0.3)	(0.8)	(0.006)	(0.4)	(1.0)	(0.008)
	2 boys	34.3***	49.6	0.929	35.1***	50.8	0.866	35.5*	49.5	0.741	37.5	49.4	0.633
		(0.8)	(2.0)	(0.011)	(0.7)	(1.5)	(0.011)	(0.5)	(1.1)	(0.009)	(0.6)	(1.4)	(0.011)
	3 girls	31.6	49.5	0.983	35.0	54.2	0.962	37.5	55.5**	0.947	39.4	57.7***	0.920
		(1.1)	(3.7)	(0.011)	(0.7)	(2.7)	(0.009)	(0.7)	(2.0)	(0.009)	(0.5)	(1.5)	(0.011)
	1 boy, 2 girls	34.4**	50.0	0.930	36.9**	55.1**	0.893	38.3	52.9	0.755	40.7*	51.9	0.702
4		(0.8)	(2.4)	(0.014)	(0.6)	(1.6)	(0.011)	(0.6)	(1.4)	(0.015)	(0.5)	(1.4)	(0.013)
	2 boys, 1 girl	36.6***	46.5*	0.885	39.1***	51.0	0.846	39.7**	52.1	0.597	44.0***	52.4	0.541
		(0.9)	(2.7)	(0.020)	(0.8)	(2.1)	(0.015)	(0.9)	(1.8)	(0.017)	(0.7)	(1.8)	(0.014)
	3 boys	33.7	55.0	0.939	37.9**	56.7*	0.883	41.6***	51.6	0.686	42.5**	44.1*	0.546
		(1.4)	(4.5)	(0.022)	(1.2)	(3.2)	(0.024)	(1.4)	(3.8)	(0.029)	(1.4)	(3.7)	(0.027)

Note. The statistics for each spell/period combination are calculated based on the competing risk hazard model for that combination as described in the main text, using bootstrapping to find the standard errors shown in parentheses. For bootstrapping, the original sample is resampled, the hazard model run on the resampled data, and the statistics calculated. This process is repeated 100 times and the standard errors calculated.

[a] Average birth interval is calculated as follows. For each woman in a given spell/period combination sample, I calculate the probability of that she will give birth for each period, conditional on the likelihood that she will eventually give birth in that spell, and use these probabilities as weights to calculated the expected spell duration. The reported statistics is the average of these intervals across all women in a given sample using the individual predicted probabilities of having had a birth by the end of the spell as weights with nine months added to account for spell start. Birth intervals for sex compositions other than all girls are tested against the duration for all girls, with *** indicating significantly different at the 1% level, ** at the 5% level, and * at the 10% level.

[b] Percent boys is calculated as follows. For each woman in a given spell/period combination sample, I calculate the predicted percent boys for each month and sum this across the length of the spell using the likelihood of having a child in each month as the weight. The percent boys is then averaged across all women in the given sample using the individual predicted probabilities of having had a birth by the end of the spell as weights. The result is the predicted percent boys that will be born to women in the sample once child bearing for that spell is over. The predicted percent boys is tested against the natural percentage boys, 105 boys per 100 girls, with *** indicating significantly different at the 1% level, ** at the 5% level, and * at 10% level.

[c] Probability of giving birth by the end of the spell period.

Table E.7: Estimated Average Birth Interval in Months, Sex Ratio, and Probability of Parity Progression for Women with 8–11 Years of Education

		1972–1984			1985–1994			1995–2004			2005–2016		
Spell	Composition of prior Children	Inter-val[a] (Mos)	Per-cent[b] boys	Proba-bility birth[c]	Inter-val[a] (Mos)	Per-cent[b] boys	Proba-bility birth[c]	Inter-val[a] (Mos)	Per-cent[b] boys	Proba-bility birth[c]	Inter-val[a] (Mos)	Per-cent[b] boys	Proba-bility birth[c]
							Urban						
2	1 girl	31.4	52.0	0.947	35.8	54.3***	0.919	37.1	55.8***	0.897	39.4	52.9*	0.866
		(0.4)	(1.4)	(0.005)	(0.4)	(1.1)	(0.007)	(0.3)	(0.7)	(0.004)	(0.4)	(1.0)	(0.007)
	1 boy	32.7*	53.5*	0.932	35.9	51.4	0.882	37.7	50.1*	0.867	39.5	50.4	0.780
		(0.6)	(1.2)	(0.007)	(0.4)	(1.0)	(0.007)	(0.3)	(0.7)	(0.004)	(0.4)	(0.9)	(0.009)
3	2 girls	34.5	53.8	0.891	39.9	61.0***	0.790	41.1	61.2***	0.786	44.9	60.2***	0.725
		(1.0)	(2.5)	(0.015)	(0.9)	(2.3)	(0.018)	(0.7)	(1.6)	(0.013)	(0.8)	(1.8)	(0.015)
	1 boy, 2 girl	35.1	55.1*	0.771	37.8	52.6	0.613	38.4***	52.4	0.537	40.9***	54.5**	0.379
		(0.8)	(2.0)	(0.014)	(0.8)	(1.7)	(0.013)	(0.6)	(1.3)	(0.010)	(1.0)	(1.6)	(0.012)
	2 boys	36.5	50.6	0.710	39.9	53.3	0.617	37.6***	48.0	0.512	43.5	48.9	0.360
		(0.9)	(2.9)	(0.023)	(1.2)	(2.1)	(0.020)	(0.8)	(2.3)	(0.017)	(1.4)	(3.2)	(0.019)
4	3 girls	35.9	59.6	0.850	40.2	64.1***	0.831	43.0	61.6**	0.846	46.6	62.5***	0.790
		(1.9)	(6.7)	(0.038)	(1.5)	(3.8)	(0.025)	(1.6)	(4.1)	(0.026)	(1.2)	(3.7)	(0.025)
	1 boy, 2 girls	34.9	52.4	0.660	41.5	52.5	0.573	42.0	61.6***	0.527	44.4	61.3***	0.383
		(1.6)	(4.3)	(0.035)	(1.3)	(2.9)	(0.025)	(1.3)	(2.7)	(0.024)	(1.4)	(3.3)	(0.023)
	2 boys, 1 girl	35.3	52.5	0.637	39.2	47.8	0.504	43.3	51.2	0.346	43.1	53.9	0.241
		(1.8)	(4.3)	(0.040)	(1.8)	(4.0)	(0.033)	(2.0)	(4.8)	(0.024)	(2.7)	(5.0)	(0.025)
	3 boys	35.8	55.5	0.677	44.4	58.1	0.495	40.9	47.9	0.457	45.5	52.4	0.325
		(3.2)	(7.9)	(0.065)	(3.2)	(8.0)	(0.052)	(2.8)	(7.3)	(0.050)	(4.0)	(8.8)	(0.044)
							Rural						
2	1 girl	32.4	50.9	0.970	34.1	52.7	0.951	34.9	55.0***	0.943	36.8	54.5***	0.922
		(0.6)	(1.7)	(0.006)	(0.4)	(1.1)	(0.005)	(0.2)	(0.5)	(0.003)	(0.3)	(0.5)	(0.004)
	1 boy	32.4	48.3*	0.948	34.1	50.8	0.923	35.2	50.4	0.904	37.4	49.9**	0.838
		(0.6)	(1.7)	(0.007)	(0.5)	(1.2)	(0.006)	(0.2)	(0.6)	(0.003)	(0.3)	(0.6)	(0.005)
3	2 girls	34.6	55.4	0.946	36.5	58.4***	0.912	37.2	59.5***	0.878	40.9	58.4***	0.833
		(1.1)	(3.3)	(0.014)	(0.9)	(2.2)	(0.013)	(0.4)	(1.1)	(0.008)	(0.4)	(1.0)	(0.007)
	1 boy, 2 girl	33.9	52.3	0.832	35.0	52.5	0.703	36.0**	54.5***	0.637	37.7***	53.2**	0.492
		(0.8)	(2.3)	(0.017)	(0.7)	(1.9)	(0.014)	(0.4)	(0.9)	(0.008)	(0.5)	(1.0)	(0.007)
	2 boys	35.6	45.9	0.806	35.3	48.7	0.692	36.3	50.4	0.589	39.3	49.6	0.449
		(1.3)	(3.3)	(0.025)	(1.1)	(2.5)	(0.021)	(0.6)	(1.4)	(0.013)	(0.8)	(1.6)	(0.011)
4	3 girls	32.3	50.4	0.976	41.4	60.9**	0.872	41.2	61.3***	0.880	41.8	59.9***	0.844
		(2.6)	(7.5)	(0.025)	(1.4)	(4.6)	(0.027)	(0.9)	(2.8)	(0.017)	(0.7)	(1.9)	(0.014)
	1 boy, 2 girls	38.2**	44.2	0.876	40.6	51.0	0.767	39.0*	55.3*	0.611	43.3	55.3**	0.491
		(1.6)	(4.3)	(0.035)	(1.0)	(2.8)	(0.024)	(0.8)	(2.1)	(0.017)	(0.8)	(1.9)	(0.013)
	2 boys, 1 girl	40.8***	50.9	0.764	41.9	55.1	0.624	40.2	52.2	0.489	47.1***	48.9	0.389
		(2.0)	(5.1)	(0.051)	(1.6)	(4.2)	(0.033)	(1.2)	(3.1)	(0.020)	(1.1)	(2.7)	(0.019)
	3 boys	37.1	56.1	0.820	40.0	42.7	0.625	41.4	60.3*	0.599	45.5*	60.9**	0.449
		(3.6)	(10.6)	(0.072)	(3.0)	(6.9)	(0.060)	(1.8)	(4.9)	(0.043)	(1.9)	(4.5)	(0.031)

Note. The statistics for each spell/period combination are calculated based on the competing risk hazard model for that combination as described in the main text, using bootstrapping to find the standard errors shown in parentheses. For bootstrapping, the original sample is resampled, the hazard model run on the resampled data, and the statistics calculated. This process is repeated 100 times and the standard errors calculated.

[a] Average birth interval is calculated as follows. For each woman in a given spell/period combination sample, I calculate the probability of that she will give birth for each period, conditional on the likelihood that she will eventually give birth in that spell, and use these probabilities as weights to calculated the expected spell duration. The reported statistics is the average of these intervals across all women in a given sample using the individual predicted probabilities of having had a birth by the end of the spell as weights with nine months added to account for spell start. Birth intervals for sex compositions other than all girls are tested against the duration for all girls, with *** indicating significantly different at the 1% level, ** at the 5% level, and * at the 10% level.

[b] Percent boys is calculated as follows. For each woman in a given spell/period combination sample, I calculate the predicted percent boys for each month and sum this across the length of the spell using the likelihood of having a child in each month as the weight. The percent boys is then averaged across all women in the given sample using the individual predicted probabilities of having had a birth by the end of the spell as weights. The result is the predicted percent boys that will be born to women in the sample once child bearing for that spell is over. The predicted percent boys is tested against the natural percentage boys, 105 boys per 100 girls, with *** indicating significantly different at the 1% level, ** at the 5% level, and * at 10% level.

[c] Probability of giving birth by the end of the spell period.

Table E.8: Estimated Average Birth Interval in Months, Sex Ratio, and Probability of Parity Progression for Women with 12 or More Years of Education

Spell	Composition of prior Children	1972–1984 Inter-val[a] (Mos)	1972–1984 Per-cent[b] boys	1972–1984 Proba-bility birth[c]	1985–1994 Inter-val[a] (Mos)	1985–1994 Per-cent[b] boys	1985–1994 Proba-bility birth[c]	1995–2004 Inter-val[a] (Mos)	1995–2004 Per-cent[b] boys	1995–2004 Proba-bility birth[c]	2005–2016 Inter-val[a] (Mos)	2005–2016 Per-cent[b] boys	2005–2016 Proba-bility birth[c]
	Urban												
	1 girl	38.3	52.3	0.887	42.0	56.4***	0.853	43.9	60.6***	0.830	45.6	59.0***	0.782
2		(0.7)	(1.8)	(0.011)	(0.6)	(1.2)	(0.009)	(0.4)	(0.8)	(0.006)	(0.4)	(1.0)	(0.008)
	1 boy	38.8	49.1	0.888	43.0	53.1	0.794	43.2	49.7**	0.773	46.8	48.8**	0.669
		(0.7)	(1.9)	(0.010)	(0.5)	(1.2)	(0.010)	(0.3)	(0.7)	(0.006)	(0.6)	(1.0)	(0.008)
	2 girls	39.5	59.9*	0.717	45.4	66.7***	0.598	47.2	72.0***	0.607	51.3	77.1***	0.514
		(1.4)	(5.0)	(0.031)	(1.5)	(2.5)	(0.025)	(1.1)	(1.9)	(0.017)	(1.3)	(2.0)	(0.019)
3	1 boy, 2 girl	41.7	49.1	0.435	42.3	55.4	0.296	42.4***	55.2*	0.252	43.5***	57.8**	0.165
		(1.7)	(4.2)	(0.028)	(1.5)	(3.2)	(0.016)	(0.9)	(2.0)	(0.009)	(1.4)	(2.9)	(0.009)
	2 boys	41.1	47.2	0.439	42.4	45.8	0.259	40.6***	37.7***	0.241	44.1***	48.0	0.172
		(2.2)	(5.2)	(0.033)	(2.3)	(4.7)	(0.021)	(1.3)	(3.1)	(0.015)	(2.1)	(4.1)	(0.012)
	Rural												
	1 girl	35.3	55.3	0.962	38.7	54.0	0.927	39.6	55.3***	0.918	41.0	57.0***	0.891
2		(1.7)	(5.0)	(0.017)	(1.1)	(3.0)	(0.014)	(0.4)	(1.0)	(0.005)	(0.4)	(0.9)	(0.007)
	1 boy	36.9	41.6**	0.923	39.8	52.8	0.838	39.0	51.2	0.843	40.8	48.1***	0.765
		(1.5)	(4.9)	(0.026)	(1.1)	(2.6)	(0.019)	(0.4)	(1.1)	(0.007)	(0.5)	(1.0)	(0.009)
	2 girls	32.0	39.4	0.750	44.2	51.4	0.799	41.5	59.6***	0.800	45.5	65.5***	0.728
		(2.8)	(11.5)	(0.075)	(2.2)	(6.4)	(0.038)	(1.0)	(2.4)	(0.016)	(0.8)	(1.8)	(0.017)
3	1 boy, 2 girl	38.4	69.1	0.655	41.1	67.6***	0.565	39.3	54.1	0.433	40.9***	55.2*	0.312
		(3.1)	(11.0)	(0.070)	(2.4)	(5.1)	(0.037)	(1.1)	(2.4)	(0.017)	(1.1)	(2.1)	(0.012)
	2 boys	36.7	28.6**	0.813	38.1	35.4**	0.568	38.8	44.2**	0.405	40.3***	46.7	0.276
		(3.6)	(9.2)	(0.072)	(3.6)	(7.0)	(0.059)	(1.7)	(3.4)	(0.023)	(1.8)	(3.9)	(0.017)

Note. The statistics for each spell/period combination are calculated based on the competing risk hazard model for that combination as described in the main text, using bootstrapping to find the standard errors shown in parentheses. For bootstrapping, the original sample is resampled, the hazard model run on the resampled data, and the statistics calculated. This process is repeated 100 times and the standard errors calculated.

[a] Average birth interval is calculated as follows. For each woman in a given spell/period combination sample, I calculate the probability of that she will give birth for each period, conditional on the likelihood that she will eventually give birth in that spell, and use these probabilities as weights to calculated the expected spell duration. The reported statistics is the average of these intervals across all women in a given sample using the individual predicted probabilities of having had a birth by the end of the spell as weights with nine months added to account for spell start. Birth intervals for sex compositions other than all girls are tested against the duration for all girls, with *** indicating significantly different at the 1% level, ** at the 5% level, and * at the 10% level.

[b] Percent boys is calculated as follows. For each woman in a given spell/period combination sample, I calculate the predicted percent boys for each month and sum this across the length of the spell using the likelihood of having a child in each month as the weight. The percent boys is then averaged across all women in the given sample using the individual predicted probabilities of having had a birth by the end of the spell as weights. The result is the predicted percent boys that will be born to women in the sample once child bearing for that spell is over. The predicted percent boys is tested against the natural percentage boys, 105 boys per 100 girls, with *** indicating significantly different at the 1% level, ** at the 5% level, and * at 10% level.

[c] Probability of giving birth by the end of the spell period.

F Infant Mortality Graphs

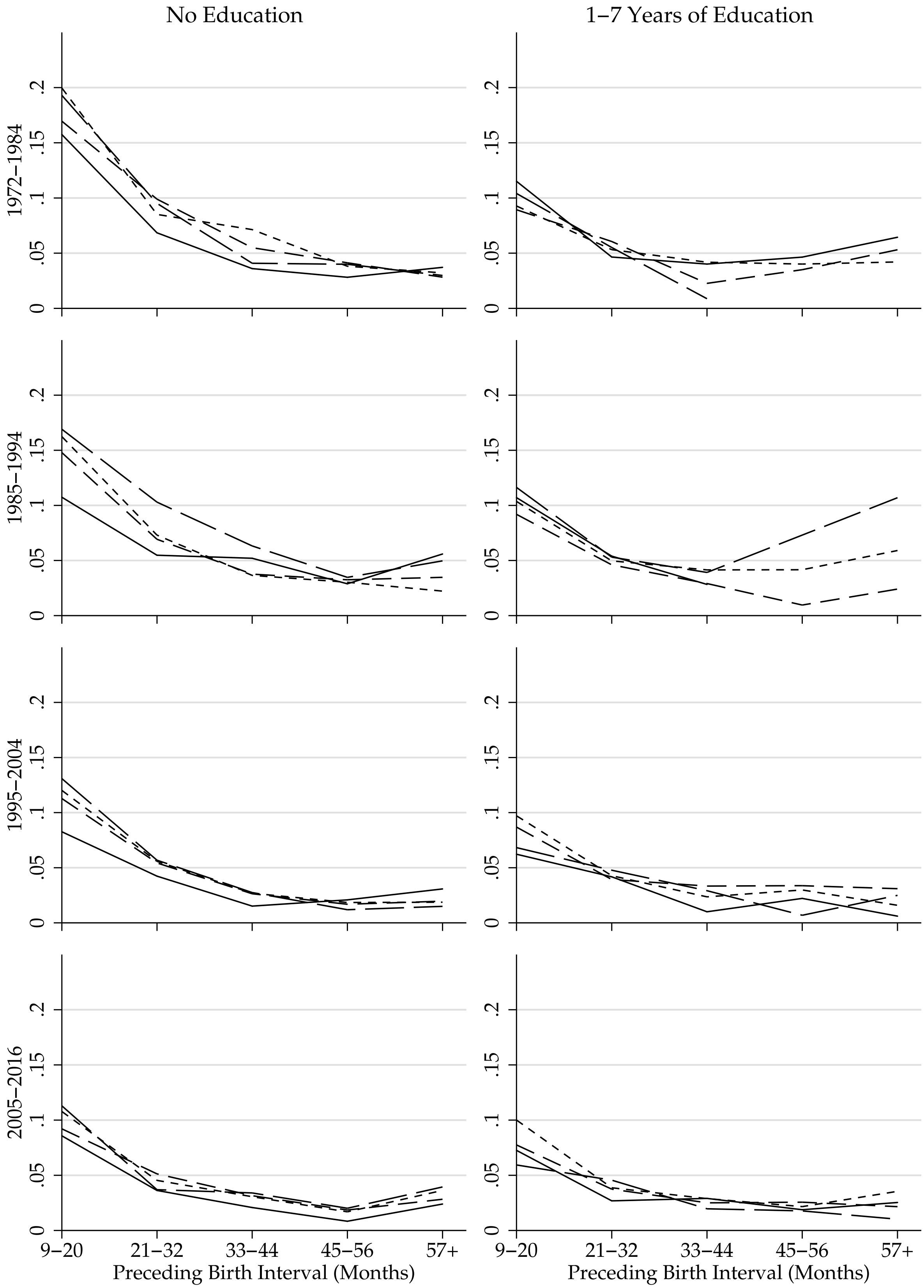


Figure F.1: Infant mortality by preceding birth interval across periods for third child of women with no education and women with 1–7 years of education

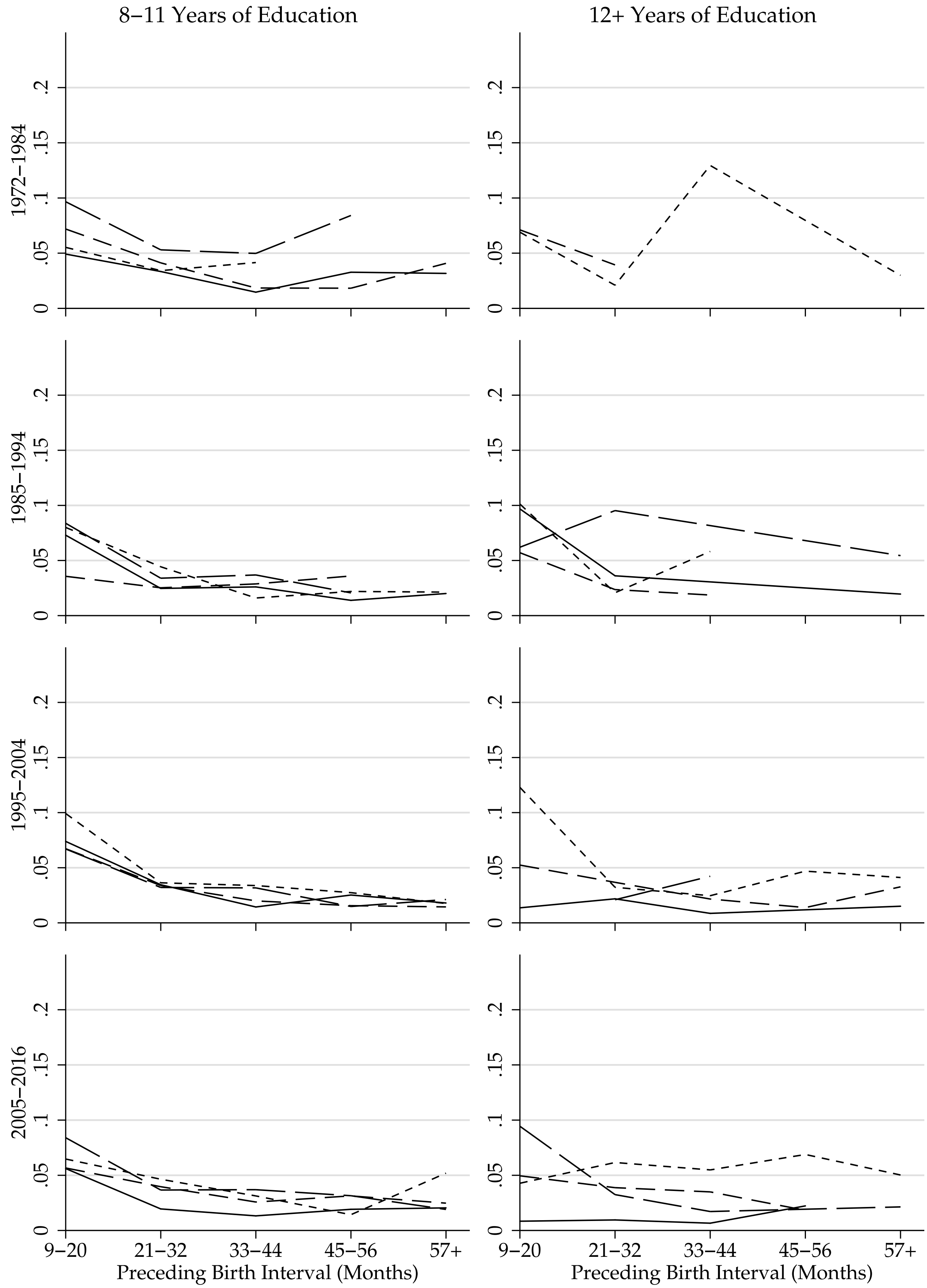


Figure F.2: Infant mortality by preceding birth interval across periods for third child of women with 8–11 and 12 and above years of education