Sex-Selective Abortions, Fertility, and Birth Spacing*

Claus C Pörtner
Department of Economics
Albers School of Business and Economics
Seattle University, P.O. Box 222000
Seattle, WA 98122
cportner@seattleu.edu
www.clausportner.com
&
Center for Studies in Demography and Ecology
University of Washington

November 2016

*I am grateful to Andrew Foster and Darryl Holman for discussions about the method. I owe thanks to Shelly Lundberg, Daniel Rees, David Ribar, Hendrik Wolff, seminar participants at University of Copenhagen, University of Michigan, University of Washington, University of Århus, the Fourth Annual Conference on Population, Reproductive Health, and Economic Development, and the Economic Demography Workshop for helpful suggestions and comments. I would also like to thank Nalina Varanasi for research assistance. Support from the University of Washington Royalty Research Fund and the Development Research Group of the World Bank is gratefully acknowledged. The views and findings expressed here are those of the author and should not be attributed to the World Bank or any of its member countries. Partial support for this research came from a Eunice Kennedy Shriver National Institute of Child Health and Human Development research infrastructure grant, 5R24HD042828, to the Center for Studies in Demography and Ecology at the University of Washington. Prior versions of this paper were presented under the title "The Determinants of sex-selective Abortions."

Abstract

This paper addresses two main questions: what is the relationship between fertility and sex selection and how does birth spacing interact with the use of sex-selective abortions? I introduce a statistical method that incorporates how sex-selective abortions affect both the likelihood of a son and spacing between births. Using India's National Family and Health Surveys, I show that falling fertility intensifies use of sex selection, leading to use at lower parities, and longer spacing after a daughter is born. Women with 8 or more years of education, both in urban and rural areas, are the main users of sex-selective abortions and have the lowest fertility. Women with less education have substantially higher fertility and do not appear to use sex selection. Predicted lifetime fertility for high-education women declined more than 10% between 1985–1994, when sex selection was legal, and 1995–2006, when sex selection was illegal. Fertility is now around replacement level. Abortions per woman increased almost 20% for urban women and 50% for rural women between the two periods, suggesting that making sex selection illegal has not reversed its use. Finally, sex selection appears to be used to ensure one son rather than multiple sons.

JEL: J1, O12, I1 Keywords: India, prenatal sex determination, censoring, competing risk

1 Introduction

The males-to-females ratio at birth increased dramatically over the last three decades in India as access to prenatal sex determination expanded.[1] Our understanding of the use of sex selection is, however, constrained by lack of information; there are no official data on sex selection, and the few surveys that ask about use of sex selection show signs of serious under-reporting (Goodkind, 1996). With no direct information, researchers have relied on a simple method for establishing factors that affect sex selection: use the sex of children born as the dependent variable, and estimate the effects of variables on the probability of having a son.[2] Based on this simple method, we know that families with no sons are more likely to use sex selection the higher the parity; that use of sex selection increases with socioeconomic status, especially education; and that sex selection is more widespread in cities than in rural areas (Retherford and Roy, 2003; Jha et al., 2006; Abrevaya, 2009).[3]

I address two important questions that the prior literature has been unable to examine because of the simple method's limitations. First, what is the relationship between fertility decisions and use of sex selection? Second, how does birth spacing interact with use of sex-selective abortions? I introduce a novel method that directly incorporates that sex-selective abortions affect both the likelihood of a son being born *and* the duration between births. I use the method to argue that differences in fertility over time and between groups explain a substantial portion of the changes in the use of sex selection in India, and to show how spacing between births play an important role in our understanding of fertility and sex selection decisions.

We already know that fertility and son preference are related from the substantial literature on

[1] See Das Gupta and Bhat (1997), Sudha and Rajan (1999), Arnold, Kishor and Roy (2002), Retherford and Roy (2003) and Jha, Kumar, Vasa, Dhingra, Thiruchelvam and Moineddin (2006). India is not alone; both China and South Korea saw significant changes in the sex ratio at birth (Yi, Ping, Baochang, Yi, Bohua and Yongpiing, 1993; Park and Cho, 1995).

[2] In the absence of any interventions, the probability of having a son is approximately 0.512, which is independent of genetic factors (Ben-Porath and Welch, 1976; Jacobsen, Moller and Mouritsen, 1999). With fetus sex random, a statistically significant variable indicates an association with use of sex-selective abortions. Examples of studies that have used this approach are Retherford and Roy (2003), Jha et al. (2006), and Abrevaya (2009).

[3] There is substantial disagreement on whether sex-selective abortion is used for the first birth (Retherford and Roy, 2003; Jha et al., 2006).

fertility stopping behavior before sex selection was available. This literature shows that families are more likely to stop childbearing after the birth of a son than after the birth of a daughter (see, for example, Das, 1987; Arnold, 1997; Clark, 2000).[4] It is also easy to see how declining fertility may increase use of sex selection. Take a family that wants one son. If the family is willing to have up to 4 children, the probability of having a son is more than 94 percent, even without sex selection, and that increases to almost 99 percent if the family is willing to have up to 6 children.[5] If the desire is instead for one son *and* a maximum of two children, there is a 24 percent chance that the family will have to resort to sex selection to achieve both targets. Despite these opposite targets, there is little empirical analysis of the effects of fertility on sex selection using individual level data (Park and Cho, 1995; Ebenstein, 2011).[6]

Closely related to the overall fertility decisions are decisions on spacing between births. In the absence of sex-selective abortions, son preference often leads to a shorter duration until the next birth if the previous birth was a daughter (see, for example, Das, 1987; Rahman and DaVanzo, 1993; Pong, 1994; Haughton and Haughton, 1996; Arnold, 1997). The resulting shorter spacing is thought to be associated with worse health outcomes for the girls (Arnold, Choe and Roy, 1998; Whitworth and Stephenson, 2002; Rutstein, 2005; Conde-Agudelo, Rosas-Bermúdez and Kafury-Goeta, 2006).

What has not previously been appreciated is that the introduction of sex-selective abortions substantially changed the relationship between son preference and birth spacing. The change happens because each abortion significantly increases the duration until the next birth. The increase

[4] Filmer, Friedman and Schady (2009) analyse the relationship between the sex composition of previous children and subsequent fertility behavior using data from 64 countries.

[5] The probability of not having a son are 48.8 percent for one child, 23.8 percent for two children, 11.6 percent for 3 children, 5.7 percent for 4 children, 2.8 percent for 5 children, and 1.4 percent for 6 children.

[6] Dharmalingam, Rajan and Morgan (2014) examine how state level fertility in India relates to desired family size and son preference over time, but does not look at how fertility preferences shape the decision on sex-selective abortions. At country level Bongaarts (2013) shows how sex ratios at births are only elevated for countries with lower fertility and Bongaarts and Guilmoto (2015) use national level estimates of the relationship between sex ratio at birth and fertility as part of their prediction of the number of missing women past and present. Simulations suggest that in Korea introduction of sex selection changed family size little, but did result in abortions of female fetuses equal to about 5 percent of actual female births (Park and Cho, 1995). For China allowing a three-child policy has been predicted to increase the fertility rate by 35 percent, but also reduce the number of girls aborted by 56 percent (Ebenstein, 2011).

in duration can be divided into three parts starting from the time of the abortion. First, the uterus needs at least two menstrual cycles to recover before conception, because a less than three months space between abortion and conception substantially increases the likelihood of a spontaneous abortion (Zhou, Olsen, Nielsen and Sabroe, 2000). Secondly, the average expected time to conception is about 6 months. Finally, sex determination tests are generally reliable only from 3 months of gestation onwards. The result is that each abortion delays the next birth by approximately a year.[7]

How spacing interacts with sex selection is important for two reasons. First, spacing, by itself, can no longer be used to predict son preference. Because each abortions extends spacing by about a year, we now have a situation where the *longest* spacing is likely observed for families with the strongest son preference. To further complicate matters, we may still observe short spacing after the birth of daughter as a representation of son preference for families who either have less access to sex-selective abortions or are willing to have more children. Spacing is still important and useful in understanding sex selection and son preference, but only if combined with the outcome of that spacing—in other words the likelihood of observing a boy or a girl.

Second, families may reverse their decision to use sex selection in-between births. A reversal could happen if they do not want the space between children to be "too long", or if there are concerns about possible infertility as a result of too many abortions in a row without a birth. Hence, for a given parity, the sample of women for whom we do observe a birth may behave differently from the sample of women who have not yet had a birth. This is a problem because births to women with shorter spacing are more likely to be in the survey for a given parity. Hence, if decisions on sex selection change with duration since last birth, the predicted sex ratio for a

[7] There are three well-developed technologies for determining a fetus' sex: Chorionic villus sampling (CVS), amniocentesis, and ultrasound. CVS can be applied after the shortest period of gestation (8 to 12 weeks). It is the most complicated, but also the most reliable, and an abortion can be done in the first trimester. Amniocentesis can be performed after fourteen weeks, but requires three to four weeks before the result is available, so an abortion cannot be performed until more than halfway through the second trimester. Ultrasound has the advantages of being non-invasive and relatively cheap but is associated with higher risk of faulty sex determination if done early. Generally, a fetus' sex can be determined in the third month of gestation if it is a boy and the fourth month if it a girl.

The waiting time to conception does vary by woman, but even if it is very short, say one month, the minimum additional space between births would be 6 months per abortion. For a discussion of time to conception see (Wang, Chen, Wang, Chen, Guang and French, 2003) parity using the simple method will be a biased estimate of the final observed sex ratio for the parity when childbearing is complete.

The main contribution of this paper is the introduction and application of a method that incorporates the decisions about fertility, birth spacing, and sex-selective abortions. The method allows us to better understand the relationship between these three decisions. The empirical model is a competing risk, non-proportional hazard model with two exit states: either a boy or a girl is born. This approach has three major advantages over the simple method. First and foremost, it models fertility and spacing decisions jointly with the birth outcome, which makes it possible to better understand how changing fertility decisions affects the use of sex selection. Secondly, by explicitly incorporating censoring of birth spacing, it addresses any potential bias from ignoring how sex selection decisions may change with duration from the previous birth. Finally, the method allows us to predict completed fertility, total number of abortions, and final sex ratio over a woman's reproductive life cycle. These provide a better way of measuring changes in the use of sex selection than what we can get from individual parities—especially because individual parities may show a decline in sex selection at the same time as overall use is increasing. None of these is possible using the simple method.

I apply the method to birth histories from India's National Family and Health Surveys for Hindu women covering the period 1972 to 2006. There are three main findings. First, fertility is an important factor in the decision to use sex-selective abortions. On the one hand, women with fewer than 8 years of education have relatively high fertility and do not appear to use sex selection. On the other hand, better-educated women in both urban and rural areas have much lower fertility and are the main users of sex-selective abortions. For women with 8 or more years of education and only daughters the use is substantial: around 60 percent of the children born are boys. Furthermore, as better-educated women's fertility has declined over time, sex selection occurs for earlier and earlier parities and has correspondingly increased in intensity. There is, however, still no evidence of sex selection being used on the first birth.

Secondly, sex selection appears to be used for securing one son, rather than a large number of sons. There is only limited use of sex-selective abortions for better-educated women with one or more sons. The exception is rural women with one son and one daughter, presumably to compensate for the higher child mortality in rural areas. These results are in line with the differential stopping behavior observed in many studies before sex selection became available (Repetto, 1972; Arnold et al., 1998; Dreze and Murthi, 2001).

Finally, the legal steps taken to combat sex-selective abortions have not been able to reverse its use. In 1994, the Central Government passed the Prenatal Diagnostic Techniques (PNDT) Act making determining and communicating the sex of a fetus illegal.[8] In the period 1985-1994 the predicted total number of abortions per 100 women by the end of childbearing was 8 for urban women and 6.8 for rural women. As completed fertility for high-education women fell to now around 2 in urban areas and 2.6 in rural areas, the number of sex-selective abortions 100 women are predicted to have during their childbearing years has increased to 9.4 for urban women and 10.5 for rural women. In other words, close to one in ten well-educated women will now have at least one abortion motivated by sex selection during their childbearing. Hence, although it is possible that the PDNT Act slowed the increase in use of sex selection, the total predicted number of abortions per woman continued to increase after the law was enacted. The end result is a sex ratio across all children of 53.7% boys for well-educated urban women and 53.4% for well-educated rural women.

2 Theory

The model I present here serves three purposes. First, it allows me to illustrate how fertility, sex selection, and birth spacing interact when changing the cost of children and access to sex selection. Second, I show that there are cases where parents reconsider their decision to use sex selection between births, which underscores why using only observed births may provide a biased view of

[8] Abortion has been legal in India since 1971 and still is. The Act is described in detail at http://pndt.gov.in/. The number of convictions has been low. It took until January 2008 for the first state, Haryana, to reach 5 convictions. Hence, private clinics operate with little risk of legal action (Sudha and Rajan, 1999). Maharashtra was the first state to pass a similar law in 1988.

how much sex selection takes place and what the final sex ratio will be. Finally, the model informs the empirical strategy presented below.

In the model, parents decide on fertility sequentially, given the number of boys and girls they already have. Parents fully control fertility in each period and the only source of uncertainty is whether they conceive a boy or a girl. This means that spacing between births arise only from the use of sex selection.[9] This is obviously a simplification and since the interaction between son preference and spacing is at the core of this paper, I first discuss factors that may affect spacing between birth.[10]

One factor that might impact desired spacing is health. As discussed above, shorter spacing after the birth of a girl is associated with worse health outcomes for both mother and children.[11] Because of the potential health effects, most of the literature on spacing for countries like India naturally focus on whether spacing is too short.

With the introduction of sex-selective abortions, "too long" spacing may, however, become a greater concern for parents, as repeated abortions can result in very long durations between births.[12] If "too long" spacing leads parents to reverse their decision to use prenatal sex determination within a spell this has important implications for the empirical method. A reversal may happen, for example, if parents have concerns about possible infertility from repeated abortions.

[9] A more realistic approach would have parents choose how "intensive" they want to use contraceptives, where the intensiveness translates into a stochastic conception process, so that parents do not directly control the timing of births but rather the probability of having a birth in a given period. The added complexity would, however, not add anything substantial to help answer the main question of what the relationship between fertility and sex selection is, and would detract from the main source of uncertainty, which is whether the couple will conceive a male or female fetus. Assuming that parents fully control fertility is relatively common in the economics literature on dynamic models of fertility, such as Happel, Hill and Low (1984), Wolpin (1984), Rosenzweig and Schultz (1985). The empirical approach does allow for stochastic occurrence of births through the use of a hazard model.

See Leung (1991) for a model that incorporates both stochastic births based on a chosen level of contraception and differential preferences for boys and girls. The model does not, however, allow for abortions and it does not appear possible to extend the model to incorporate abortions and still solve it an similar manner.

[10] It is possible that parents care directly about the length of spacing between births, but spacing outcomes are more likely the results of parents weighing many factors against each other.

[11] Wolpin (1984) and Newman (1988) present dynamic models where both births and deaths are stochastic, but the likelihood of a child dying is independent of the length of spacing to the prior birth.

[12] Shorter spacing was probably less of a concern to begin with for better educated mothers—who are also the most likely to use sex selection—since their children are substantially less likely to be negatively affected by short spacing than children of less educated mothers (Whitworth and Stephenson, 2002). In general, mortality risk is negatively related to maternal education (for India, see, for example, Tulasidhar, 1993), although the underlying mechanism is subject to debate (Kovsted, Pörtner and Tarp, 2002).

Furthermore, with the increasing education and wealth in India, a growing portion of the population is likely to behave in a manner that makes the literature on shorter spacing in middle- and high-income countries more relevant.[13] There may, for example, be economies of scale in childrearing—both in terms of time cost and direct cost—that are easier to take advantage of if births are closer (Newman and McCulloch, 1984, p 947). Similarly, if women's wages increase with age parents prefer to have their children early and close together while the opportunity cost of children is lower (Heckman and Willis, 1976).[14]

Finally, increased reliability of access and effectiveness of contraceptive can lead to shorter spacing between births (Keyfitz, 1971; Heckman and Willis, 1976). With less reliable contraception parents choose a higher level of contraception—resulting in longer spacing—to avoid having too many children by accident. But, as contraception becomes more effective parents can more easily avoid future births, allowing them to reduce the spacing between births without having to worry about overshooting their preferred number of children. This idea may also help explain shorter spacing for better educated women than for less educated women, provided that knowledge and ability to use contraception differ across education groups (Tulasidhar, 1993; Whitworth and Stephenson, 2002).

Instead of trying to model each of the factors that may affect spacing I instead set up a dynamic model with a discount rate. Parents maximize utility over a finite time horizon T

$$\max E \sum_{t=0}^{T} d^t [u(c_t) + \alpha u^b(b_t) + (1-\alpha)u^g(g_t)], \tag{1}$$

where E is the expectation operator, c_t consumption in period t, b_t the stock of boys in period t, g_t the stock of girls in period t, and d the discount rate. For ease of analysis I assume that utility in each period is separable in parental consumption, boys, and girls. I define son preference, α, as

[13] For the first birth, a potentially important factor in India is the pressure to show fecundity, which would tend to shorten the duration to the first birth (Dyson and Moore, 1983; Sethuraman, Gujjarappa, Kapadia-Kundu, Naved, Barua, Khoche and Parveen, 2007; Dommaraju, 2009).

[14] The time needed to care for young children can also impact timing if skills depreciate when out of the labor market (Happel et al., 1984). Whether depreciation leads to longer or shorter spacing depends on the specification of the depreciation function. See also the discussion in Hotz, Klerman and Willis (1997, p 315) and references therein.

higher marginal utility of next child being a boy if parents have an equal number, possibly zero, of boys and girls. The utility function covers a variety of different preferences from equal utility of boys and girls ($\alpha = 0.5$ provided $u^b(\cdot) = u^g(\cdot)$) to an extreme son preference where there is no utility of having a daughter ($\alpha = 1$).[15] The lower d is the more parents prefer immediate utility relative to future utility. Hence, the discount factor is a convenient way to capture how patient parents are and therefore how willing parents are to wait through multiple abortions to ensure a son.

At the beginning of each period parents have 3 possible choices: no pregnancy, a pregnancy without a prenatal sex determination scan, or a pregnancy with a prenantal sex determination scan followed by an abortion if the fetus is female. The probability of conceiving a boy is π, which is the same for all parents and in all periods. There is no child mortality, so both b and g are non-decreasing over time.

If a child is born parents incur a cost p_k for that child in the period of birth and all subsequent periods until the end of the time horizon.[16] If parents select a pregnancy with prenatal sex determination they pay p_s and also p_k if the fetus is a son and therefore carried to term. For two reasons the prenatal sex determination scan is best thought of as a bundled service that includes both the prenatal sex determination scan *and* the abortion if the fetus is female. First, it is more tractable than including additional steps in the decision process, especially since the only motivation for a prenatal scan in the model is sex selection, and a scan would therefore be "wasted" unless a female fetus was aborted. Second, I argue in the online Appendix that both parents and providers may prefer a bundled service, where there is an upfront cost and the service includes both the prenatal screening and the abortion—if needed—from the same provider. The budget constraint for each period is then

$$I_t = c_t + p_k(b_t + g_t) + p_s s, \tag{2}$$

[15] Other ways of defining son preference, such as wanting at least one son and not caring about sex composition after that, are possible but will be explored here. The basic results remain as long as there is different utility of sons and daughters for at least some sex compositions.

[16] Clearly boys and girls may carry different costs, but since the model already assumes that parents have different preferences over boys and girls there is no reason to further complicate the model. Similarly, the cost of maintaining a child likely depend on its age, but incorporating that would add little to the conclusions.

where I_t is income in period t and s is an indicator variable for whether the parents purchased prenatal sex determination.[17]

This maximization problem can be solved using dynamic programming, but because the choice variable and the state variables (number of boys and girls) are discrete a closed-form solution is generally not available. This means that simulation is the best way to analyze the model, but before turning to simulations it is worthwhile illustrating how the model works. I begin with the possible utility outcomes in period T, the last period in which parents make decisions on fertility. If parents decide on "no pregnancy" their utility in the final period will be

$$U_T^N = u(I - p_k(b_{T-1} + g_{T-1})) + \alpha u^b(b_{T-1}) + (1-\alpha)u^g(g_{T-1}). \tag{3}$$

If they instead decide to have a pregnancy without a prenatal scan their expected utility will be

$$\begin{aligned} U_T^B = \pi[&u(I - p_k(b_{T-1} + g_{T-1} + 1)) + \alpha u^b(b_{T-1} + 1) + (1-\alpha)u^g(g_{T-1})] + \\ &(1-\pi)[u(I - p_k(b_{T-1} + g_{T-1} + 1)) + \alpha u^b(b_{T-1}) + (1-\alpha)u^g(g_{T-1} + 1)]. \end{aligned} \tag{4}$$

Finally, if they decide to use prenatal sex determination their expected utility will be

$$\begin{aligned} U_T^S = \pi[&u(I - p_k(b_{T-1} + g_{T-1} + 1) - p_s) + \alpha u^b(b_{T-1} + 1) + (1-\alpha)u^g(g_{T-1})] + \\ &(1-\pi)[u(I - p_k(b_{T-1} + g_{T-1}) - p_s) + \alpha u^b(b_{T-1}) + (1-\alpha)u^g(g_{T-1})], \end{aligned} \tag{5}$$

since parents incur the cost of the scan, p_s, whether they conceive a male or a female fetus, but will not incur any additional childrearing costs if a girl is conceived.

To illustrate how the decision process works, consider the decision in the final period on whether to use sex selection or not (assuming that both are superior to no birth). Parents choose a

[17] This assumes that there is no saving or borrowing across periods. This is a common assumption in this type of model. See, for example, Heckman and Willis (1976), Wolpin (1984), Rosenzweig and Schultz (1985), Newman (1988), and Leung (1991). That there are only two stock variables, the number of boys and the number of girls, greatly simplifies the analysis.

pregnancy without prenatal sex determination if $U_T^B > U_T^S$, which leads to

$$(1-\pi)(1-\alpha)[u^g(g_{T-1}+1)-u^g(g_{T-1})] >$$
$$\pi u(I-p_k(b_{T-1}+g_{T-1}+1)-p_s)+(1-\pi)u(I-p_k(b_{T-1}+g_{T-1})-p_s)$$
$$-u(I-p_k(b_{T-1}+g_{T-1}+1)). \quad (6)$$

Hence, parents choose a pregnancy without prenatal scan over a pregnancy with a prenatal scan in the final period if the additional utility of having an extra girl (the left-hand-side), weighted by the probability of having a girl and the weight parents assign to utility from having girls, is larger than the expected impact on utility from consumption (the right-hand side), where the first two terms are the expected utility from consumption if using prenatal sex determination and the last term is utility from consumption if parents simply have a birth.[18]

If a son is conceived the money for a prenatal scan are "wasted," which means that the utility from consumption if they use prenatal scan and conceive a boy is alway going to be lower than utility from consumption if the parents had a birth without a prenatal scan. Hence, assuming that the marginal utility of girls is always positive, but declining in the number of girls they have, parents will pick a birth with scan over a birth without scan only if the difference between utility from consumption when using prenatal scan and conceiving a girl is sufficiently higher than the utility of consumption if the parents simply had a child without a scan. It follows that the higher the cost of the prenatal scan is relatively to the cost of maintaining a child the less likely it is that parents will use sex selection. Furthermore, if the cost of a prenatal scan, p_s, is larger than the cost of maintaining a child in one period, p_k, parents will never select a prenantal scan in the final period. This result holds, however, only because this is the last period. The earlier the decision on sex selection is made in the time horizon the lower the cost of prenatal sex determination is going to be relative to the cost of maintaining the child until the end of the time horizon.

[18] Notice that the marginal utility of having a boy does not enter into the decision on whether to use prenatal sex determination or not (except through the value of α). Only the marginal utility of having another girl and the total number of children, which affects the trade-off between consumption and use of sex selection, matters. This is an artifact of the separability between consumption, number of boys, and number of girls in the utility function.

Finally, increasing the cost of children, p_k—as would happen with higher education of mothers—increases the likelihood that sex selection will be used at a given number of children.[19] There are two reasons for this. First, when the cost per child goes up the given number of children translates into less income per period available for consumption. Second, the decline in consumption from having an additional child becomes larger. These combine to increase the marginal utility of consumption and thereby make it more attractive to have a prenatal scan.

Although it is possible to examine how decisions are made in the last period, the absence of closed-form solutions means that I cannot directly examine important questions such as whether parents will reverse their use of sex selection between births. I therefore now turn to simulation of the model for different parameters. Appendix Tables A.1-A.4 show the simulation results for average fertility and the ratio of boys to births for selected values of son preference (α), cost of prenatal sex determination (p_s) and cost of children (k). Appendix Tables A.5-A.8 show the corresponding simulation results for number of abortions per 100 women, average number of spells where prenatal scan has been used, and the percent of spells where the choice is initially pregnancy *with* a prenatal scan but the birth is from a pregnancy *without* a prenatal scan. The latter captures the likelihood of changing the decision to use sex selection between births and I cover that separately below. Appendix Tables A.9-A.12 show the average and maximum spacing between births by parity.

The specification and parameter values are chosen to illustrate the effects of changing parameters, rather than to provide a realistic set of outcomes. The utility function used for the simulations is[20]

$$U = 0.27\frac{(c-30)^{0.5}}{0.5} + \alpha\frac{b^{0.75}}{0.75} + (1-\alpha)\frac{g^{0.75}}{0.75}.$$

The simulations presented in the tables assume 15 periods, a period income of $I = 200$, and that the

[19] Higher education likely also increases household income, which makes it *less* likely parents will choose a birth with prenantal scan over a birth without a prenatal scan. Higher income means lower marginal utility from consumption, which makes the whole right-hand side move toward zero. For a given number of girls, this makes it more likely that the utility from an additional girl is sufficiently high that parents will simply have a birth. Empirically, increasing education of mothers is, however, strongly associated with lower fertility, which indicates that the negative effect of higher opportunity cost more than outweighing the positive effect of higher income (Schultz, 1997).

[20] See Leung (1994) for a discussion of potential utility functions with different preferences for sons and daughters.

probability of a son is 0.5. The four parameters and their examined values are the cost of children ($k \in 12, 14, 16, 18, 20, 22$), cost of prenatal sex determination ($p \in 12, 16, 20, 24, 200$)—where the last value is equivalent to no prenatal sex determination available, the degree of son preference ($\alpha \in 0.5, 0.55, 0.6, 0.65$), and the discount rate ($d \in 0.85, 0, 9, 0.95, 1.0$). The optimal choice sets are applied to a sample of 50,000 "individuals", each with 15 "potential" children, whose sex comes from a binomial distribution with the probability above.[21]

In the absence of prenatal sex determination, stronger son preference is often thought to increase overall fertility. That is not the case here. In fact, there is little correlation between the weight placed on utility from boys and fertility.[22] Similarly, parents' discount factor has no impact on fertility in the absence of prenatal sex determination. The one factor that does affect fertility is the cost of children; increasing the cost of children substantially reduces fertility.

Introducing prenatal sex determination has two opposing effects on fertility in the model. On one hand, it takes fewer births to reach a desired number of sons and this reduces fertility. On the other hand, parents no longer have to pay for unwanted children and this "wealth effect" increases fertility. The simulations show that for most combinations of son preference and cost of children cutting the cost of abortion has little effect on fertility—even if the cut is substantial—indicating that for this set-up and the chosen parameter values the two effects cancel each other out.[23]

Lowering the cost of prenatal sex determination does, however, bias the overall sex ratio further towards boys, and the stronger the son preference and the more patient the parents, the larger the change in sex ratio. Correspondingly, both the number of abortions per woman and the average number of spells per woman where a prenatal scan is used also increases. Since fertility changes little, the increased use of abortion is associated with longer spacing between births. This increase in spacing is, however, not uniform across parities. In addition to increasing the overall sex ratio,

[21] I also ran simulations on an expanded set of parameter values. I use these results for regression analysis of the effect of parameters. These are available upon request.

[22] This is confirmed by regressing the weight places on sons, cost of children, and discount factor against fertility for the expanded set of values.

[23] Running regressions on the expanded simulation results show a negative, but statistically insignificant relationship between cost of abortion and fertility. For high son preference and cost of children the effect of decreasing cost of prenatal scan is either nill or slightly positive. See also the discussions in Leung (1994) and Davies and Zhang (1997).

lower cost of prenatal scan leads to use of sex selection at earlier parities. The result is that in some cases there is either no change or a *decrease* in average spacing for a given parity—although with a more than compensating increase in an earlier parity.[24] Hence, it is possible for individual parities to show a *decline* in sex selection at the same time as the overall use goes up. This is an important caution against over-interpreting individual parity results. It also highlights the need to incorporate fertility progression into estimates, something the simple model is incapable of.

The strongest driver of fertility in the model is the cost of child maintenance per period. As fertility decreases with higher cost of children, sex ratios become more male biased—although it is possible that there is non-linearity in the effect of child cost on sex ratios.[25] This non-linearity also shows up in the number of abortions and spells where a prenatal scan has been used, but the overall trend is towards more abortions and more spells with prenatal scan per birth as the cost of children increase.

Increasing the value of having sons, α, when there is access to sex selection results in slightly lower fertility in most cases, but the effect is neither strong nor uniform. What is clear is that the sex ratio becomes more male biased the stronger the son preference. Correspondingly, there is an increased number of abortions, more spells where a prenatal scan is used, and the spacing between births is longer.

Son preference, however, manifests in two ways in this model. First, if α is larger than 0.5 parents gain more utility from having an additional son than from an additional daughter—provided the had the same number of sons and daughters before. Second, parents will never abort a male fetus, only a female one. This explains why even when parents have equal utility from an additional son or daughter sex ratios still increases as cost of children increases and cost of prenatal scans

[24] One example is the second parity for $k = 22$ and $\alpha = 0.65$ when cost of prenatal scan decreases from 24 to 20. The average spacing for the second parity falls from 1.5 to 1.25, but the average spacing for the first parity goes from 1 (no use of sex selection) to 1.5. Another example is for $\alpha = 0.5$ when cost of prenatal scan falls from 20 to 16 when cost of children is 16. The average spacing for parity 5 births falls from 1.44 to 1.18, but the spacing for parity 4 births increases only from 1 to 1.09. What this hides is, of course, that there are substantially more parity 4 births than there are parity 5 births–and only a slight decline in fertility from 4.16 to 4.11—and that the number of abortions per 100 woman doubles.

[25] The changes in sex ratio are not uniformly positive, possibly because the discrete nature of fertility decisions combined with the uncertainty of the sex of the next conception produce knife-edge cases that can dramatically swing the outcomes.

decline.

At $\alpha = 0.5$ parents prefer an equal number of boys and girls. The more children you have the less likely it is that you will resort to sex selection to ensure a balance between sons and daughters. First, the chances of having, for example, only boys or only girls, decreases with each additional child.[26] Second, the more children you have the lower the marginal utility of having another, which means that, for a given price of prenatal scan, the less attractive it is to bear the cost of using prenatal scans to ensure a specific sex. As fertility fall to, say, two, however, those parents who had a girl as their first child will now want to use prenatal sex determination to ensure a balanced number of sons and daughters and this is why the sex ratio is so unbalanced as the cost of children increases. Parents who had a son as their first child would also want to use sex selection to ensure both a son *and* a daughter, but since that option is not available here they have their second birth without scan.

Stretching the interpretation of the model, think of $\alpha = 0.5$ as capturing parents treating sons and daughters equally once born. The use of sex selection to achieve balance—but only when the fetus is female—could be a potential explanation for the suggestion that sons and daughters are treated relatively equally and we are still seeing an unequal sex ratio. What is relevant here it that there is no way to identify which of these two different types of son preference affect sex ratios from fertility data. This is a concern because the way we currently measure son preference allows us to capture only the distribution preference, and the different types of son preference likely have different policy implications.

The discount rate affects fertility little, but sex ratios become more biased the more patient people are (higher d).[27] Similarly, the number of abortions and the number of spells where prenatal scans are used are higher the more weight is place on future utility over current utility. Just like the discount rate, increasing parents' horizon (larger T) changes fertility little, but does tend to

[26] For 2 children the likelihood of only boys or only girls is 50%, but for 4 children it is 12.5% (assuming equal probability of a boy or a girl).

[27] If son preference is very strong the effect appear to depend on the cost of children. For low cost of children higher impatience leads to higher fertility, but for higher cost of children it is sometimes reversed. Furthermore, these effects are not very strong or clear and potentially non-linear.

increase the sex ratio in favor of boys when there is access to sex selection.[28] Correspondingly, the number of abortions are higher the longer the time horizon.

An important question here is whether parents ever change their use of prenatal sex determination between two consecutive births. I capture this by the percent of spells where prenatal scans were initially used for one or more period, but the birth is the result of a pregnancy without a prenatal scan. Whether parents will consider the duration from last birth too long depends mainly on the discount rate. On average, the more impatient parents are—the less they like long spells between births—the more likely they are to change their decision to use sex selection.[29] Lowering the cost of prenatal sex determination generally leads to a smaller percentage of parents who change their use of sex selection. But, the total number of spells with a change may still go up because lower cost of prenatal sex determination also increases the use of sex selection.[30]

Another reason for parents to change their decision to use sex selection is that they get "too close" to the end of the time horizon after extensive use of abortions and prefer any child to the potential of having no child at all. This type of reversal explains why the effects of changing the discount rate and cost of prenatal sex determination are not uniform. Related, extending the time horizon leads to a smaller likelihood of parents reversing their use of sex selection between births when there is strong incentive to use sex selection.[31]

Increasing the cost of children and the degree of son preference both tend to lower the likelihood that parents will change their decision to use sex selection. Working in the opposite direction is that some women with higher cost of children, for example because of higher education, are also likely to marry later. The later marriage effectively shortens their reproductive time horizon and thereby makes it more likely that they will reverse their use of sex selection between births.

[28] These simulation results are presented in the online Appendix.

[29] Using only those situations where there are any abortions, regressing the discount rate against the percent spells where prenatal scan is initially used but not for the birth show a strong positive effect—higher number, more patient—holding all the other parameters constant.

[30] An example of this is when the discount rate is 0.95, cost of children 14, cost preference of 0.6, and the cost of a prenatal scan falls from 16 to 12, resulting in a decline in the probability of changing from 38.1% to 30.9%. In this case the average number of spells with a change increases from 0.19 spells at the higher cost of prenatal scan to 0.37 for the lower cost.

[31] These results are available in the online Appendix.

There are three main conclusions from the model.[32] First, the strongest driver of increased use of sex selection is the fertility decline that arise from an higher cost of children—for example because of more education for women or migration to urban areas. The increased use of sex selection shows up both in the proportion of boys among births and longer spacing between births—and the higher the parity the longer the duration between births. The other factors, such as the price of sex selection, discount factor, and son preference also affect the use of sex selection, but to a much smaller degree. Second, parents do reverse the use of sex selection, both when they use sex selection relatively infrequently and when they use it heavily. Reversal are more likely the more impatient parents are or the shorter time they have left in their reproductive horizon, which means that the longer the duration has been since the last birth the more likely they are to reverse their decision to use sex selection. Finally, the model shows that son preference in the number of children is not required for an unequal sex ratio. As long as parents are only willing to abort female fetuses, declining fertility will lead to increased use of sex selection to ensure a balanced number of sons and daughters.

The model highlights three major limitations of the simple empirical method, which a better empirical approach needs to allow for. First, the simple model cannot capture changes in fertility and the extent to which these fertility changes drive the use of sex selection. Second, increased use of sex selection leads to longer spacing which, everything else equal, reduces the number of births available for estimation in the simple model and thereby lowers its precision because fewer parents will make it to a given parity by the time of the survey. Furthermore, the more intensively sex selection is used the larger the decline in sample size. Finally, by using only observed births the simple method cannot capture when parents change their decision on the use of sex selection; with a reversal the spell can still result in the birth of a girl. This last point is especially important when trying to establish whether son preference has changed over time in a situation where the cost of prenatal sex determination has likely *increased* over time because of the PNDT act. As I show an increase the cost of prenatal sex determination does decrease the sex ratio and lower the

[32] A caveat is that these results reflect the particular utility function chosen. If parents have a different utility function, like a preference for one son but otherwise no preference across boys and girls the results may look different.

number of abortions, but it also *increases* the likelihood that parents change their initial decision to use sex selection within a spell.

3 Estimation Strategy

The theoretical model has three implications for fertility decisions with access to sex-selective abortions: a higher probability that next child is a son, longer average time to next birth, and that the use of prenatal sex determination may change between one observed birth and the next. All three must be incorporated into the estimation strategy to provide unbiased and precise estimates of the use of sex-selective abortions.[33]

The empirical model is a discrete time non-proportional competing risk hazard model with two exit states: either a boy or a girl is born.[34] A woman's reproductive life is divided into spells which each covers the period between births (from marriage to first birth for the first spell). 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. The time of censoring is assumed independent of the hazard rate, as is standard in the literature.

There are two exit states: birth of a boy, $j = 1$, or 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

$$h_{ijt} = \Pr(T_i = t, J_i = j \mid T_i \geq t; \mathbf{Z}_{it}, \mathbf{X}_i), \tag{7}$$

where T_i is a discrete random variable that captures when woman i's birth occurs. To ease presentation the indicator for spell number is suppressed. The vectors of explanatory variable $\mathbf{Z}_{it}$ and $\mathbf{X}_i$ include information about various individual, household, and community characteristics discussed below.

[33] For comparison the online Appendix presents the estimation strategy for the simple model. The online Appendix also shows how individual parity results compare between the simple model and the model suggested here. As mentioned, the simple model cannot provide complete fertility and total number of abortions predictions.

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

The hazard rate is specified as

$$h_{ijt} = \frac{\exp(D_j(t) + \alpha'_{jt}\mathbf{Z}_{it} + \beta'_j\mathbf{X}_i)}{1 + \sum_{l=1}^{2}\exp(D_j(t) + \alpha'_{lt}\mathbf{Z}_{it} + \beta'_l\mathbf{X}_i)} \quad j = 1,2 \tag{8}$$

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

$$D_j(t) = \gamma_{j1}D_1 + \gamma_{j2}D_2 + \ldots + \gamma_{jT}D_T, \tag{9}$$

where $D_m = 1$ 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.

Specifying the model as a proportional hazard model, i.e. one where explanatory variables simply shift the hazard rates up or down independent of spell length, results in greater efficiency provided the proportionality assumption holds. The problem is that the proportional hazard model does not allow covariates to have different effects over time within a spell and ignoring differences in the shape of the hazard functions between different types of individuals can lead to substantial bias. It is highly unlikely, even in the absence of prenatal sex determination, that the baseline hazards are the same across education levels, areas of residence, or sex composition of previous births. The bias from the proportionality assumption is likely exacerbated by the introduction of prenatal sex determination for two reasons. First, one of the main points of this paper is that use of sex-selective abortions affects birth spacing, and use of sex selection differs across groups. Second, as discussed above, the use of sex selection may vary within a spell depending on the length of the spell.

I therefore use a non-proportional model where the main explanatory variables and the interactions between them are interacted with the baseline hazards. This is captured by the Z set of explanatory variables

$$\mathbf{Z}_{it} = D_j(t) \times (\mathbf{Z}_1 + Z_2 + \mathbf{Z}_1 \times Z_2), \tag{10}$$

where $D_j(t)$ is the piece-wise linear baseline hazard and $\mathbf{Z}_1$ captures sex composition of previous children, if any, and Z_2 captures area of residence. This allows the effects of the main explanatory variables on the probabilities of having a boy, a girl, or no birth to vary over time within a spell. The use of a non-proportional specification, together with a flexible baseline hazard, also mitigates any potential effects of unobserved heterogeneity (Dolton and von der Klaauw, 1995).

The remaining explanatory variables, **X**, enter proportionally. To further minimize any potential bias from assuming proportionality, estimations are done separately for different levels of mothers' education and for different time periods. The exact specifications and the individual variables are described below.

Equation (8) is equivalent to the logistic hazard model and has the same likelihood function as the multinomial logit model (Allison, 1982; Jenkins, 1995). Hence, if the data are transformed so the unit of analysis is spell unit rather than the individual woman, the model can be estimated using a standard multinomial logit model.[35] In the reorganized data the outcome variable is zero if the woman does not have a child in a given period, one if she gives birth to a son in that period, and two if she gives birth to a daughter in that period.

Direct interpretation of the estimated coefficients for this model is challenging because of the competing risk setup. First, coefficients show the change in hazards relative to the base outcome, no birth, rather than simply the hazard of an event. Second, a positive coefficient does not necessarily imply that an increase in a variable's value increases the probability of the associated event because the probability of another event may increase even more (Thomas, 1996).

The model does, however, make it straightforward to calculate the predicted probabilities of having a boy and of having a girl for each t, conditional on a set of explanatory variables and not having had a child before that period. The predicted probability of having a boy in period t for a given set of explanatory variable values, $\mathbf{Z}_k$ and $\mathbf{X}_k$, is

$$P(b_t|\mathbf{X}_k, \mathbf{Z}_{kt}, t) = \frac{\exp(D_j(t) + \alpha_{1t}'\mathbf{Z}_{kt} + \beta_1'\mathbf{X}_k)}{1 + \sum_{l=1}^{2}\exp(D_j(t) + \alpha_{lt}'\mathbf{Z}_{kt} + \beta_l'\mathbf{X}_k)}, \tag{11}$$

[35] A potentially issue is that the multinomial model assumes that alternative exit states are stochastically independent, also known as the Independence of Irrelevant Alternatives (IIA) assumption. This assumption rules out any individual-specific unmeasured or unobservable factors that affect both the hazard of having a girl and the hazard of having a boy. To address this issue the estimations include a proxy for fecundity discussed in Section 4. In addition, the multivariate probit model can be used as an alternative to the multinomial logit because the IIA is not imposed (Han and Hausman, 1990). The results are essentially identical between these two models and available upon request.

and the predicted probability of having a girl is

$$P(g_t|\mathbf{X}_k,\mathbf{Z}_{kt},t) = \frac{\exp(D_j(t) + \alpha_{2t}'\mathbf{Z}_{kt} + \beta_2'\mathbf{X}_k)}{1+\sum_{l=2}^{2}\exp(D_j(t) + \alpha_{lt}'\mathbf{Z}_{kt} + \beta_l'\mathbf{X}_k)}. \tag{12}$$

With these two probabilities is it easy to calculate, for each t, the estimated percentage of children born that are boys, $\hat{Y}$,

$$\hat{Y}_t = \frac{P(b_t|\mathbf{X}_k,\mathbf{Z}_{kt},t)}{P(b_t|\mathbf{X}_k,\mathbf{Z}_{kt},t) + P(g_t|\mathbf{X}_k,\mathbf{Z}_{kt},t)} \times 100, \tag{13}$$

and the associated confidence interval for given values of explanatory variables.[36]

For ease of exposition the procedure is presented here in two steps, but the actual calculation of the percent boys is done in one step with the 95 percent confidence interval calculated using the Delta method. Results are presented as the estimated percent boys born by length of birth spacing using graphs.[37] For each graph, the extent to which the percent boys is statistically significantly above the natural sex ratio indicates the use of sex selection.

Another important aspect of the hazard model is the survival curve, which shows the probability of not having had a birth yet by spell duration. The survival curve for t is

$$S_t = \prod_{d=1}^{t}\left(1 - \left(P(b_d|\mathbf{X}_k,\mathbf{Z}_{kd},d) + P(g_d|\mathbf{X}_k,\mathbf{Z}_{kd},d)\right)\right), \tag{14}$$

or equivalently

$$S_t = \prod_{d=1}^{t}\left(\frac{1}{1+\sum_{l=2}^{2}\exp(D_j(t) + \alpha_{ld}'\mathbf{Z}_{kd} + \beta_l'\mathbf{X}_k)}\right). \tag{15}$$

The survival curves are presented for two reasons. First, they show progression to the next birth and how quickly it occurs, if at all. In the absence of sex selection, I expect most parities to show an "inverted s" pattern, where there initially are relatively few births, followed by a substantial number of births over a 1 to 2 year period, and then relatively few births thereafter. As sex selection becomes more widely used the associated longer spacing shows up by making the survival curve straighter, indicating that some of the births that would originally have taken place

[36] Within each period $1 - P(b_t) - P(g_t)$ is the probability of not having a birth in period t.
[37] The parameter estimates are available on request.

now take place later because of abortions. The use of sex selection is clearly not the only factor that can change the shape of the survival curves; factors such as the desired number of children and use of contraceptives may also shape the shape. To account for this it is best to compare survival curves for an individual parity between women who are likely to use sex selection and women who are not, for example because they already have one or more sons.

Secondly, the survival curves provide "weighting" for the associated percentage boys born. The steeper the survival curve, the more weight should be assigned to a given spell period because it is based on more births, whereas a period with a flat survival curve should be given little weight because the percentage boys is based on few births. Hence, although they cannot by themselves show sex selection, the survival curves are a crucial complement to the estimated sex ratios by duration.

4 Data

The data come from the three rounds of the National Family Health Survey (NFHS-1, NFHS-2 and NFHS-3), collected in 1992–93, 1998–99, and 2005–2006.[38] The International Institute for Population Sciences in Mumbai collected the data, which have nationwide coverage. The surveys are large: NFHS-1 covered 89,777 ever-married women aged 13–49 from 88,562 households, NFHS-2 covered 90,303 ever-married women aged 15–49 from 92,486 households and NFHS-3 covered 124,385 never-married and ever-married women aged 15–49 from 109,041 households.

I exclude visitors to the household, as well as women married more than once, divorced, or not living with their husband, women with inconsistent information on age of marriage, and those with missing information on education. Women interviewed in NFHS-3 who were never married or where gauna had not been performed were also dropped. The same goes for women who had at least one multiple birth, reported having a birth before age 12, had a birth before marriage, or a duration between births less than 9 months. Women who reported less than 9 months between

[38] A delay in the survey for Tripura means that NFHS-2 has a small number of observation collected in 2000.

marriage and first birth remain in the sample unless they are dropped for another reason.[39]

Finally, I restrict the sample to Hindus, who constitute about 80 percent of India's population. If use of sex selection differ between Hindu and other religions, such as Sikhs, assuming that the baseline hazard is the same would lead to bias. The other groups are, however, each so small relative to Hindus that it is not possible to estimate different baseline hazards for each group. Furthermore, the groups are so different in terms of background and son preference that combining them into one group would not make sense.

There are four advantages to using the NFHS. First, surveys enumerators pay careful attention to spacing between births and probe for "missed" births. Second, no other surveys cover as long a period in the same amount of detail. The three NFHS rounds allow me to show the development from before sex-selective abortions were available until 2006. Third, NFHS has birth histories for a large number of women.[40] Finally, even if probing for missing births may not completely eliminate recall error, the overlap in cohorts covered and the large sample size make it possible to establish where recall error remains a problem.

Recall error arise mainly from child mortality, when respondents are reluctant to discuss deceased children.[41] Systematic recall error, where the likelihood of reporting a deceased child depends on the sex of the child, is especially problematic because it biases the sex ratios. Probing catches many missed births, but systematic recall error is still a potentially substantial problem. Three factors contribute to the problem here. First, girls have significantly higher mortality risk than boys. Second, son preference may increase the probability that boys are remembered relative to girls. Finally, in NFHS-1 and NFHS-2 enumerators probed only for a missed birth if the initial reported birth interval was four calendar years or more. But, given short durations between births,

[39] Women who report less than 9 months between marriage and first birth are retained because between 10 and 20 percent fall into this category. Although it is possible that some of these births are premature the high number of women who report a birth less than 6 months after marriage indicates that conception likely occurred before marriage in most cases.

[40] The Special Fertility and Mortality Survey appears to cover a much large number of households than the three rounds of the NFHS combined, but Jha et al. (2006) only use the births that took place in 1997 making their sample sizes by parity smaller than here. Their sample consists of 133,738 births of which 38,177 were first born, 36,241 second born, and 23,756 were third born. The differences in results for first born children are discussed in the online Appendix.

[41] The online Appendix contains a more thorough discussion of recall error and how I address it.

especially after the birth of a girl, that procedure is unlikely to pick up all missed children.

Observed sex ratios by cohort provide a straightforward way to determine whether recall error is a problem. Because prenatal sex determination techniques did not become widely available until the mid-1980s, a higher than natural sex ratio for cohorts born before that time must be the result of systematic recall error. As shown in the online Appendix, the observed sex ratio by parity becomes more male dominated the further back births took place. In addition, births in the same cohort tend to be more male dominated the more recent the survey (births in the cohort took place longer ago relative to the survey). Hence, there is evidence of recall error and the degree of recall error increases with length of time between survey and cohort.

Using cohort year of birth to analyze recall error and decide which observations to keep is, however, problematic because the year of birth for a given parity is affected by recall error; for example, a second born child listed as first born will be born later than the real first born child. Year of marriage should, however, be unaffected by recall error. Using year of marriage the basic recall error pattern remains with women married longer ago more likely to report that their child was a boy for a given parity. Similarly, comparing women married in the same period across surveys shows that women married longer ago are more likely to report having sons.

That recall error increases the longer ago somebody was married means that duration of marriage is a better predictor of recall error than calendar year of marriage. Figure 1 shows the observed sex ratio for children reported as first born as a function of duration of marriage combining all three surveys.[42] The solid line is the sex ratio of children reported as first born by the number of years between the survey and marriage, the dashed lines indicate the 95 percent confidence interval and the horizontal line the natural sex ratio (approximately 0.512). To ensure sufficient cell sizes the years are grouped in twos.

Figure 1 clearly illustrates the systematic recall error problem. The observed sex ratio is increasingly above the expected value the longer ago the parents were married. The increasingly unequal sex ratio with increasing marriage duration suggests that a solution to the recall error

[42] The graph for second births shows a similar pattern. The graphs for the second births and the individual survey rounds are available upon request.

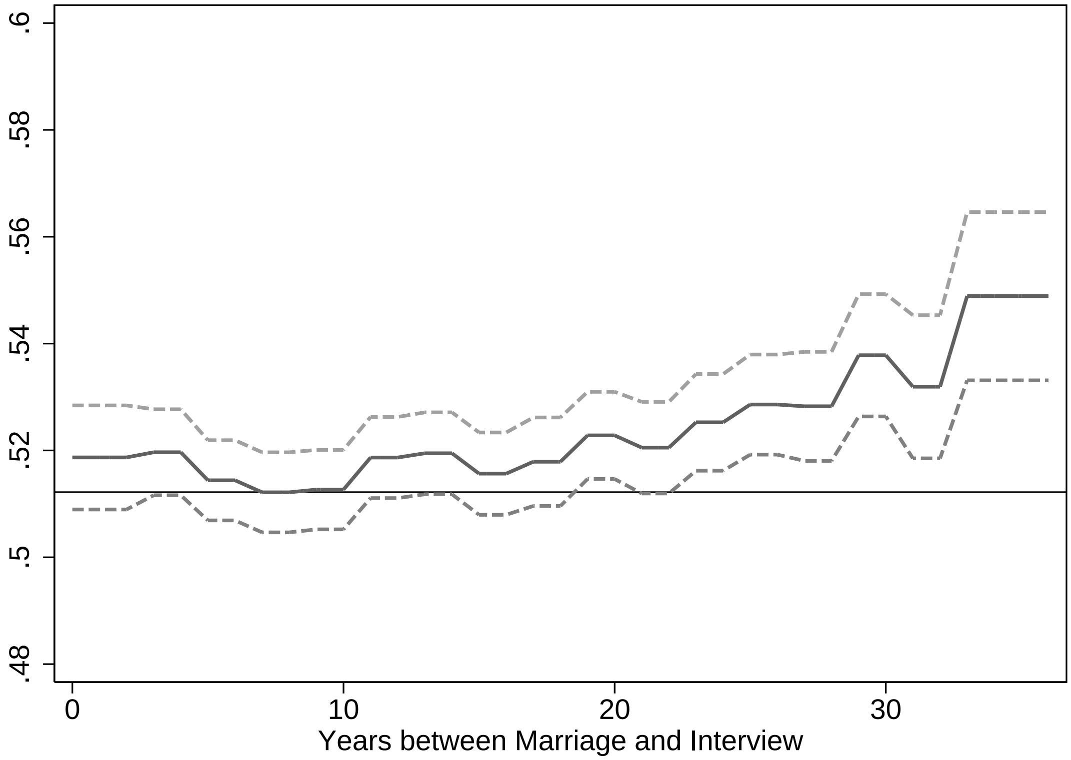

Figure 1: Ratio of boys in “first” births

problem is to drop women who were married “too far” from the survey year. The main problem is establishing what the best cut-off point should be. The observed sex ratio is consistently significantly higher than the natural sex ratio from around 24 years of marriage, so one possibility is simply to drop all women married more than 24 years at the time of the survey. But, as the Appendix shows, there are differences across the three surveys and between parities. Based on the differences between surveys the cut-off points I use vary by survey round. For NFHS-1 women married 22 years or more were dropped, with the corresponding cut-off points 23 years for NFHS-2 and 26 years for NFHS-3. The final sample consists of 146,096 women, with 332,951 parity one through four births.[43]

[43] The online Appendix presents the results for a more restrictive definition and for the women dropped because of recall error concerns.

4.1 Spell Definition

Spell duration is measured in quarters of a year, that is 3 month periods, hereafter referred to as quarters. The first spell begins at the month of marriage rather than 9 months after because many women report giving birth less than 9 months after they were married. For women who began living with their husbands at too young an age to conceive the starting point should ideally be first ovulation, when she becomes "at risk" for a pregnancy, rather than month of marriage. Unfortunately, information on age of menarche is only available in NFHS-1. Instead, for women who began living with their husband before age 12, I set the the month they turned 12 years of age as staring point for the first spell.

The second and subsequent spells begin 9 months after the previous birth because that is the earliest we should expect to observe a new birth. A few women report births that occurred less than 9 months after the previous birth; those women are dropped.

All spells continue until either a child is born or the spell is censored. Censoring can happen for three reasons: the survey takes place; the woman is sterilized; or the number of births observed becomes too sparse for the method to work. The timing of censoring because of too few births vary slightly by spell but is generally 21 quarters after the beginning of the spell.

I group spells into three time periods based on spell start date: 1972–1984, 1985–1994, and 1995–2006. The first period covers the time before sex-selective abortions became widely available. Abortion was legalized in 1971 and amniocentesis was introduced in India in 1975, but the first newspaper reports on the availability of prenatal sex determination were not until 1982–83 (Sudha and Rajan, 1999; Bhat, 2006; Grover and Vijayvergiya, 2006). The number of clinics quickly increased, and knowledge about sex selection became widespread after a senior government official's wife aborted a fetus that turned out to be male (Sudha and Rajan, 1999, p. 598). The second period covers the time from the widespread emergence of sex-selective abortions until the prenatal Diagnostic Techniques (PNDT) act was passed in 1994. The final period is from the PNDT act until the last available survey. The PNDT act made it a criminal offence to reveal the sex of the fetus and was followed by a campaign against the use of sex selection, although enforcement appears to be relatively lax.

By dividing spells into these periods I can examine how fertility decisions and the use of sex selection have changed across the three different regimes. Note that the periods are based on the spells' beginning year, and some spells will therefore cover two periods. A couple may, for example, be married in 1984, but not have their first child until 1986. That couple's first spell will be in the 1972–1984 period, even though most of the spell actually falls in the 1985–1994 period. Some children born from spells that began in the 1972–1984 period may therefore have been conceive when prenatal sex determination techniques were available, which could result in evidence of sex-selective abortions even for this period. Similarly, a spell that began in the 1985–1994 period may have been partly or mostly under the PDNT act. The overall effect is to bias downwards any differences between the periods.

4.2 Explanatory Variables

The explanatory variables are divided into two groups. The first group consists of variables expected to affect the shape of the hazard function: mother's education, sex composition of previous children, and area of residence. Increasing the number of variables interacted with the baseline hazard lowers the risk of bias but requires more data to precisely estimate. I chose these variables because the prior literature shows that they affect fertility and spacing choices and because the prior literature on sex selection indicates that these are correlated with sex selection. The second group of variables are those expected to have a proportional effect on the hazard: age of the mother at the beginning of the spell, length of her first spell (for second spell and above), whether the household owns land, and whether the household belongs to a scheduled tribe or caste.

Increasing education of mothers is strongly associated with lower fertility, with the negative effect of higher opportunity cost on fertility more than outweighing the positive effect of higher income (Schultz, 1997).[44] Higher education should therefore be associated with higher use of sex

[44] Fathers' education has two opposite predicted effects: the associated higher income should increase fertility and therefore lower the pressure to use sex selection, but the higher income also makes the use of sex selection cheaper. In practice, fathers' education had little effect on the hazards and the use of sex-selective abortions and is not included.

selection. I divide women into three education groups: no education, 1 to 7 years of education, and 8 and more years of education. The models are estimated separately for each education level. A potential concern here is reverse causation, where the sex of children affect women's education. Although no direct information is available on when women left school it is possible to estimate school leaving age from the highest completed grade and the usual starting age. As described in the online Appendix, relatively few women could potentially have returned to school after the birth of their first child, and only 56 could possibly have ended up in the wrong education group. Hence, there is little likelihood that reverse causation is a substantial concern here.

As discussed, the sex composition of previous children affects both the timing of fertility and the use of sex-selective abortions. Here I capture sex composition of previous children by dummy variables for the possible combinations for the specific spell, ignoring the ordering of births. As an example, for the third spell three groups are used: Two boys, one girl and one boy, and two girls.

The area of residence is a dummy variable for the household living in an urban area.[45] Area of residence captures both access to prenatal sex determination techniques and the cost of children. The cost of children is higher in urban areas than in rural and access to prenatal sex determination is easier; both are expected to lead to greater use of sex-selective abortions in urban than in rural areas. Because of concerns about selective migration I use where the household was living at the end of each spell.[46]

The sex composition of children, area of residence, and their interactions are interacted with the piece-wise linear baseline hazard dummies. In other words, the baseline hazards are assumed to be different depending on where a woman lives and the sex composition of her previous children. As an example, for the second spell a separate regression is run for each education level and in each regression four different baseline hazards are included (first child a boy in rural area, first child a boy in urban area, first child a girl in rural area, first child a girl in urban area). Although this approach substantially increases the number of regressions and estimated parameters

[45] NFHS uses four categories for area of residence: Large city, small city, town and countryside. To reach a sufficient sample size urban areas are merged into one group.

[46] As online Appendix Table D.1 shows there is little difference across education levels in migration patterns within each period and patterns across periods are also relatively stable.

it reduces the potential problem of including other variables as proportional effects. In addition, it forces attention to how much data are really available to estimate the determinants of sex-selective abortions.

The remaining variables are expected to affect hazards proportionally. Although fecundity cannot be observed directly a suitable proxy is the duration from marriage until first birth. Most Indian women do not use contraception before the first birth and there is pressure to show that a newly married woman can conceive (Dyson and Moore, 1983; Sethuraman et al., 2007; Dommaraju, 2009). This is confirmed by the very short spells between marriage and first birth, even among the most educated. Hence, a long spell between marriage and first birth is likely due to low fecundity. The expected effect of a longer first spell is to reduce sex-selective abortions in subsequent spells. For both this variable and the age of the mother at the beginning of the spell the squares are also included. The remaining variables are dummies for household ownership of land and membership of a scheduled caste or tribe.

4.3 Descriptive Statistics

Appendix Table A.13 presents descriptive statistics for the spells by education level and when the spell began. There is a substantial number of censored observations. As an example, for highly educated women who had their first child in the 1995–2006 period, almost half did not have their second child by the time of the survey. Hence, although about 13,000 women began the second spell there are only about 7,000 births to these women. Censoring becomes even more important for the third and fourth spells, where around 70 percent of the observations are censored. Generally, censoring increases with parity and time period. This reflects a combination of factors: timing of the surveys relative to the periods of interest, later beginning of childbearing, falling fertility, and the longer spells from sex-selective abortions. The high number of censored observations underscore the importance of controlling for censoring when examining the relationship between fertility and sex selection.

The descriptive statistics also provide a first indication of how the sex ratio at birth changes over time and by spell. For the first spell the sex ratio is very close to the natural for all education groups and all three time periods. As an example, among the highly educated group for the 1995–2006 period, 51.3 percent of the children born were boys.[47] For the second spell, all but the highly educated group in the last two periods have sex ratios in line with the natural sex ratio. Women with 8 or more years of education have 53.1 and 54.3 percent boys in the 1985–1994 and 1995–2006 periods, respectively. This pattern repeats itself for the third spell, except the percentage boys is higher for the high education group (55.3 and 55.9 for the last two time periods). Finally, for the fourth spell the high education group had 60 percent boys in the last period, i.e. after the PNDT act was introduced. Note, however, that for the fourth spell the number of births is substantially smaller and censoring even more important than for the other spells.

India's population has become progressively more urban. For the first period, 32 percent of the women entering the first spell lived in urban areas. This increases to 35 percent for the second period and to 42 percent for the final period. The population is also substantially better educated. Women with no education constituted almost 60 percent in the first period, but less than thirty percent in the last period. Correspondingly, in the first period just over twenty percent had 8 or more years of education, but in the last period it was almost half. Part of the increase in education is correlated with the increase in urbanization, but the proportion of better-educated women has increased substantially in the rural areas as well. Among the high education group almost 70 percent lived in urban areas during the first period but this had fallen to less than 60 percent in the last period.

The increase in urbanization and education is likely to exert downward pressure on fertility and the high censoring rates for the later periods are evidence of this. The average number of children born to women by the time they turn 35 illustrate how strong the decline in fertility has been.[48] Women born in the early 1940s had on average close to 5 children when they reached 35, but women born in the early 1970s had only just over three children. The low number of children is

[47] There still appears to be some recall error for the group of women without education for the 1972–1984 period, where 52.3 percent of the children born were boys.

[48] Figure A.1 shows the full results.

especially remarkable because it combines all education levels and all areas of residence.

5 Results

One of the main questions here is how fertility affects sex selection use. I start by showing the relationship between self-reported desired fertility and sex selection, which also illustrates how to interpret the results. Although self-reported desired fertility is an imperfect proxy for actual fertility behavior, the analysis of desired fertility indicates that there is a relationship between fertility decisions and the use of sex selection and motivates examining the relationship more closely.

Because of the desired fertility measure's potential shortcomings, I next examine the relationship between actual fertility and use of sex selection for better-educated women. There are two steps in this process. First, I show how fertility has declined for better-educated women with one son—a group unlikely to use sex selection, which means that sex selection will not affect the progression rates to next birth for these women. Second, I show how, corresponding to the fertility decline, there is an increase in sex-selective abortions for better-educated women without a son. I next show how women with lower cost of children appear to follow a high fertility, low use of sex selection strategy compared to the low fertility, high use of sex selection of the better-educated women. The results all show clear evidence of son preference in fertility and sex selection use, but exactly what form son preference takes is important, so I next discuss what we can learn about son preference from the sex selection behavior. Finally, I predict lifetime fertility, number of abortions, and final sex ratios for the better-educated women.

Except for the predictions, results are presented using graphs of estimated percentage boys born by quarter, the associated 95 percent confidence interval, and the survival curve for a "representative woman" using the method detailed in Section 3. The "representative woman" characteristics are based on means of continuous explanatory variables and the majority category for categorical explanatory variables. Common to all "representative women" is that they do not own land and belong to neither a scheduled caste nor a scheduled tribe. The graphs also show the expected natural rate of boys, approximately 51.2 percent, for comparison. Graphs for all groups and spells, even if not discussed here, are available in the online Appendix.

5.1 Desired Fertility and Sex Selection

A first step to understand the relationship between fertility and sex selection is to examine how use of sex-selective abortions vary with self-reported desired fertility. If lower fertility drives sex selection and desired and actual fertility are at least partly correlated, women with lower desired fertility should be more likely to use sex selection than women with higher desired fertility, holding other characteristics constant. Figure 2 presents results by desired fertility for the second spell of women with 8 or more years of education whose first child was a girl.[49]

A majority of better-educated women report that they want two or fewer children, and the proportion who wants two or fewer is increasing over time.[50] To achieve a large enough sample of women who want three or more children, I use all second spells that began in the period 1985 to 2006. This allows me to estimate non-proportional hazards by area of residence, sex of previous child, and desired fertility. For both rural and urban women, the left panel shows the results for women who want two or fewer children and the right panel shows the results for women who want three or more children.[51]

Three main results stand out. First, the sex ratios by quarter for women who want 2 or fewer children show substantial evidence of sex selection, while there is little evidence among those who want 3 or more. This supports that fertility is an important factor in the use of sex selection. Second, for women who want 2 or fewer children, use of sex selection is higher among urban than rural women, but not significantly so. The proportion of boys born is between 55 and 60 percent

[49] For women with living children the question asked was “If you could go back to the time you did not have any children and could choose exactly the number of children to have in your whole life, how many would that be?”, while for women with no living children the question was “If you could choose exactly the number of children to have in your whole life, how many would that be?”

[50] In the first period 2,055 out of 8,202 (25%) women wanted 3 or more children, including giving a non-numeric response. In the second period this number was 2,583 out of 16,600 (16%) and in the third period it was 1,264 out of 13,610 (9%).

[51] Restricting to wanting exactly 3 children has little to no impact on the spacing pattern, suggesting that higher desired number of children does not lead to substantially shorter spacing.

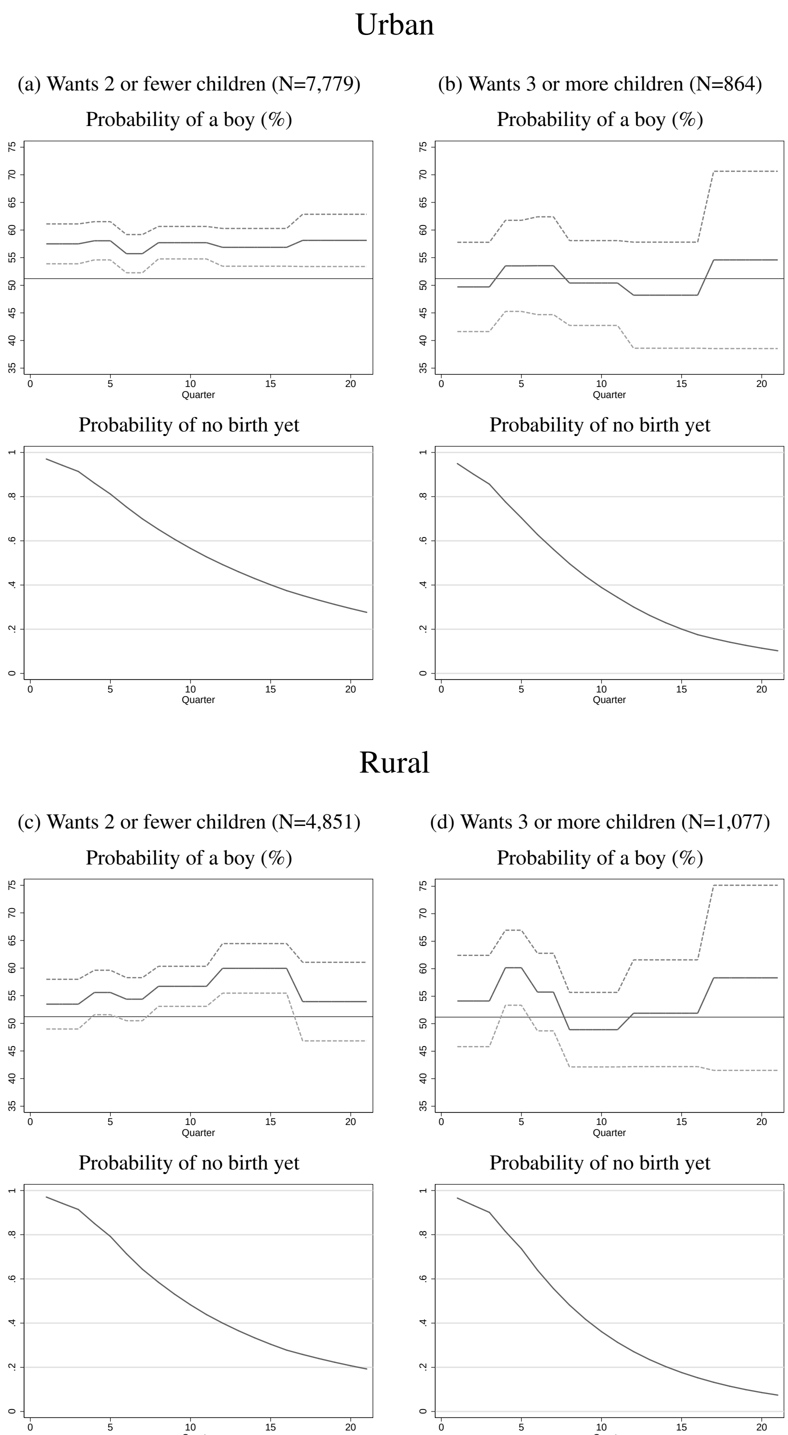

Figure 2: Desired fertility and predicted probabilities of having a boy and no birth yet from 9 months after first birth for women with 8 or more years of education by quarter (3 month period). Predictions based on first child a girl and woman age 22 at first birth. N indicates the number of women in the relevant group in the underlying samples.

and statistically significant higher than the natural sex ratio for all quarters for urban women, whereas for rural women the proportion is generally 2 to 3 percentage points below the urban level.[52]

Third, the effects of sex-selective abortions on spacing show clearly in the differences across the survival curves for the different groups. A normal spacing pattern without sex-selective abortions—where most women have the second child relatively early—leads to a survival curve with a steep slope first, followed by a leveling off. This pattern is followed by rural women who want 3 or more children. As discussed above, use of sex-selective abortions should results in substantially longer spacing between births, which makes the survival curves appear more as straight lines. Urban women who want 2 or fewer children show this pattern.

Another way to see the effects of sex-selective abortions on spacing is to compare the proportion of women who have not had a second birth yet at a specific time. Ten quarters into the spell—equivalent to 13 quarters (3¼ years) after the first birth—just below 35% of rural women who want 3 or more children have not had their second birth yet, compared with more than 45% among rural women who want 2 or fewer children. Similarly, among urban women about 35% of those who want 3 or more children have not had a second birth yet at 10 quarters after their first birth, compared with almost 55% of those who want 2 or fewer.

There are, however, three major methodological concerns with using self-reported desired fertility. First, although the correlation between desired and actual fertility is positive, it is far from one. Second, it is potentially endogenous to the number of children a woman already has and may be measured with error (Jensen, 1985; Rasul, 2008; Ashraf, Field and Lee, 2009). Finally, there is much less variation in desired fertility than in actual fertility, making it difficult to precisely estimate changes in sex selection over time. I therefore next examine whether decreases in observed fertility over time are associated with increased use of sex-selective abortions.

[52] For comparison, if 55 percent of children born in a given quarter were boys, approximately 14 percent of the female fetuses were aborted. Assume 105 boys per 100 girls born, the expected natural sex ratio. With b boys, we should expect $b\frac{100}{105}$ girls born. If we observe g girls the number of abortions is therefore $b\frac{100}{105} - g$ and the percent aborted female fetuses is $\frac{b\frac{100}{105}-g}{b\frac{100}{105}} \times 100$. With 55 percent boys we get $\frac{55\frac{100}{105}-45}{55\frac{100}{105}} \times 100 = 14.09$. The corresponding numbers for 60 percent and 65 percent boys are approximately 30 percent and 43 percent of the female fetuses aborted.

5.2 Changes in Fertility over Time

The first step when examining how declining fertility affects the use of sex selection is to show how fertility has decreased over time. The challenge is that women who use sex selection have longer birth spacing, which makes it look like they have lower fertility than they really do, and consequently would make the relationship between fertility and sex selection appear stronger than it really is. As I show below, and as suggested by the previous literature, women with one or more sons do not appear to use sex selection. Hence, these women's fertility decisions will not be affected by the availability of prenatal sex determination techniques. I therefore show fertility progression only for women who have already had at least one son, continuing to focus on the better-educated women.

Figure 3 shows the predicted progression to next birth for urban and rural women with 8 or more years of education, conditional on having at least one boy, by the starting period of the spell, and within each period by spell.[53] In all cases the proportion of women without a birth by the end of the spell period has increased substantial. In other words, fertility has declined over time for both urban and rural women. Although it is possible that some women will have a child after the end of each estimated spell, it is unlikely to be a substantial number given the shape of the survival curves.

For urban women with a son as the first child, the proportion who did not have a second child 6 years after the birth of their first child increased from around 15% in 1972–1984 period to more than 30% in the 1995–2006 period.[54] Similarly, the proportion who did not have a third child by 6¾ years after their second birth went from 40% in the 1972–1984 period to almost 70% in the

[53] Could the prior births for each of these groups have been the result of sex selection? As I show in the online Appendix there is little evidence of sex selection on first births, so it is unlikely that women with a son as their first child ended up with a boy through anything other than random chance. Similarly, for the third spell group, women with two boys are unlikely to have used sex selection since there is no evidence on sex selection on first birth and no evidence of sex selection if a son is already present. It is possible that third spell women with one son and one daughter could have used sex selection in a prior spell, if they had the girl as the first child, as described below. There is, however, little difference in fertility progression for the third spell between women with two sons and women with one son and one daughter as their first children.

[54] Recall that for the second and higher spell, the spells are estimated starting from the fourth quarter after the birth of their previous child. Hence, 3 quarters has to be added to the spell lengths in the figure to get the actual spacing.

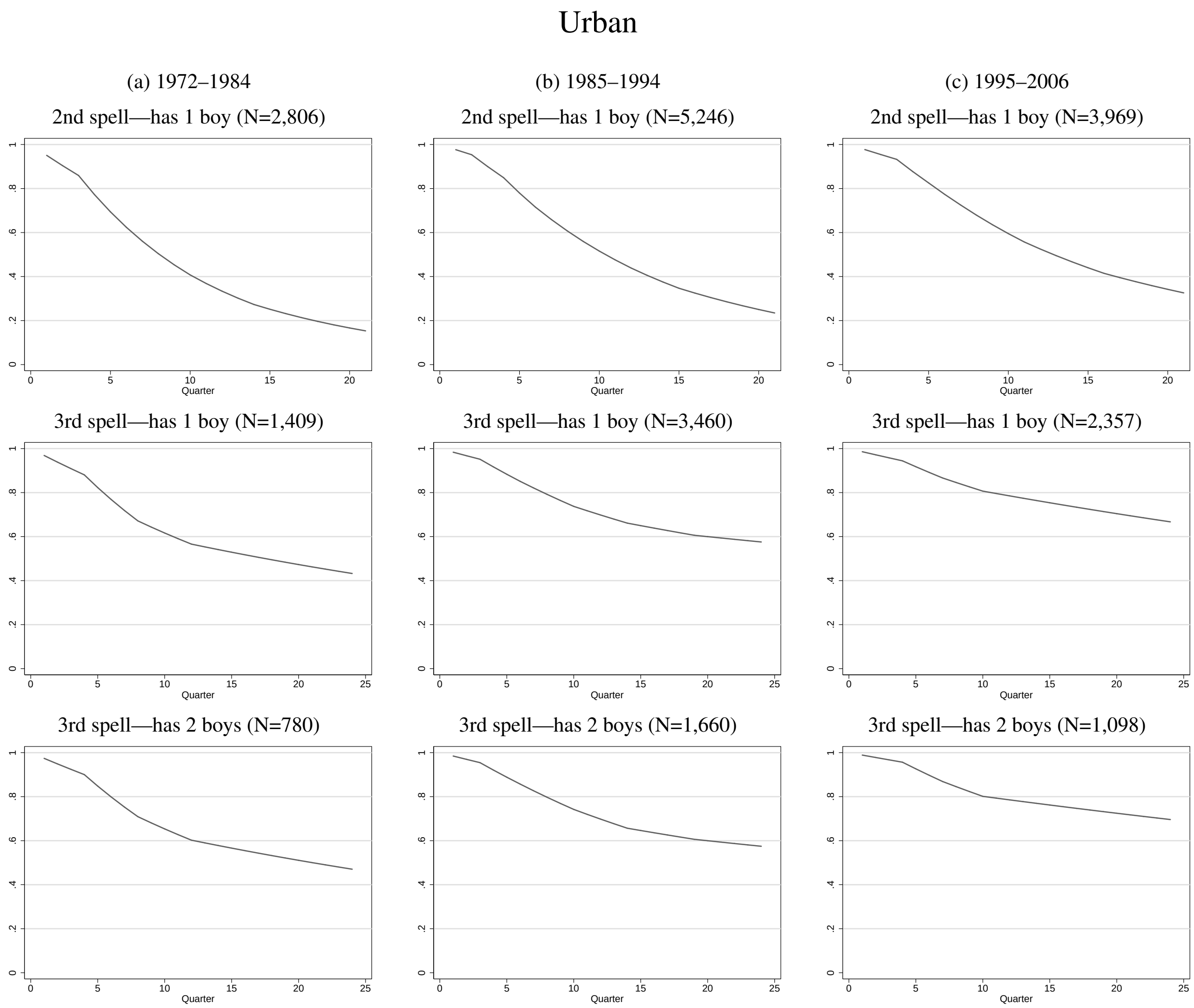

Figure 3: Predicted progression to birth for women with 8 or more years of education by quarter (3 month period) conditional on having at least one boy. Left column shows results prior to sex selection available, middle column before sex selection illegal, and right column after sex selection illegal. N indicates the number of women in the relevant group in the underlying samples.

1995–2006 period if the woman already had one son, and from 45% to more than 70% if she had two sons. Rural fertility is higher, but the underlying pattern is the same. In all cases, more women finish the spell without another birth in the last period than in the first.[55]

Changes over time for this group of women provides an indication of whether increased availability of contraceptives affects the spacing between births over time. Increased use of modern, re-

[55] The results for the fourth spell—available in the on-line Appendix—show similar results with women with at least one son experiencing large reductions in progression rates over time.

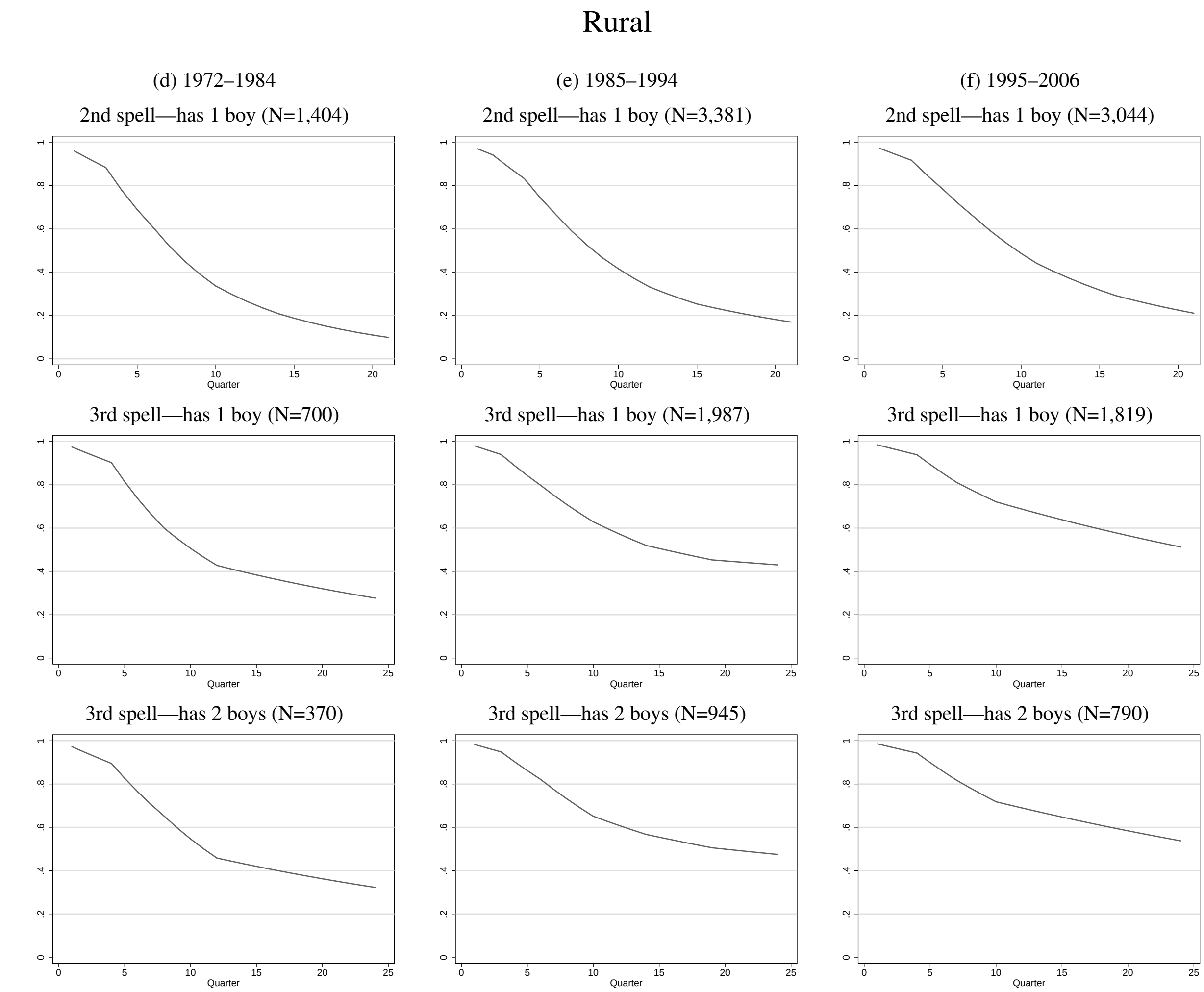

Figure 3: (Continued) Predicted progression to birth for women with 8 or more years of education by quarter (3 month period) conditional on having at least one boy. Left column shows results prior to sex selection available, middle column before sex selection illegal, and right column after sex selection illegal. N indicates the number of women in the relevant group in the underlying samples.

versible contraceptives allows greater control over spacing, potentially making the survival curves straighter if there are *uniformly* distributed "preferences" for how long spacing between births should ideally be. There are two reasons why this is not a substantial concern here. First, use rates of modern, reversible contraceptive have not changed much. For India as a whole current use of any modern method has gone from 36.5% in NFHS-1 to 48.5% in NFHS-3, but most of this increase has come from female sterilization, which has increased from 27.4% to 37.3% over the same period (International Institute for Population Sciences (IIPS) and Macro International, 2007, p. 127). Second, survival curves in Figure 3 appear to have retained their shapes across periods to the extent possible given fertility declines, suggesting that the availability of contraceptives has not had a strong effect on the spacing between births. Because the estimations are done separately by periods the similarity of shapes come from the data, not from assumptions about functional form.

The decline in fertility over time implicitly provide information on the relative cost of having a boy versus a girl.[56] As discussed in Section 2, there are two opposite effects of introducing sex selection on fertility: parents can reach their desired number of sons with fewer births, which reduces fertility, but also do not have to pay for unwanted children, and this wealth effect will tend to increase fertility. The size of the wealth effect depends on the relative cost of boys and girls and the cost of sex selection; if girls are very costly and abortion cheap the wealth effect will be larger, making it more likely that fertility increases with introduction of sex selection. The cost of sex selection does, indeed, appear to be relatively low (see, for example Khanna, 1997). Hence, the decline in fertility after the introduction of sex determination is an indicator that girls are not substantially more expensive than boys.

5.3 Effect of Declining Fertility on Sex-selective Abortions

The second step is to show that with the fertility decline there is a corresponding increase in sex-selective abortions. If the decline in fertility drives the increase in use of sex-selective abortions, we should see an increase in sex ratios for a given spell number *and* use of sex selection for earlier spells over time. As discussed, the group most likely to use sex selection is women without sons. Figures 4 and 5 therefore show the development in sex ratios by quarter for second and third spells for women without sons in urban and rural areas. Both urban and rural women follow the expected pattern, consistent with declining fertility driving the use of sex selection.

For urban women's third spell in the first period, the predicted sex ratios show no evidence of sex-selective abortions. After the introduction of prenatal sex determination techniques there

[56] I am grateful to an anonymous reviewer for suggesting this point.

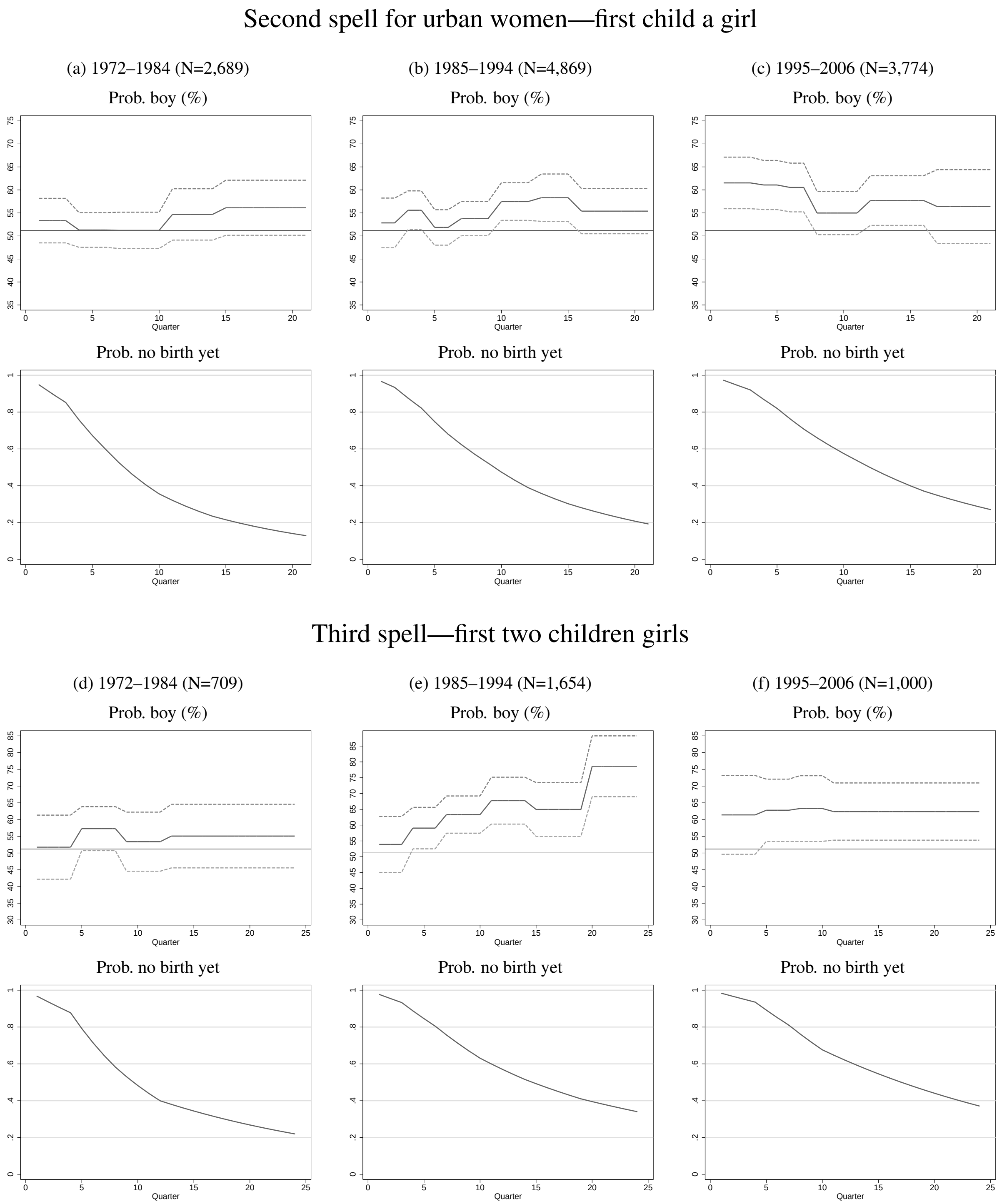

Figure 4: Predicted probability of having a boy and probability of no birth yet from 9 months after first birth for urban women with 8 or more years of education by quarter (3 month period). Predictions based on age 22 at first birth for second spell and on age 24 at second birth for third spell. Left column shows results prior to sex selection available, middle column before sex selection illegal and right column after sex selection illegal. N indicates the number of women in the relevant group in the underlying samples.

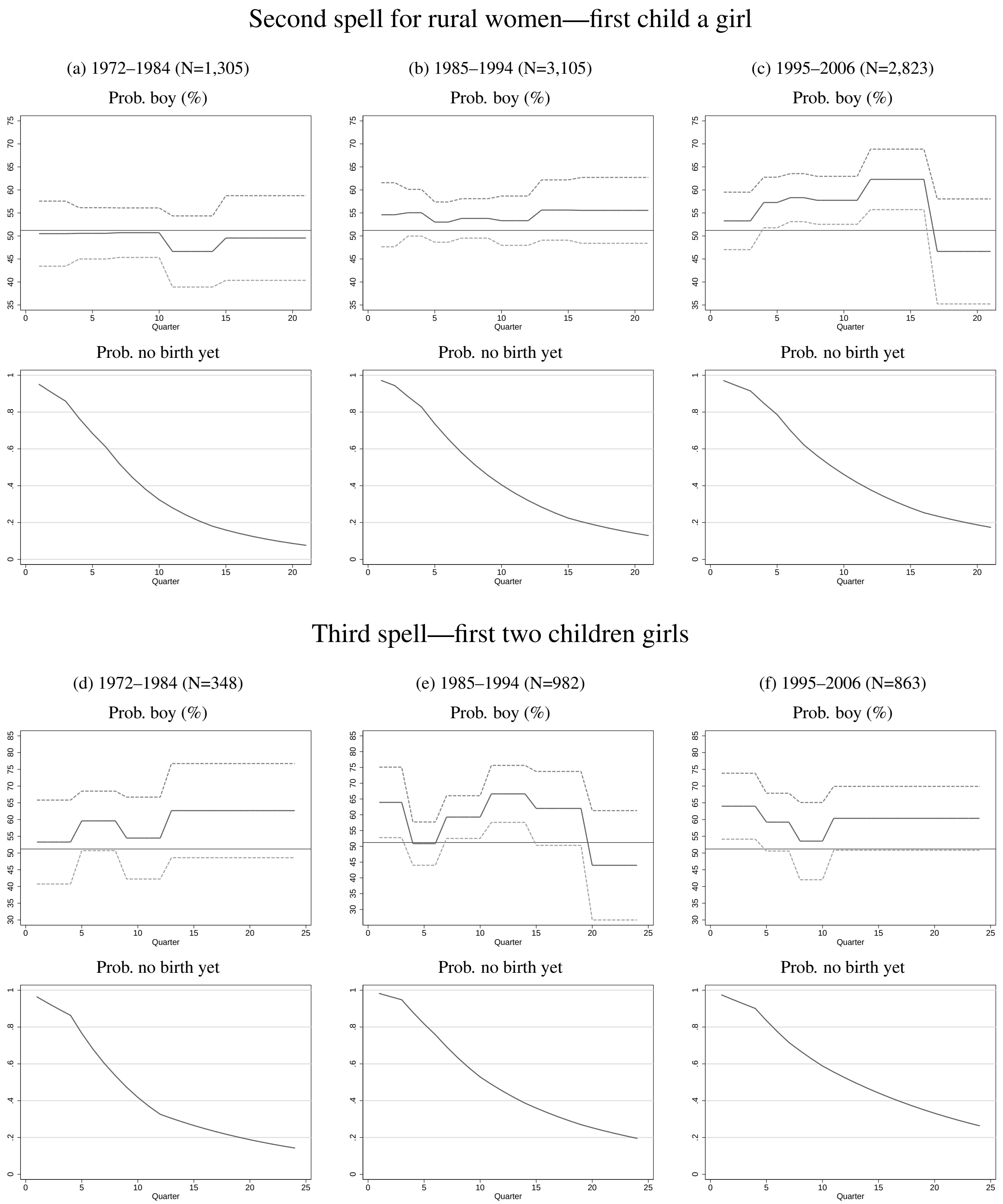

Figure 5: Predicted probability of having a boy and probability of no birth yet from 9 months after first birth for rural women with 8 or more years of education by quarter (3 month period). Predictions based on age 22 at first birth for second spell and on age 24 at second birth for third spell. Left column shows results prior to sex selection available, middle column before sex selection illegal and right column after sex selection illegal. N indicates the number of women in the relevant group in the underlying samples.

is substantial evidence of sex selection both before and after sex selection was made illegal. The increased sex ratio within the spell for the 1985–1994 period is likely the result of those women who—for one reason or another—waited longer to try for a third child having easier access to sex selection. Compared to the 1985–1994 period, there appears to be a leveling off of the sex ratio for the 1995–2006 period and the overall sex ratio may even be a little lower. Consistent with this there is little difference in the survival curves between the two periods.

Does the small difference between the two last periods for the third spell then show that banning sex selection at least stalled the increase in the use of sex selection? The results for the second spell show that this is not the case. With the falling fertility there is increased use of sex selection for the second spell. There is limited evidence of sex selection for the second spell in the 1985–1994 period, which is expected given that many women were still having three children. For the 1995–2006 period, however, there is is a consistently high and statistically significant sex ratio. Hence, with declining fertility the use of sex selection has simply moved to an earlier parity. Consistent with the theoretical model predictions the result is a decline in sex ratio for an *individual* parity at the same time as the overall use of sex selection increases. The most likely explanation for the relative small difference between periods for the third spell is that a smaller proportion of women make it to a situation where they have two girls as their first two children in the latest period; those with the strongest preference for having a boy and for lower fertility have already used sex selection during the second spell.

Rural women follow the same general pattern as urban women, but the samples are smaller making for noisier estimates. The changes between the 1985–1994 and 1995–2006 periods for the third spell is again of special interest because it appears that the use of sex selection falls over time. But, the change for the second spell over time is even more pronounces for rural women than for urban women with very substantial increase in the use of sex selection for the second spell.

Another way to see the interaction between fertility and sex selection is to compare the survival curves across sex composition and spells. As fertility has fallen the survival curves have become straighter for women without sons relative to for women with sons; the result of longer spacing arising from the use of sex selection. Among women with no sons the proportion of women without a birth by the end of the spells has increased, but to a much smaller extent than for women with at least one son.

5.4 Fertility and Sex Selection Across Groups

As shown the decline in fertility over time is associated with both an increased use of sex-selective abortions for a given spell *and* use of sex selection for earlier spells for the women most likely to have low and falling fertility, women with 8 or more years of education. What remains is to show that women who have lower costs of children have higher fertility and consequently show less or no use of sex-selective abortions. Assuming that preferences for having one son is similar across education groups the lower cost of children makes it more attractive for less-educated women to continue having children with the aim of having at least one son instead of resorting to sex selection.

Figures 6 and 7 show sex ratios and survival curves for the three education groups for the latest period, 1995–2006, for urban and rural women. For each education group the figure shows the first spell, from marriage to first birth, the second spell for women with a girl as the first child, and, finally, the third spell for women with two girls as their first children. The second and third spells for the better-educated women are the same as in Figure 4 and 5, panels (c) and (f), and are reproduced to ease comparison.

As expected, progression rates are higher the lower the education level and higher in rural areas than in urban areas. The proportion of women with no education who end up with no birth at the end of the third spell is less than 10 % for urban women and less than 5% for rural women. For those with 1 to 7 years of education less than 20% of urban women do not go on to having a third child, while for rural women it is less than 10%. What is more, the progression rates for women with either two boys or a boy and a girl as their first children are only marginally higher than for women with two girls.[57] Hence, women with less than 8 years of education still have high fertility

[57] In the interest of space these are shown in the online Appendix. The Appendix also shows progression rates for

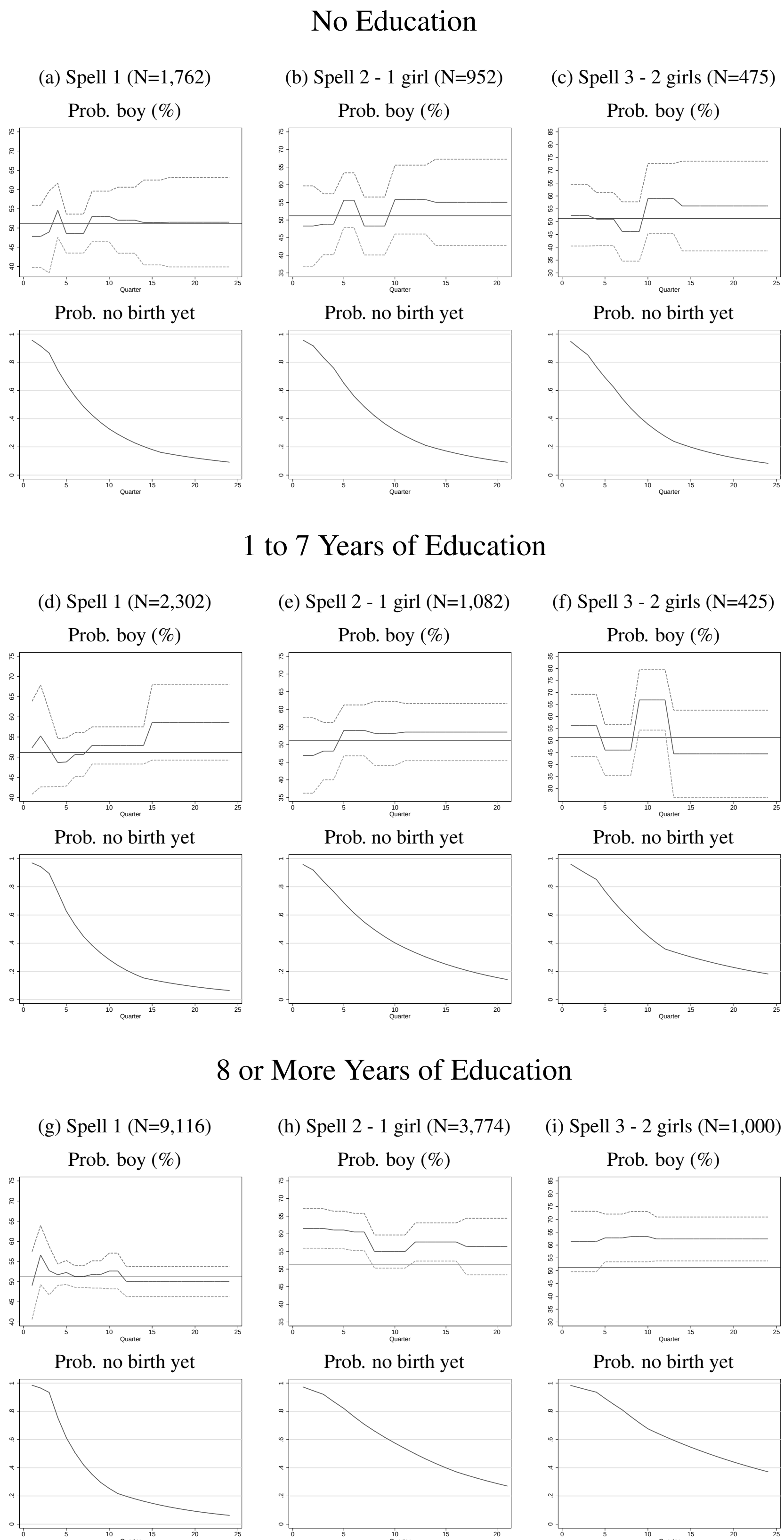

Figure 6: Predicted probability of having a boy and probability of no birth by quarter (3 month period) for urban women for 1995–2006. N is number of women in the relevant group in the underlying samples.

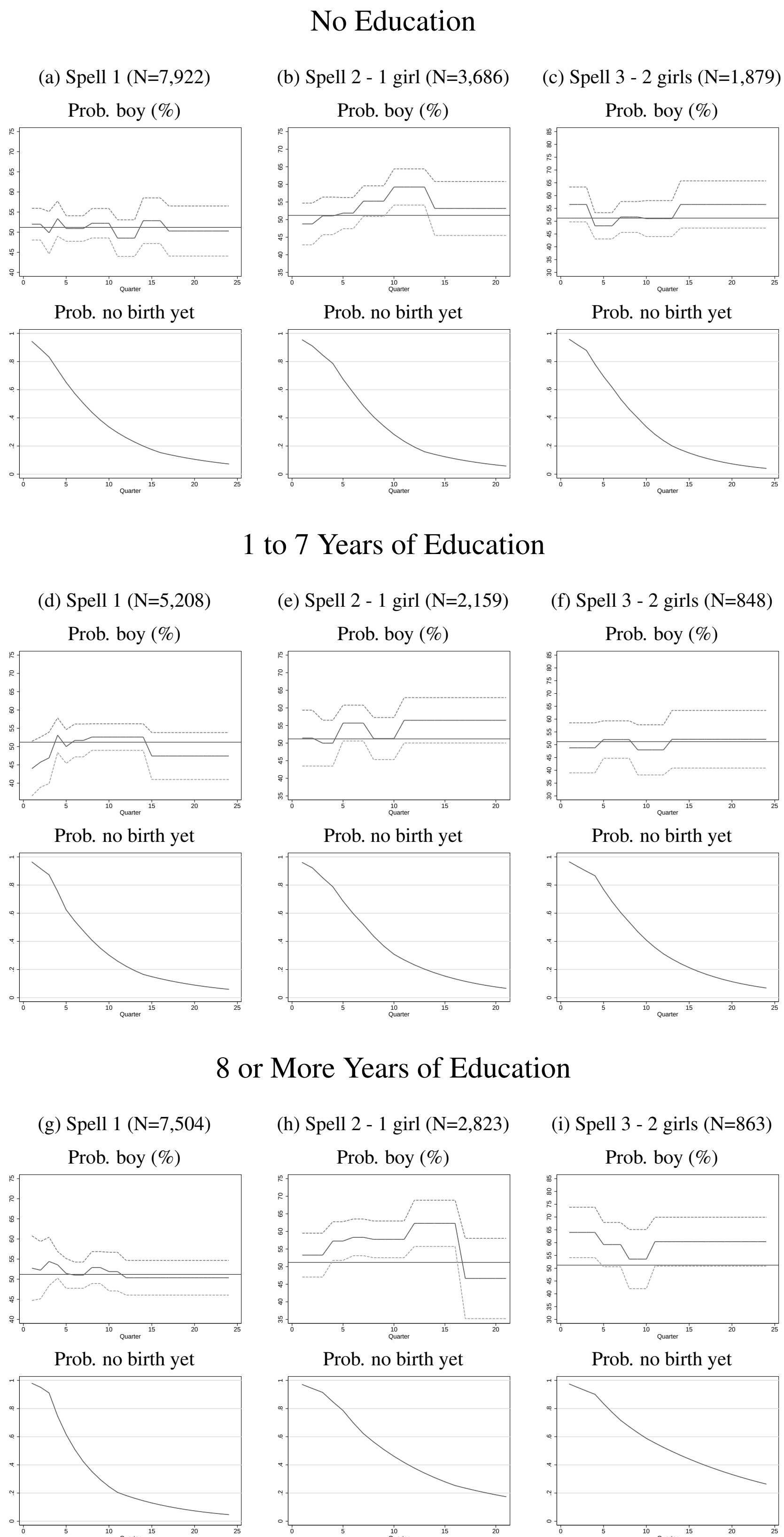

Figure 7: Predicted probability of having a boy and probability of no birth by quarter (3 month period) for rural women for 1995–2006. N is number of women in the relevant group in the underlying samples.

in both urban and rural areas.

Corresponding to the higher fertility among women with less education there is little evidence of sex selection among women with less than 8 years of education. Generally the predicted sex ratios are not statistically significantly higher than the natural rate and the survival curves all show a similar pattern where most of the births occur early in the spell and there is no evidence of the changing survival curves associated with longer spells that would indicate use of sex-selective abortions.[58] Hence, there is evidence of two different paths to having a son: high education women have few children and substantial use of sex selection, while low education women have many children and little to no use of sex selection.

Two other important results stand out. First, there is no evidence of sex selection on first birth, no matter the education level. The sex ratios are never statistically significant different from the expected and timing of births is close to identical for all groups, with most women having their first child soon after marrying.[59] Second, the natural sex ratio for India appear to be in line with what is found for other countries at around 105 boys per 100 girls. For all groups for whom we would expect little to no use of sex selection and have many births to base the estimate on, such as rural women with no education and urban women with 8 or more years of education, the sex ratios almost completely coincide with the 105/100 line.

5.5 One Son or Many Sons?

In the discussion of declining fertility I rely on sex selection not being used by families that already has one son. The extent to which this holds is of interest for two reasons. First and foremost, it can help us understand what form son preference takes in India. This is important in itself, but

the fourth spell. Although samples become very small, the results correspond well. Progression rates are higher the lower the education and higher for rural women than for urban women. The samples become so small exactly for the reason discussed above: there is a less than 12% chance of not having a son by the third child.

[58] The exceptions are small parts of the second spell for no education women and third spell for women with 1 to 7 years of education. As the survival curves show both are based on very few births. Fourth spell results generally confirm the absence of sex selection among women with less education.

[59] This cast serious doubts on the data used by Jha et al. (2006) and their result that there is substantial use of sex selection on first births. As discussed above and in the online Appendix their results are likely the result of substantial recall bias.

especially as we try to predict what will happen to fertility and sex selection use in the future. Second, if families use sex selection to reach two or more sons, progression rates for families with one son may overestimate the decline in fertility.

Women with 8 or more years of education is the group the most likely to use sex selection if they have no son as shown above. Hence, if sex selection is also used to achieve more than one son, we should be most likely to find evidence for this group of women as well. Figure 8 therefore shows sex ratios and survival curves for the 1995–2006 period for urban and rural women with 8 or more years of education, conditional on having at least one son. The first column shows outcomes for the second spell if the first born is a son, the second column shows third spell when the first two children were a son and a daughter, and the third column shows third spell when the first two children were sons.

For the second spell the predicted sex ratios closely follow the natural sex ratio for both urban and rural women. Furthermore, the survival curves follow the expected pattern if no sex selection is taking place. There is also no evidence of sex selection for the third spell for women with two sons; the sex ratios follow the natural sex ratio for both urban and rural women. Sample sizes are, however, less than ⅓ of the sample sizes for the second spell and the progression rate to a third birth is low at only 30% for urban women and 55% for rural women, resulting in wide confidence intervals. The survival curves are particularly flat for the first year, meaning that the apparent deviations from the natural sex ratio in the beginning of the spell are based on very few births.

Even though there is no evidence of using sex selection to have an additional son when the previous children are all sons, it is possible that families want more sons than daughters and therefore use sex selection for the third spell when they already have one of each. Urban women show little evidence of this being the case. Although the sex ratio is above the natural from quarter 11 until the end of the spell, only about ⅓ of the births occur in this interval. Furthermore, the dip below the natural sex ratio prior to this point also accounts for approximately ⅓ of the births. Hence, these two parts cancel each other out. With the first part being to the natural sex ratio the end result is that there is little evidence for urban women using sex selection if they already have a son and a

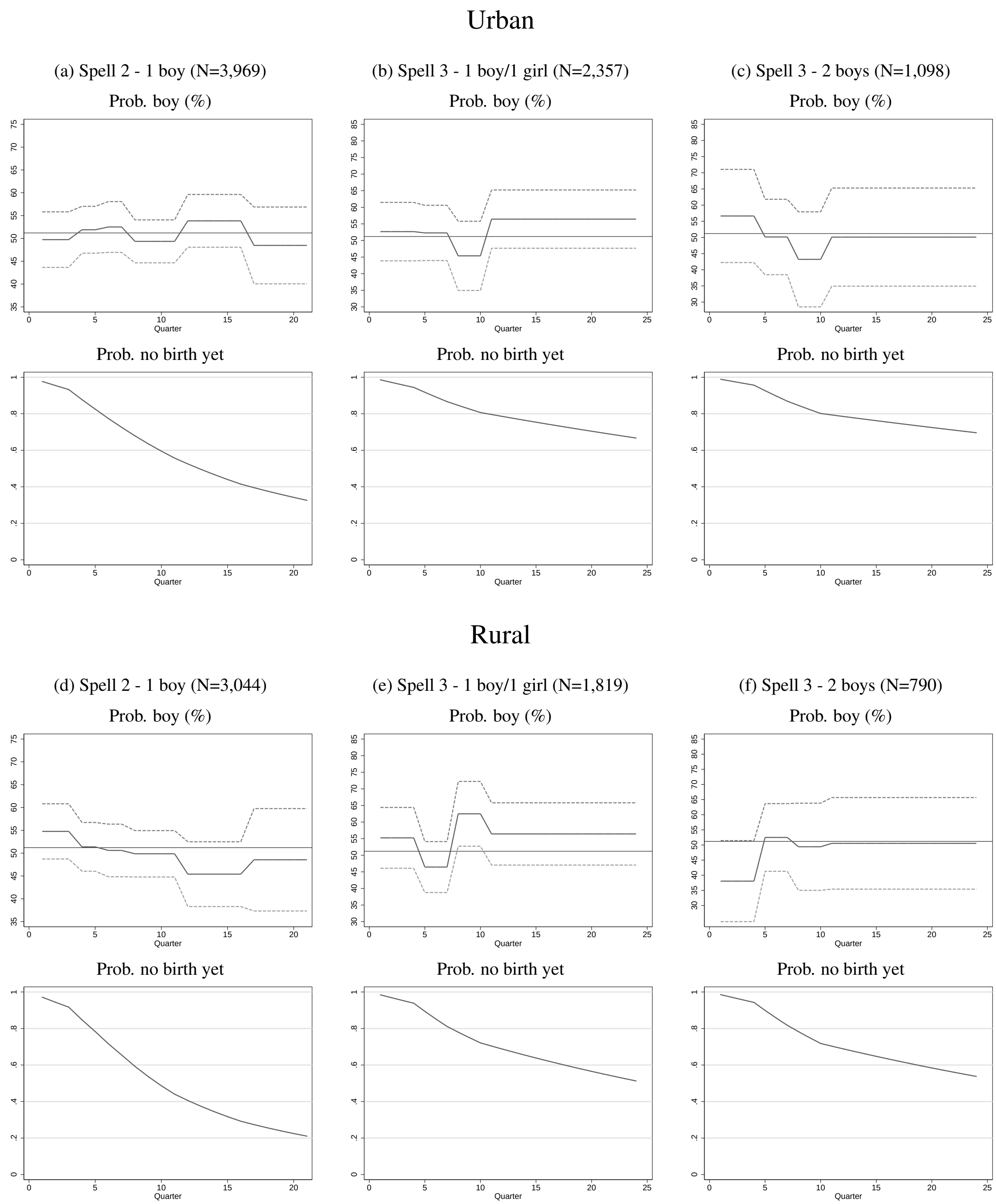

Figure 8: Predicted probability of having a boy and probability of no birth by quarter (3 month period) for women with 8 or more years of education for 1995–2006. N is number of women in the relevant group in the underlying samples.

daughter.

For rural women, however, the dip and the associated number of births is not large enough to bring the overall sex ratio for the spell back to natural sex ratio. The sex ratio for the entire spell is therefore likely more male dominated than the natural rate, although it is only statistically significantly higher for two individual quarters of the spell. There are two possible explanations for rural women appearing more likely than urban women to use sex selection on the third spell if they already have a son and a daughter. First, rural women could have a stronger son preference than urban women and want two sons rather than only one. Second, mortality is higher in rural than urban areas and this higher mortality, either experienced or anticipated, make rural women use sex selection to secure a second son, essentially as an insurance. Separating these two possible explanations is difficult, but the "heir and a spare" explanation appears more likely than difference in preferences given that urban women use sex selection more than rural women for the second birth in the absence of a son. An alternative explanation is that what we are observing is simply random variation. This would explain why we get see differences in sex ratios between urban and rural women with one son across the third and fourth spells as shown in the online Appendix.[60]

Son preference can manifest itself through other channels than sex selection. Differential investments in education and health across boys and girls, resulting in lower education and higher mortality of girls relatively to boys, could be thought of as evidence of son preference, although Rosenzweig and Schultz (1982) argue that both may represent parents' rational response to market opportunities rather than inherent preferences of parents. Whatever way son preference presents itself, it appears that the dominant preference—as expressed through use of sex selection—is for one son, rather than multiple sons.

[60] Urban women with a son and two daughters as their first 3 births show a sex ratio that is significantly higher than the natural, but no evidence of sex selection if they have two sons and a daughter as their first children. Rural women show only a marginally higher sex ratio with a son and two daughters and no effect at all with two sons and a daughter. These results are, however, based on very small samples. There are 590 urban women with a son and two daughters, of which less than 40% have a fourth child, 344 urban women with two sons and one daughter, and only 20% of those have a fourth child. For rural women the numbers are 564, with 40% having a fourth child, and 367 with approximately 30% having a fourth birth. This comes to approximately 300 urban births and only slightly more for rural across the two sex compositions.

5.6 Predicted Lifetime Number of Children and Abortions

One of the main advantages of the method proposed is that we can predict what completed fertility, total number of abortions, and the sex ratios will be for women in the samples at the end of childbearing. This cannot be done with the simple model because it does not predict fertility progression, does not take into account censoring, and cannot capture if parents change their use of sex selection within a spell.

The predictions are important for three reasons. First, they allows us to quantify whether overall use of sex selection is intensifying or easing over time by examining how the total number of abortions women will have over their childbearing, and the resulting final sex ratios, change. This is a more accurate representation than what we get from sex ratios for individual parities. As the theory section shows, it is possible to get no change—or even a decline—in use of sex selection for an individual parity, at the same time as the overall use of sex selection is increasing. Second, completed fertility and sex ratios are what matters when examining the future impacts of sex selection in areas such as the chance of finding a spouse, savings behavior, and the potential problems associated with a surplus of bachelors (Lancaster, 2002; Ding and Zhang, 2009; Wei and Zhang, 2009; Edlund, Li, Yi and Zhang, 2013). Finally, as I show in the online Appendix and discuss above, relying only on observed sex ratios of recorded births is problematic because these are based on selection and the observed sex ratio may be biased predictors of final sex ratio when people change their use of sex selection during a spell.

Table 1 shows predicted birth progression rates, number of abortions, sex ratios, and completed fertility for the three samples of women with 8 or more years of education: the 11,271 women who were married in the the 1972-1984 period, the 19,072 women who were married in the 1985–1994 period, and the 16,620 women who were married in the 1995–2006 period.[61] Predictions for each period assumes that behavior remains constant and that all spells a woman goes through are within the same period. Each woman is assumed to follow the fertility and sex selection behavior for each

[61] These are the women used to estimate the results for the spell from marriage to first birth above. For more information see Table A.13.

spell up to and including the fourth spell using the period's estimates and her characteristics. All results are for women predicted to have one or more births.[62]

The predictions are done as follows. Starting with the first spell I calculate each woman's probabilities of having a boy, $P(b_t)$, a girl, $P(g_t)$, or no birth, $1-P(b_t)-P(g_t)$, in each quarter after marriage based on the period results for equations (11) and (12) using her individual values for $\mathbf{Z}_{it}$ and $\mathbf{X}_i$. She then is assigned one of these outcomes—boy, girl, or no birth—based on random draws from a uniform distribution. The first quarter she has a draw that results in a birth she leaves the spell and the quarter reached is used to calculate her starting age for the second spell. If she has no draw that result in a birth by the end of the spell her childbearing stops and she does not enter the next spell. If she does have birth, the process is repeated for the second through fourth spells. Randomization is necessary because each spell's results, except for the first, depends on the sex composition of previous children and the duration of the first spell. The results presented are averaged outcomes over all urban women and all rural women using 1,000 repetitions.

Birth progression rates are the percentage of women predicted to have a birth by the end of each spell. Fertility is the average number of children born according to the randomization. With the large number of replications this number is the same as using progression rates at the end of the spell to calculate the average number of children.[63]

For abortions I first calculate each quarter's probability of abortions using $\frac{100}{105}P(b_t)-P(g_t)$, where $\frac{100}{105}P(b_t)$ is the probability of having a girl that should have prevailed in the absence of sex selection (0.952 girls born per boy). This probability is multiplied with the probability of not having had a birth yet at the beginning of the quarter. Abortions for each spell are then found by summing over the entire spell.[64] To account for random variation, the abortion rate is the sum over

[62] This means that fertility predictions are larger than standard estimates, which include women with no children. Working in the opposite direction is that number of children is restricted to be at most four.

[63] Given that all numbers are conditional on having at least one child, using progression rates for, say, urban women from the 1985-1994 period leads to $1+1\times 0.782+1\times 0.782\times 0.499+1\times 0.782\times 0.499\times 0.448 = 2.3$ children.

[64] One way to see how this works is to imagine that we start the spell with 100 women. After the first quarter we are left with $N_2 = (1-P(b_1)-P(g_1))\times 100$, where N_2 is the number of women who start the second quarter. After the second quarter we then have $N_3 = (1-P(b_2)-P(g_2))\times N_2$, etc.

Say that 65.88 women of the original 100 still have not had a birth yet by the start of quarter 6 and that the predicted probability of having a son in quarter 6 is 0.0931 and the probability of having a girl is 0.0566 (the probability of not having a birth in quarter 6 is 0.8503). For this quarter the abortion probability is then $\frac{100}{105}\times 0.0931-0.0566 = 0.0321$.

both positive (more boys than the natural rate) and negative (more girls than the natural rate) values of the abortion calculation within the spell. Finally, the percentage of children born that are boys is based on the randomization of births described above.[65]

Table 1: Predicted Fertility Behavior, Sex Ratio, and Abortions for Women with 8 or More Years of Education

	1972-1984				1985-1994				1995-2006			
	Births (%) / fertility[a]	Abortions per 100 births[b]	Abortions per 100 women[c]	Boys (%)	Births (%) / fertility[a]	Abortions per 100 births[b]	Abortions per 100 women[c]	Boys (%)	Births (%) / fertility[a]	Abortions per 100 births[b]	Abortions per 100 women[c]	Boys (%)
Urban												
Spell 2	85.9	2.0	1.8	52.3	78.2	4.7	3.7	53.7	68.0	8.0	5.4	55.3
Spell 3	64.4	5.1	3.3	53.9	49.9	9.8	4.9	56.2	38.6	7.8	3.0	55.3
Spell 4	57.0	2.8	1.6	52.6	44.8	2.6	1.1	52.6	33.7	21.8	7.3	62.3
Overall[d]	2.7	2.0	5.5	52.3	2.3	3.4	8.0	53.1	2.0	4.6	9.4	53.7
Rural												
Spell 2	92.5	−1.4	−1.3	50.5	87.6	3.1	2.7	52.8	83.1	4.4	3.6	53.5
Spell 3	80.9	2.6	2.1	52.5	70.6	6.5	4.6	54.5	59.6	10.6	6.3	56.7
Spell 4	75.7	−3.1	−2.4	49.6	62.0	0.2	0.1	51.3	51.9	6.1	3.2	54.4
Overall[d]	3.2	−0.3	−1.1	51.2	2.9	2.4	6.8	52.8	2.6	4.1	10.5	53.4

Note. Predictions are based on estimates of equations (11) and (12). The samples consist of all women from the data with 8 or more years of education who married during the indicated period using the estimation results for that periods and the women's characteristics at the start of their marriage. All numbers presented are for women predicted to have one or more births. Birth/progression rates are based on the ratio of women predicted to have a birth by the end of each spell. Abortion rates within each spell are based on the predicted number of abortions each woman would have if she went through the entire spell. To generate conditions such as sex composition and fecundity for second and higher spells each woman is randomly assigned outcomes based on the estimation results and her characteristics as follows. For each quarter, her probabilities of having a boy, a girl, or no birth is calculated. She is assigned one of these outcomes based on a random draw from a uniform distribution. The first quarter where she has a draw that results in a birth she leaves the spell and the quarter reached is used to calculate her starting age for the subsequent spell. If she has no draw that result in a birth within a spell her childbearing stops and she does not enter the next spell. Results are averaged over 1,000 repetitions.
[a] For individual spells the column shows the percent of women who started the spell and ended up with a birth by the end of the spell period covered. For the "Overall" row, the number is the expected number of children born per woman over the first four spells, conditional on having at least one birth.
[b] For individual spells the column shows the number of abortions per 100 births predicted to take place by the end of the spell. For the "Overall" row, the number is the total number of abortion per 100 births predicted to take place over all four spells.
[c] For individual spells the column shows the number of abortions predicted to take place by the end of the spell per 100 women who started the spell . For the "Overall" row, the number is the total number of abortion predicted to take place over all four spells per 100 women who had at least one child.
[d] Covers first through fourth spells.

The results show a substantial reduction in fertility over time. Predicted completed fertility went from 2.7 for urban women married in the 1972–1984 period to just 2 for urban women married in the 1995–2006 period. Hence, urban fertility is now below replacement, especially considering that these predictions are conditional on having at least one child. Rural women showed a similar decline in completed fertility, going from 3.2 to 2.6. Corresponding to the decline in overall fertility, there were also substantial reductions in the individual parity progression rates.

In other words, the probability of having a girl should have been $\frac{100}{105} \times 0.0931 = 0.0887$, but only a probability of 0.0566 was predicted. Hence, in quarter 6 the predicted number of sons born is $0.0931 \times 65.88 = 6.13$, the predicted number of daughters born is $0.0566 \times 65.88 = 3.73$, and $0.0321 \times 65.88 = 2.11$ abortions must have taken place to reach these births.

[65] This number is the predicted sex ratio at birth and differ from actual observed sex ratios when the children are older because of mortality. On one hand, the anticipated or experienced death of a son increases the likelihood of sex selection even if parents already had a son, which would make the later observed sex ratio lower than what is predicted here. On the other hand, mortality risk is higher for girls than for boy, which would make the sex ratio more male dominated.

For example, urban women with 3 children went from having a 57% chance of having a 4th child for the 1972–1984 cohort to a 33% chance for the 1995–2006 cohort—and they had a substantially lower probability of even making it to 3 children in the first place.

Associated with the decline in completed fertility is an increase in sex selection. For urban women the predicted number of abortions per 100 women by the end of childbearing have gone up by over 17 percent between the last two cohorts (8.0 to 9.4) and the number of abortions per 100 births have gone up by over 35 percent (3.4 to 4.6). For rural women, abortions per 100 women increased almost 55 percent (6.8 to 10.5), while abortions per 100 births increased over 70 percent (2.4 to 4.1).[66] The combined effects of the declines in fertility and increased use of sex selection are that the percentage boys increases from 53.1 to 53.7 percent for urban women, and from 52.8 to 53.4 percent for rural women.

Of particular note is the high number of abortions among rural women for the 1985–1994 period. Educated rural women obviously had few constraints on access to prenatal sex determination even when the techniques were relatively new. The higher abortion rate per woman for rural women than urban women likely comes from a combination of higher likelihood of having an additional child and changes in use of sex selection within spell as shown in the graphs above.

The results from theoretical model showed that it is possible for the use of sex selection to fall for an individual parity, even as overall use of sex selection increases. This is the case here, where the use of sex selection fell for the third spell from 9.8 per 100 births to 7.8 for urban women between the last two periods. As already discussed, total use of sex selection went up between the last two periods, so the reduction for the third spell is not an indication of reduced use of sex selection overall, but simply the result of fewer women making it to a third birth and those who did

[66] Unfortunately there are no solid official estimates to compare these numbers to. The total number of abortions per year, not just those based on son preference, vary between the official count of 600,000–700,000 and an estimate of 6.4 million from the 2002 Abortion Assessment Project-India. The 6.4 million abortions per year may even be an underestimate (Stillman, Frost, Singh, Moore and Kalyanwala, 2014). NFHS does ask about abortions in all three surveys, although the questions change substantially between surveys. However, the PNDT act prohibits using prenatal diagnostic tests to determine a fetus' sex and revealing a fetus' sex to parents. Hence, respondents have a strong incentive not to disclose abortions motivated by son preference. In addition, abortion are considered a taboo subject and many women are unwilling or uncomfortable reporting their abortions to government sponsored enumerators (Rossier, 2003; Stillman et al., 2014).

were more likely to already have a son—for the second spell the number of abortions per 100 births for urban women went from 4.7 to 8.0, a 70 percent increase.[67] This underscores why focusing exclusively on individual parities can be misleading.

The results for rural women illustrate the two different strategies for achieving one son: either have many children or have few children and use sex selection. For the 1986–1994 period there is no use of sex selection on fourth birth, which fits with 62 percent of women end up with three or more children and a full 62 percent of women with three children have a fourth birth (recall that there is a 94 percent chance of having at least one son if you have four children). The use of sex selection on second and third spells indicates that one group of rural women follows the high fertility route, whereas the other group follows the pattern of urban women and combine restricting fertility with use of sex selection.

Another way to see the spread of access to sex selection over time is to compare urban women in the first period with rural women in the last period. At 2.7 fertility is already relatively low for urban women in the 1972–1984 period and there is some evidence of sex selection for these women. As discussed in Section 4.1, the higher than natural sex ratio for urban well-educated women this early is likely a combination of early access to prenatal sex determination and that some of the spells end in the 1985–1994 period when there was more widespread access. Rural women in the 1995–2006 period had a fertility only slightly lower than that of urban women in the 1972–1984 periode, but the number of abortions both per birth and per woman were twice as high.

For comparison Appendix Tables A.14 and A.15 show predicted fertility, number of abortions, and sex ratio for the two other education groups. As expected, fertility for women with no education is substantially higher and the decline over time much smaller than for the high education group. Predicted fertility fell from 3.6 to 3.3 for urban women and from 3.7 to 3.5 for rural women between the 1972–1984 and the 1995–2006 periods.[68] Consistent with the discussion above, there

[67] The amount of sex selection in the fourth spell reinforces this point: abortions per 100 births went up almost tenfold. Only 26 percent of urban women with at least one child make it to the beginning of the fourth spell in the last period, and less than 10 of all women have a fourth birth, but for those who do make it to the fourth spell the pressure to ensure a son is large.

[68] A caveat is that my estimates did not cover parities higher than 4, which could bias downward the change in predicted fertility.

is evidence of sex selection for neither urban nor rural women, with the sex ratio for all predicted births in the last two periods close to normal.[69] Random variation makes it appears that some individual parities had a higher than normal sex ratio, which, if studied in isolation, could be taken as evidence of use of sex selection, and reinforces why supplementing analysis of individual parities with this analysis of the overall pattern is important.

Fertility for women with between 1 and 7 years of education was slightly lower than the no education group in the 1972–1984 period, but the decline over time was larger. For the 1995–2006 period predicted completed fertility was 2.8 for urban women and 3.2 for rural women. There is only limited evidence of sex selection for urban women in this education group. The exception is for rural women in the last period where the overall sex ratio is 52.1% boys, although given the high fertility for this group and the small sample size for this education group it is unclear whether this simply reflects random variation.

The predictions discussed here provide further support for the idea that there are two alternative strategies to ensure the birth of a son, either have many children or use sex-selective abortions. The best educated group mostly follow the low fertility, high use of sex selection strategy, whereas the two lower education groups still have relatively high fertility and little to no use of sex selection. It is, however, clear that fertility is declining over time for all groups. With lower fertility in both urban and rural areas, we are likely to see further increases in the use of sex-selective abortions among those who already use sex selection, and among the groups who have not previously use sex selection we will see beginning use of sex-selective abortions.

6 Conclusion

If women have preferences over both the number of children they have *and* the sex composition of these children, they face a trade-off between the cost—both monetary and psychological—of sex selection and the cost of children. This paper introduces a novel approach to understanding

[69] The higher than normal sex ratios for the 1972–1984 period are most likely remnants of recall error not removed by the sample restriction.

the relationship between fertility and use of sex selection, and how sex selection interact with birth spacing. The proposed method allows for joint estimation of fertility and sex-selective abortions using a non-proportional, competing risk hazard model.

Three results stand out. First, lower fertility is an important factor in the decision to use sex-selective abortions. In both urban and rural areas, only women with the lowest predicted fertility—those with 8 or more years of education—use sex selection, and as fertility falls they use it for earlier parities. Women with less education instead follow a high fertility strategy to ensure they have a son and do not appear to use sex selection. Previous research was unable to explain why sex selection in India only occurred among higher education women because it failed to tie the use of sex selection and the fertility decision together.

Second, the legal steps taken to combat sex-selective abortion have not been able to reverse the practice. The use of sex selection has been increasing over time and is higher now than before the PNDT Act was passed. The predicted number of sex-selective abortions per 100 women during their childbearing years is now around 10 for women with 8 or more years of education in both urban and rural areas. This is especially interesting given that the cost of prenatal sex determination has likely increased in response to the PNDT Act. This also emphasizes why accounting for the possibility that parents may change their decision to use sex selection within a spell is important. As the theory shows an increase in the cost of prenatal sex determination increases the likelihood of parents changing their decision to use sex selection.[70]

Third, there is little evidence that women with one or more sons use sex selection, and their probability of another birth declines substantially once they have a son. The main exception is for rural women with one son and one daughter, presumably as an insurance against mortality. Hence, parents appear to have a preference for one son rather than multiple sons.

These results imply that the way we have been measuring son preference may not be useful for understanding how people make decisions on use of sex selection. Recent research suggests that

[70] A feature of the new approach is that it allows for changes in the decision to use sex selection within a spell. This is most clearly seen for better-educated urban women whose only child is a girl, for whom the use of sex selection declines as the second spell becomes longer.

son preference in India, when measured as ideally having more boys than girls, is decreasing over time and with higher education (Bhat and Zavier, 2003; Pande and Astone, 2007).[71] Despite this, use of sex selection has increased and for exactly the group argued to show declining preference for sons. The culprit may be that parents want *one* son and will use sex selection intensively to get that son, but refrain from using sex selection to have more sons, and our standard measure of son preference cannot captured that. A better approach may be to directly ask if there is a minimum number of each sex that respondents want, possibly in combination with ideal number questions.

This is of more than theoretical interest. If son preference is expressed as a very strong desire for having at least one son then reductions in fertility will lead to a further increase in the use of sex selection across all groups that hold that preference. What is more, as shown in the theory section, it is possible to get increasingly unequal sex ratio when fertility falls even if parents do not want more sons than daughters as long as they only use abortion on female fetuses. A deeper understanding of exactly what type of son preference is responsible for the increase use of sex selection is clearly an important question for future data collection and research.

An often-repeated, but poorly substantiated, argument for why there is sex selection in India is the dowry system. This explanation fits poorly with observed behavior. If true, dowries increase the cost of having girls relative to boys because you have to pay to ensure your girls are married. This implies that poorer households should be the most likely to use sex selection, and that the use of sex selection should increase the more girls they have.[72] Similarly, for all households there would be a financial incentive to achieve a higher number of sons than daughters. As shown here, however, sex selection is predominantly used by better educated and therefore, on average, wealthier households and only to secure one son rather than multiple sons. Finally, fertility's rapid decline after the introduction of prenatal sex determination, combined with low cost of sex

[71] This measure of son preference is commonly used in the literature. See, for example, Clark (2000), Jensen and Oster (2009), and Hu and Schlosser (2015). In NFHS, and Demographic and Health Surveys in general, son preference is measured as part of the general fertility questions. The first question is how many children a woman would have if she could choose exactly how many. This if followed by the sex preference question: "How many of these children would you like to be boys, how many would you like to be girls and for how many would the sex not matter?"

[72] The exception would be if dowries increase more than proportionally with education level and income, but there does not appear to be evidence of this.

selection, suggests that parents' perceived costs of boys and girls are similar.[73] Hence, banning dowries, as India has done, is unlikely to affect the use of sex selection.

The results presented here lead to a number of important questions for future research. One is whether marriage market sex ratios affect the use of sex selection. Parents may care not only about the number and type of children they have but also whether they will have grandchildren. If they care about grandchildren, then a boy could still be preferred over a girl, but a married girl would be preferred over an unmarried boy (Bhaskar, 2011). The implication is that parents respond to changes in the expected sex ratio of their children's marriage market, even given their preference for a son. This hypothesis can be tested using measures of the observed distributions of boys and girls and the method proposed here.

A second question for future research, which is especially important when designing policies aimed at reducing the use of sex selection, is who the agents are in the decisions to use sex selection. Here, I have treated the household as a single unit, but it is possible, and indeed likely, that husband and wife have different preferences over both the factors that determine use of sex selection and sex selection itself. Some of the popular press have assumed that the decision to use sex selection rests with the husband. This, however, does not fit well with the general pattern that women, on average, prefer to have fewer children than men do and that declining fertility appear to be the main driver of sex selection. A better understanding of who holds what preferences in the family would be a good first step to disentangling who makes decisions about sex selection.

A third question is whether there are interactions between sex selection and child outcomes, such a survival and education. It has been argued that access to sex selection may benefit girls because those girls who are born are more likely to be wanted by their parents. For mortality it is, however, possible that improvements are the result of a purely mechanical effect. As I have shown, increased use of sex selection lengthens the birth spacing after a girl and that by itself can improve her survival chances, even if she is no more wanted than before. The method suggested here can predict the likelihood of a woman using prenatal sex determination for a given birth based on her

[73] See the discussion in Section 5.2 for more detail.

characteristics. This predicted probability can then be used in estimations of the determinants of child health to directly test whether increasing use of sex selection is beneficial for the girls who are born. It is unlikely, however, that a substantial mortality effect exists since sex selection is mainly used by well-educated women, who tend to have lower mortality, but there might be effects on education investments.

In conclusion, the results provide strong clues to how sex selection use will change in the future. Because lower fertility is responsible for the increase in sex-selective abortions, it is likely that we will see further increases in the practice as more families want fewer children, either because of urbanization or because of increases in female education. With already low fertility for better-educated urban women, a substantial future increase in sex-selective abortions per woman is unlikely, but a higher proportion of women will belong to this group in the future. For rural, better-educated women fertility is still falling. To the extent that it falls to the same level as for urban women, I expect a corresponding increase in sex selection. Finally, and most importantly, we are beginning to see evidence of lower fertility for women with lower levels of education. If women with less education hold the same preference for one son as the better-educated, once the less-educated women's fertility begins to drop to three—and even two—we are likely to see a substantially increased use of sex selection in India.

References

Abrevaya, Jason, "Are There Missing Girls in the United States? Evidence from Birth Data," *American Economic Journal: Applied Economics*, 2009, *1* (2), 1–34.

Allison, Paul D, "Discrete-Time Methods for the Analysis of Event Histories," *Sociological Methodology*, 1982, *13*, 61–98.

Arnold, Fred, "Gender Preferences for Children," Demographic and Health Surveys Comparative Studies 23, Macro International Inc, Calverton, Maryland 1997.

_ **, Minja Kim Choe, and T K Roy**, "Son Preference, the Family-Building Process and Child Mortality in India," *Population Studies*, 1998, *52* (3), 301–315.

_ **, Sunita Kishor, and T K Roy**, "Sex-Selective Abortions in India," *Population and Development Review*, 2002, *28* (4), 759–785.

Ashraf, Nava, Erica Field, and Jean Lee, "Household Bargaining and Excess Fertility: An Experimental Study in Zambia," 2009.

Ben-Porath, Yoram and Finis Welch, "Do Sex Preferences Really Matter?," *The Quarterly Journal of Economics*, 1976, *90* (2), 285–307.

Bhaskar, V, "Sex Selection and Gender Balance," *American Economic Journal: Microeconomics*, 2011, *3* (1), 214–244.

Bhat, P N Mari, "Sex Ratio in India," *Lancet*, 2006, *367* (9524), 1725–1726.

_ **and A J Francis Zavier**, "Fertility Decline and Gender Bias in Northern India.," *Demography*, 2003, *40* (4), 637–657.

Bongaarts, John, "The Implementation of Preferences for Male Offspring," *Population and Development Review*, 2013, *39* (2), 185–208.

_ **and Christophe Z. Guilmoto**, "How Many More Missing Women? Excess Female Mortality and Prenatal Sex Selection, 1970–2050," *Population and Development Review*, 2015, *41* (2), 241–269.

Clark, Shelley, "Son Preference and Sex Composition of Children: Evidence from India," *Demography*, 2000, *37* (1), 95–108.

Conde-Agudelo, Agustin, Anyeli Rosas-Bermúdez, and Ana Cecilla Kafury-Goeta, "Birth spacing and risk of adverse perinatal outcomes: A meta-analysis," *JAMA*, 2006, *295* (15), 1809–1823.

Das Gupta, Monica and P N Mari Bhat, "Fertility Decline and Increased Manifestation of Sex Bias in India," *Population Studies*, 1997, *51* (3), 307–315.

Das, Narayan, "Sex preference and fertility behavior: A study of recent Indian data," *Demography*, 1987, *24* (4), 517–530.

Davies, James B and Junsen Zhang, "The Effects of Gender Control on Fertility and Children's Consumption," *Journal of Population Economics*, 1997, *10* (1), 67–85.

Dharmalingam, Arunachalam, Sowmya Rajan, and S. Philip Morgan, "The Determinants of Low Fertility in India," *Demography*, 2014, *51* (4), 1451–1475.

Ding, Weili and Y Zhang, "When a Son is Born: The Impact of Fertility Patterns on Family Finance in Rural China," 2009.

Dolton, Peter and Wilbert von der Klaauw, "Leaving Teaching in the UK: A Duration Analysis," *Economic Journal*, March 1995, *105* (429), 431–444.

Dommaraju, Premchand, "Timing of first birth in India," *Genus*, 2009, *65* (1), 81–101.

Dreze, Jean and Mamta Murthi, "Fertility, Education, and Development: Evidence from India," *Population and Development Review*, 2001, *27* (1), 33–63.

Dyson, Tim and Mick Moore, "On Kinship Structure, Female Autonomy, and Demographic Behavior in India," *Population and Development Review*, 1983, *9* (1), 35–60.

Ebenstein, Avraham Y, "Estimating a Dynamic Model of Sex Selection in China," *Demography*, 2011, *48*, 783–811.

Edlund, Lena, Hongbin Li, Junjian Yi, and Junsen Zhang, "Sex Ratios and Crime: Evidence from China," *Review of Economics and Statistics*, September 2013.

Filmer, Deon, Jed Friedman, and Norbert Schady, "Development, Modernization, and Childbearing: The Role of Family Sex Composition," *World Bank Economic Review*, 2009, *23* (3), 371–398.

Goodkind, Daniel, "On Substituting Sex Preference Strategies in East Asia: Does Prenatal Sex Selection Reduce Postnatal Discrimination," *Population and Development Review*, 1996, *22* (1), 111–125.

Grover, Anil and Rajesh Vijayvergiya, "Sex Ratio in India," *Lancet*, 2006, *367* (9524), 1725–1726.

Han, Aaron and Jerry A Hausman, "Flexible Parametric Estimation of Duration and Competing Risk Models," *Journal of Applied Econometrics*, 1990, *5* (1), 1–28.

Happel, S. K., J. K. Hill, and S. A. Low, "An economic analysis of the timing of childbirth," *Population Studies*, 1984, *38* (2), 299–311.

Haughton, Dominique and Jonathan Haughton, "Using a mixture model to detect son preference in Vietnam," *Journal of Biosocial Science*, 7 1996, *28*, 355–365.

Heckman, James J. and Robert J. Willis, *Estimation of a Stochastic Model of Reproduction: An Econometric Approach*, NBER,

Hotz, V Joseph, Jacob Alex Klerman, and Robert J Willis, "The Economics of Fertility in Developed Countries," in Mark R Rosenzweig and Oded Stark, eds., *Handbook of Population and Family Economics*, Elsevier B.V, 1997, pp. 275–347.

Hu, Luojia and Analía Schlosser, "Prenatal Sex Selection and Girls' Well-Being: Evidence from India," *The Economic Journal*, 2015, *125* (587), 1227–1261.

International Institute for Population Sciences (IIPS) and Macro International, *National Family Health Survey (NFHS-3), 2005–06: India*, Vol. 1, Mumbai, India: IIPS, September 2007.

Jacobsen, R, H Moller, and A Mouritsen, "Natural Variation in the Human Sex Ratio," *Human Reproduction*, 1999, *14* (12), 3120–3125.

Jenkins, Stephen P, "Easy Estimation Methods for Discrete-Time Duration Models," *Oxford Bulletin of Economics and Statistics*, 1995, *57* (1), 129–138.

Jensen, Eric, "Desired fertility, the "up to god" response, and sample selection bias," *Demography*, 1985, *22* (3), 445–454.

Jensen, Robert and Emily Oster, "The Power of TV: Cable Television and Women's Status in India," *The Quarterly Journal of Economics*, 2009, *124* (3), 1057–1094.

Jha, Prabhat, Rajesh Kumar, Priya Vasa, Neeraj Dhingra, Deva Thiruchelvam, and Rahim Moineddin, "Low male-to-female [sic] sex ratio of children born in India: national survey of 1.1 million households," *Lancet*, 2006, *367*, 211–218.

Keyfitz, Nathan, "How birth control affects births," *Social Biology*, 1971, *18* (2), 109–121.

Khanna, Sunil K, "Traditions and Reproductive Technology in an Urbanizing North Indian Village," *Social Science & Medicine*, 1997, *44* (2), 171–180.

Kovsted, Jens, Claus C. Pörtner, and Finn Tarp, "Child Health and Mortality: Does Health Knowledge Matter?," *Journal of African Economies*, 2002, *11* (4), 542–560.

Lancaster, John, "The Desperate Bachelors," *The Washington Post*, 2002, *December 2*, A01.

Leung, Siu Fai, "A Stochastic Dynamic Analysis of Parental Sex Preferences and Fertility," *The Quarterly Journal of Economics*, 1991, *106* (4), 1063–1088.

_ , "Will Sex Selection Reduce Fertility?," *Journal of Population Economics*, 1994, *7* (4), 379–392.

ling Pong, Suet, "Sex Preference and Fertility in Peninsular Malaysia," *Studies in Family Planning*, 1994, *25* (3), pp. 137–148.

Merli, M Giovanna and Adrian E Raftery, "Are Births Underreported in Rural China? Manipulation of Statistical Records in Response to China's Population Policies," *Demography*, 2000, *37* (1), 109–126.

Newman, John L, "A Stochastic Dynamic Model of Fertility," in T Paul Schultz, ed., *Research in Population Economics*, Greenwich, Conn: JAI Press, 1988, pp. 41–68.

_ **and Charles E McCulloch**, "A Hazard Rate Approach to the Timing of Births," *Econometrica*, 1984, *52* (4), 939–961.

Pande, Rohini P and Nan Marie Astone, "Explaining Son Preference in Rural India: The Independent Role of Structural Versus Individual Factors," *Population Research and Policy Review*, 2007, *26* (1), 1–29.

Park, Chai Bin and Nam Hoon Cho, "Consequences of Son Preference in a Low-Fertility Society: Imbalance of the Sex Ratio at Birth in Korea," *Population and Development Review*, 1995, *21* (1), 59–84.

Rahman, Mizanur and Julie DaVanzo, "Gender preference and birth spacing in matlab, Bangladesh," *Demography*, 1993, *30* (3), 315–332.

Rasul, Imran, "Household Bargaining over Fertility: Theory and Evidence from Malaysia," *Journal of Development Economics*, 2008, *86* (2), 215–241.

Repetto, Robert, "Son Preference and Fertility Behavior in Developing Countries," *Studies in Family Planning*, 1972, *3* (4), 70–76.

Retherford, Robert D and T K Roy, "Factors Affecting Sex-Selective Abortion in India and 17 Major States," Technical Report, Mumbai, India 2003.

Rosenzweig, Mark R and T Paul Schultz, "Market Opportunities, Genetic Endowments, and Intrafamily Resource Distribution: Child Survival in Rural India," *American Economic Review*, 1982, *72* (4), 803–815.

_ **and** _ , "The Demand for and Supply of Births: Fertility and Its Life Cycle Consequences," *American Economic Review*, 1985, *75* (5), 992–1015.

Rossier, Clémentine, "Estimating Induced Abortion Rates: A Review," *Studies in Family Planning*, 2003, *34* (2), 87–102.

Rutstein, S. O., "Effects of preceding birth intervals on neonatal, infant and under-five years mortality and nutritional status in developing countries: evidence from the demographic and health surveys," *International Journal of Gynecology and Obstetrics*, Oct 2005, *89* (S1), S7–S24.

Schultz, T Paul, "Demand for Children in Low Income Countries," in Mark R Rosenzweig and Oded Stark, eds., *Handbook of Population and Family Economics*, Amsterdam: Elsevier Science B.V., 1997, pp. 349–430.

Sethuraman, Kavita, Lokesh Gujjarappa, Nandita Kapadia-Kundu, Ruchira Naved, Alka Barua, Prachi Khoche, and Shahana Parveen, "Delaying the First Pregnancy: A Survey in Maharashtra, Rajasthan and Bangladesh," *Economic and Political Weekly*, 2007, *42* (44), 79–89.

Stillman, Melissa, Jennifer J. Frost, Susheela Singh, Ann M. Moore, and Shveta Kalyanwala, "Abortion in India: A Literature Review," Report, Guttmacher Institute, New York, NY December 2014.

Sudha, S and S Irudaya Rajan, "Female Demographic Disadvantage in India 1981-1991: Sex Selective Abortions and Female Infanticide," *Development and Change*, 1999, *30* (3), 585–618.

Thomas, Jonathan M, "On the Interpretation of Covariate Estimates in Independent Competing-Risks Models," *Bulletin of Economic Research*, 1996, *48* (1), 27–39.

Tulasidhar, V. B., "Maternal education, female labour force participation and child mortality: evidence from the Indian census," *Health Transition Review*, 1993, *3* (2), 177–190.

Wang, Xiaobin, Changzhong Chen, Lihua Wang, Dafang Chen, Wenwei Guang, and Jonathan French, "Conception, early pregnancy loss, and time to clinical pregnancy: a population-based prospective study," *Fertility and Sterility*, 2003, *79* (3), 577 – 584.

Wei, Shang-Jin and Xiaobo Zhang, "The Competitive Saving Motive: Evidence from Rising Sex Ratios and Savings Rates in China," 2009.

Whitworth, Alison and Rob Stephenson, "Birth spacing, sibling rivalry and child mortality in India," *Social Science & Medicine*, 2002, *55* (12), 2107 – 2119.

Wolpin, Kenneth I, "An Estimable Dynamic Stochastic Model of Fertility and Child Mortality," *Journal of Political Economy*, 1984, *92* (5), 852–874.

Yi, Zeng, Tu Ping, Gu Baochang, Xu Yi, Li Bohua, and Li Yongpiing, "Causes and Implications of the Recent Increase in the Reported Sex Ratio at Birth in China," *Population and Development Review*, 1993, *19* (2), 283–302.

Zhou, Weijin, J orn Olsen, G L Nielsen, and S Sabroe, "Risk of Spontaneous Abortion Following Induced Abortion is only Increased with Short Interpregnancy Interval," *Journal of Obstetrics and Gynaecology*, 2000, *20* (1), 49–54.

A Appendix

Table A.1: Fertility and Percent Boys by Cost of Children and prenatal Sex Determination

	Discount rate ($d = 1.0$) Cost of prenatal Sex Determination (p_s)									
	12		16		20		24		200	
Cost of children	Avg Fertility	Percent Boys[a]	Avg Fertility	Percent Boys[a]	Avg Fertility	Percent Boys[a]	Avg Fertility	Percent Boys[a]	Avg Fertility	Percent Boys[a]
	Son Preference ($\alpha = 0.5$)									
k = 12	7.47	50.0	7.47	50.0	7.47	50.0	7.47	50.0	7.47	50.0
k = 14	5.41	50.3	5.41	50.2	5.42	50.0	5.43	50.0	5.43	50.0
k = 16	4.10	51.4	4.11	51.3	4.16	50.6	4.17	50.5	4.19	49.9
k = 18	3.13	54.0	3.14	53.7	3.19	52.9	3.25	51.7	3.25	50.0
k = 20	2.50	55.1	2.50	55.0	2.50	54.9	2.50	54.7	2.50	50.0
k = 22	2.00	62.5	2.00	62.4	2.00	62.1	2.00	61.0	2.00	50.0
	Son Preference ($\alpha = 0.55$)									
k = 12	7.29	50.6	7.30	50.0	7.31	50.0	7.31	50.0	7.31	50.0
k = 14	5.26	53.3	5.37	51.5	5.40	50.4	5.41	50.1	5.42	50.0
k = 16	4.10	57.8	4.10	52.6	4.10	51.4	4.11	51.2	4.19	49.9
k = 18	3.13	57.0	3.13	54.0	3.13	54.0	3.14	53.8	3.32	50.0
k = 20	2.25	61.2	2.25	61.1	2.27	60.7	2.31	59.5	2.50	50.0
k = 22	2.00	62.5	2.00	62.5	2.00	62.5	2.00	62.4	2.00	50.0
	Son Preference ($\alpha = 0.6$)									
k = 12	7.14	54.2	7.26	51.4	7.32	50.3	7.34	50.0	7.34	50.0
k = 14	5.05	61.7	5.07	56.1	5.11	53.6	5.22	50.9	5.26	50.0
k = 16	4.06	66.3	4.06	60.1	4.07	58.6	4.07	55.2	4.16	49.9
k = 18	3.13	69.7	3.13	68.3	3.13	64.9	3.13	57.5	3.32	50.0
k = 20	2.68	67.5	2.25	61.2	2.25	61.1	2.25	61.1	2.63	50.0
k = 22	2.00	62.5	2.00	62.5	2.00	62.5	2.00	62.5	2.25	49.9
	Son Preference ($\alpha = 0.65$)									
k = 12	7.09	62.8	7.13	57.5	7.19	53.9	7.26	51.7	7.34	50.0
k = 14	5.05	73.9	5.05	66.6	5.07	61.9	5.08	58.5	5.27	50.0
k = 16	4.06	74.9	4.06	73.0	4.06	68.8	4.07	63.3	4.17	49.9
k = 18	3.13	69.9	3.13	69.7	3.13	69.5	3.13	68.3	3.32	50.0
k = 20	2.73	72.5	2.69	72.1	2.56	70.7	2.25	66.6	2.38	50.0
k = 22	2.00	97.2	2.00	86.6	2.00	68.7	2.00	62.5	2.25	49.9

Note. Simulations based on 50,000 individuals, 15 periods, $I = 200$, and a probability of a son of 0.5.
[a] Percent boys is the percent boys of all births.

Table A.2: Fertility and Percent Boys by Cost of Children and prenatal Sex Determination

	Discount rate ($d = 0.95$) Cost of prenatal Sex Determination (p_s)									
	12		16		20		24		200	
Cost of children	Avg Fertility	Percent Boys[a]	Avg Fertility	Percent Boys[a]	Avg Fertility	Percent Boys[a]	Avg Fertility	Percent Boys[a]	Avg Fertility	Percent Boys[a]
					Son Preference ($\alpha = 0.5$)					
k = 12	7.47	50.0	7.47	50.0	7.47	50.0	7.47	50.0	7.47	50.0
k = 14	5.41	50.2	5.42	50.1	5.43	50.0	5.43	50.0	5.43	50.0
k = 16	4.11	51.3	4.16	50.7	4.17	50.3	4.19	49.9	4.19	49.9
k = 18	3.13	53.9	3.25	51.9	3.25	51.7	3.25	50.0	3.25	50.0
k = 20	2.50	55.0	2.50	55.0	2.50	54.7	2.50	52.6	2.50	50.0
k = 22	2.00	62.5	2.00	62.1	2.00	59.4	2.00	50.0	2.00	50.0
					Son Preference ($\alpha = 0.55$)					
k = 12	7.30	50.1	7.30	50.0	7.31	50.0	7.31	50.0	7.31	50.0
k = 14	5.38	51.4	5.40	50.2	5.41	50.1	5.42	50.0	5.42	50.0
k = 16	4.10	54.9	4.10	51.4	4.13	51.0	4.17	50.5	4.19	49.9
k = 18	3.13	54.0	3.13	54.0	3.14	53.7	3.26	51.8	3.32	50.0
k = 20	2.25	61.1	2.27	60.7	2.50	55.0	2.50	54.9	2.50	50.0
k = 22	2.00	62.5	2.00	62.5	2.00	62.4	2.00	62.1	2.00	50.0
					Son Preference ($\alpha = 0.6$)					
k = 12	7.27	51.2	7.33	50.1	7.34	50.0	7.34	50.0	7.34	50.0
k = 14	5.06	58.0	5.14	52.7	5.22	50.8	5.25	50.1	5.26	50.0
k = 16	4.06	59.0	4.06	57.8	4.07	52.6	4.08	51.2	4.16	49.9
k = 18	3.13	69.0	3.13	64.8	3.13	54.0	3.13	53.9	3.32	50.0
k = 20	2.25	61.2	2.25	61.2	2.25	61.1	2.27	60.7	2.63	50.0
k = 22	2.00	62.5	2.00	62.5	2.00	62.5	2.00	62.5	2.25	49.9
					Son Preference ($\alpha = 0.65$)					
k = 12	7.11	58.4	7.23	52.2	7.32	50.3	7.34	50.0	7.34	50.0
k = 14	5.05	68.2	5.06	60.3	5.10	54.7	5.20	51.5	5.27	50.0
k = 16	4.06	74.1	4.06	69.0	4.06	61.3	4.07	57.5	4.17	49.9
k = 18	3.13	69.9	3.13	69.7	3.13	68.3	3.13	64.9	3.32	50.0
k = 20	2.71	72.4	2.56	70.7	2.00	62.5	2.00	62.4	2.38	50.0
k = 22	2.00	85.8	2.00	62.5	2.00	62.5	2.00	62.5	2.25	49.9

Note. Simulations based on 50,000 individuals, 15 periods, $I = 200$, and a probability of a son of 0.5.
[a] Percent boys is the percent boys of all births.

Table A.3: Fertility and Percent Boys by Cost of Children and prenatal Sex Determination

	Discount rate ($d = 0.9$) Cost of prenatal Sex Determination (p_s)									
	12		16		20		24		200	
Cost of children	Avg Fertility	Percent Boys[a]	Avg Fertility	Percent Boys[a]	Avg Fertility	Percent Boys[a]	Avg Fertility	Percent Boys[a]	Avg Fertility	Percent Boys[a]
Son Preference ($\alpha = 0.5$)										
k = 12	7.47	50.0	7.47	50.0	7.47	50.0	7.47	50.0	7.47	50.0
k = 14	5.42	50.1	5.43	50.0	5.43	50.0	5.43	50.0	5.43	50.0
k = 16	4.16	50.7	4.17	50.5	4.19	49.9	4.19	49.9	4.19	49.9
k = 18	3.25	51.9	3.25	51.8	3.25	50.0	3.25	50.0	3.25	50.0
k = 20	2.50	55.0	2.50	54.7	2.50	50.0	2.50	50.0	2.50	50.0
k = 22	2.00	62.3	2.00	56.2	2.00	50.0	2.00	50.0	2.00	50.0
Son Preference ($\alpha = 0.55$)										
k = 12	7.30	50.0	7.31	50.0	7.31	50.0	7.31	50.0	7.31	50.0
k = 14	5.40	50.3	5.41	50.1	5.42	50.0	5.42	50.0	5.42	50.0
k = 16	4.10	51.4	4.16	50.7	4.17	50.5	4.19	49.9	4.19	49.9
k = 18	3.13	54.0	3.16	53.5	3.26	51.8	3.28	50.9	3.32	50.0
k = 20	2.27	60.8	2.50	55.0	2.50	54.9	2.50	53.8	2.50	50.0
k = 22	2.00	62.5	2.00	62.5	2.00	62.1	2.00	56.2	2.00	50.0
Son Preference ($\alpha = 0.6$)										
k = 12	7.32	50.3	7.34	50.0	7.34	50.0	7.34	50.0	7.34	50.0
k = 14	5.10	53.4	5.24	50.5	5.25	50.1	5.26	50.0	5.26	50.0
k = 16	4.06	58.4	4.07	52.2	4.10	51.0	4.13	50.5	4.16	49.9
k = 18	3.13	66.8	3.13	54.0	3.14	53.8	3.26	51.8	3.32	50.0
k = 20	2.25	61.2	2.25	61.1	2.28	60.3	2.50	55.0	2.63	50.0
k = 22	2.00	62.5	2.00	62.5	2.00	62.5	2.00	62.3	2.25	49.9
Son Preference ($\alpha = 0.65$)										
k = 12	7.16	53.9	7.32	50.3	7.34	50.0	7.34	50.0	7.34	50.0
k = 14	5.05	62.5	5.08	54.1	5.22	50.8	5.26	50.0	5.27	50.0
k = 16	4.06	71.3	4.06	58.8	4.07	55.2	4.08	51.2	4.17	49.9
k = 18	3.13	69.9	3.13	69.0	3.13	57.5	3.13	53.9	3.32	50.0
k = 20	2.64	71.6	2.00	62.5	2.00	62.5	2.01	62.3	2.38	50.0
k = 22	2.00	62.5	2.00	62.5	2.00	62.5	2.00	62.5	2.25	49.9

Note. Simulations based on 50,000 individuals, 15 periods, $I = 200$, and a probability of a son of 0.5.
[a] Percent boys is the percent boys of all births.

Table A.4: Fertility and Percent Boys by Cost of Children and prenatal Sex Determination

	Discount rate ($d = 0.85$) Cost of prenatal Sex Determination (p_s) 12		16		20		24		200	
Cost of children	Avg Fertility	Percent Boys[a]	Avg Fertility	Percent Boys[a]	Avg Fertility	Percent Boys[a]	Avg Fertility	Percent Boys[a]	Avg Fertility	Percent Boys[a]
					Son Preference ($\alpha = 0.5$)					
k = 12	7.47	50.0	7.47	50.0	7.47	50.0	7.47	50.0	7.47	50.0
k = 14	5.42	50.0	5.43	50.0	5.43	50.0	5.43	50.0	5.43	50.0
k = 16	4.16	50.6	4.19	49.9	4.19	49.9	4.19	49.9	4.19	49.9
k = 18	3.25	51.9	3.25	50.0	3.25	50.0	3.25	50.0	3.25	50.0
k = 20	2.50	55.0	2.50	50.0	2.50	50.0	2.50	50.0	2.50	50.0
k = 22	2.19	54.3	2.00	50.0	2.00	50.0	2.00	50.0	2.00	50.0
					Son Preference ($\alpha = 0.55$)					
k = 12	7.31	50.0	7.31	50.0	7.31	50.0	7.31	50.0	7.31	50.0
k = 14	5.40	50.2	5.42	50.0	5.42	50.0	5.42	50.0	5.42	50.0
k = 16	4.16	50.7	4.17	50.6	4.19	49.9	4.19	49.9	4.19	49.9
k = 18	3.14	53.7	3.26	51.9	3.32	50.0	3.32	50.0	3.32	50.0
k = 20	2.50	55.1	2.50	55.0	2.50	52.6	2.50	50.0	2.50	50.0
k = 22	2.00	62.5	2.00	62.2	2.00	50.0	2.00	50.0	2.00	50.0
					Son Preference ($\alpha = 0.6$)					
k = 12	7.33	50.0	7.34	50.0	7.34	50.0	7.34	50.0	7.34	50.0
k = 14	5.24	51.3	5.25	50.1	5.26	50.0	5.26	50.0	5.26	50.0
k = 16	4.06	52.2	4.13	50.7	4.14	50.4	4.16	49.9	4.16	49.9
k = 18	3.13	54.0	3.14	53.9	3.26	51.9	3.32	50.0	3.32	50.0
k = 20	2.25	61.2	2.31	59.5	2.50	55.0	2.52	54.4	2.63	50.0
k = 22	2.00	62.5	2.00	62.5	2.00	62.4	2.13	58.1	2.25	49.9
					Son Preference ($\alpha = 0.65$)					
k = 12	7.31	50.7	7.34	50.0	7.34	50.0	7.34	50.0	7.34	50.0
k = 14	5.07	54.9	5.24	50.5	5.26	50.0	5.27	50.0	5.27	50.0
k = 16	4.06	59.0	4.07	55.2	4.10	51.0	4.17	50.1	4.17	49.9
k = 18	3.13	69.7	3.13	57.0	3.13	53.9	3.26	51.8	3.32	50.0
k = 20	2.00	62.5	2.00	62.5	2.01	62.2	2.25	55.5	2.38	50.0
k = 22	2.00	62.5	2.00	62.5	2.00	62.5	2.00	62.4	2.25	49.9

Note. Simulations based on 50,000 individuals, 15 periods, $I = 200$, and a probability of a son of 0.5.
[a] Percent boys is the percent boys of all births.

Table A.5: Abortions and Change in Abortion Use by Cost of Children and prenatal Sex Determination

	Discount rate ($d = 1.0$) Cost of Prenatal Sex Determination (p_s) 12			16			20			24		
Cost of children	Abortions per 100 Women	Average Spells w. Scan[a]	Percent Change[b]	Abortions per 100 Women	Average Spells w. Scan[a]	Percent Change[b]	Abortions per 100 Women	Average Spells w. Scan[a]	Percent Change[b]	Abortions per 100 Women	Average Spells w. Scan[a]	Percent Change[b]
	Son Preference ($\alpha = 0.5$)											
k = 12	0.6	0.0	54.8	0.0	0.0	.	0.0	0.0	.	0.0	0.0	.
k = 14	3.1	0.0	8.4	2.6	0.0	28.5	0.8	0.0	50.3	0.0	0.0	.
k = 16	12.4	0.1	3.9	10.9	0.1	23.5	5.5	0.1	12.9	4.7	0.1	25.6
k = 18	25.1	0.3	2.0	23.5	0.3	12.5	18.6	0.3	41.8	11.0	0.1	12.7
k = 20	25.3	0.3	0.2	25.1	0.3	0.8	24.4	0.3	3.2	23.6	0.3	6.4
k = 22	50.3	0.5	0.2	49.9	0.5	0.9	48.7	0.5	3.2	44.0	0.5	12.6
	Son Preference ($\alpha = 0.55$)											
k = 12	8.3	0.2	47.8	0.8	0.0	50.3	0.0	0.0	.	0.0	0.0	.
k = 14	35.0	0.5	24.5	16.7	0.3	38.3	4.4	0.1	45.4	1.6	0.0	51.2
k = 16	64.2	0.7	12.0	22.0	0.3	23.0	12.0	0.1	7.8	10.6	0.1	25.1
k = 18	44.1	0.6	22.6	25.2	0.3	1.1	25.0	0.3	2.2	24.1	0.3	7.9
k = 20	50.3	0.5	0.3	49.9	0.5	1.7	48.7	0.5	6.3	43.9	0.6	22.9
k = 22	50.4	0.5	0.1	50.3	0.5	0.2	50.1	0.5	0.4	49.9	0.5	0.9
	Son Preference ($\alpha = 0.6$)											
k = 12	60.4	0.9	32.5	20.5	0.3	27.7	3.9	0.1	50.0	0.0	0.0	.
k = 14	119.3	1.3	12.1	62.1	0.8	21.9	37.0	0.5	26.6	10.2	0.1	27.6
k = 16	133.6	1.7	20.4	82.8	0.9	10.1	70.2	1.0	32.7	43.0	0.6	33.1
k = 18	123.8	1.2	1.4	114.6	1.2	6.9	93.4	1.1	18.3	47.0	0.5	12.2
k = 20	94.3	0.9	0.0	50.3	0.5	0.1	50.2	0.5	0.5	50.0	0.5	1.1
k = 22	50.4	0.5	0.0	50.4	0.5	0.1	50.3	0.5	0.1	50.3	0.5	0.2
	Son Preference ($\alpha = 0.65$)											
k = 12	182.2	2.2	16.8	108.0	1.4	25.0	56.7	0.9	40.2	25.2	0.5	50.1
k = 14	241.8	2.7	11.2	169.4	2.0	17.3	121.4	1.6	23.0	86.8	1.3	31.6
k = 16	203.9	2.1	3.2	188.2	2.0	7.9	154.2	1.8	16.2	109.7	1.3	14.6
k = 18	125.4	1.2	0.5	123.9	1.2	1.3	122.2	1.2	2.5	114.5	1.2	6.9
k = 20	123.9	1.2	0.0	119.5	1.2	0.0	106.9	1.1	0.1	75.3	0.7	0.2
k = 22	189.4	2.0	4.4	147.3	1.8	17.6	75.1	1.3	39.9	50.3	0.5	0.1

Note. Simulations based on 50,000 individuals, 15 periods, $I = 200$, and a probability of a son of 0.5.
[a] Percent of spells where prenatal scan was initially used but birth is the result of pregnancy without prenatal scan.

Table A.6: Abortions and Change in Abortion Use by Cost of Children and prenatal Sex Determination

	Discount rate ($d = 0.95$) Cost of Prenatal Sex Determination (p_s) 12			16			20			24		
Cost of children	Abortions per 100 Women	Average Spells w. Scan[a]	Percent Change[b]	Abortions per 100 Women	Average Spells w. Scan[a]	Percent Change[b]	Abortions per 100 Women	Average Spells w. Scan[a]	Percent Change[b]	Abortions per 100 Women	Average Spells w. Scan[a]	Percent Change[b]
					Son Preference ($\alpha = 0.5$)							
k = 12	0.2	0.0	48.2	0.0	0.0	.	0.0	0.0	.	0.0	0.0	.
k = 14	3.0	0.0	16.7	1.2	0.0	27.5	0.0	0.0	.	0.0	0.0	.
k = 16	11.0	0.1	22.8	6.0	0.1	7.0	3.1	0.1	50.0	0.0	0.0	.
k = 18	24.4	0.3	6.7	12.2	0.1	3.5	11.0	0.1	12.7	0.0	0.0	.
k = 20	25.2	0.3	0.5	24.9	0.3	1.8	23.6	0.3	6.4	12.6	0.3	50.4
k = 22	50.1	0.5	0.4	48.7	0.5	3.2	37.7	0.5	25.4	0.0	0.0	.
					Son Preference ($\alpha = 0.55$)							
k = 12	1.2	0.0	27.5	0.2	0.0	48.2	0.0	0.0	.	0.0	0.0	.
k = 14	15.6	0.3	46.0	2.8	0.0	14.1	1.2	0.0	27.5	0.0	0.0	.
k = 16	41.0	0.7	38.5	12.1	0.1	7.1	9.1	0.2	42.5	4.7	0.1	25.6
k = 18	25.2	0.3	0.6	25.0	0.3	2.2	23.5	0.3	12.5	11.8	0.1	6.4
k = 20	50.1	0.5	0.9	48.7	0.5	6.3	25.1	0.3	0.8	24.4	0.3	3.2
k = 22	50.3	0.5	0.1	50.3	0.5	0.2	49.9	0.5	0.9	48.7	0.5	3.2
					Son Preference ($\alpha = 0.6$)							
k = 12	18.3	0.2	23.7	2.0	0.0	51.9	0.0	0.0	.	0.0	0.0	.
k = 14	82.1	1.2	30.9	28.5	0.5	38.1	8.3	0.2	50.1	1.6	0.0	51.2
k = 16	73.7	0.7	2.3	64.2	0.7	12.1	21.8	0.3	23.8	10.6	0.1	25.1
k = 18	119.3	1.2	4.2	92.6	1.1	19.5	25.1	0.3	0.8	24.7	0.3	4.0
k = 20	50.3	0.5	0.2	50.3	0.5	0.2	50.0	0.5	1.1	48.5	0.5	6.5
k = 22	50.4	0.5	0.1	50.3	0.5	0.1	50.3	0.5	0.2	50.1	0.5	0.4
					Son Preference ($\alpha = 0.65$)							
k = 12	120.8	1.7	30.9	31.9	0.4	23.7	3.9	0.1	50.0	0.0	0.0	.
k = 14	184.4	2.5	25.6	105.0	1.3	17.7	48.5	0.8	37.5	16.6	0.3	50.3
k = 16	197.8	2.1	5.1	155.7	1.8	15.7	93.2	1.3	26.1	61.8	1.0	39.3
k = 18	125.3	1.2	0.5	123.8	1.2	1.4	114.5	1.2	6.9	93.3	1.1	18.3
k = 20	122.3	1.2	0.0	106.9	1.1	0.1	50.3	0.5	0.2	50.1	0.5	0.4
k = 22	144.2	1.8	20.8	50.4	0.5	0.1	50.3	0.5	0.1	50.3	0.5	0.2

Note. Simulations based on 50,000 individuals, 15 periods, $I = 200$, and a probability of a son of 0.5.
[a] Percent of spells where prenatal scan was initially used but birth is the result of pregnancy without prenatal scan.

Table A.7: Abortions and Change in Abortion Use by Cost of Children and prenatal Sex Determination

	Discount rate ($d = 0.9$) Cost of Prenatal Sex Determination (p_s)											
	12			16			20			24		
Cost of children	Abortions per 100 Women	Average Spells w. Scan[a]	Percent Change[b]	Abortions per 100 Women	Average Spells w. Scan[a]	Percent Change[b]	Abortions per 100 Women	Average Spells w. Scan[a]	Percent Change[b]	Abortions per 100 Women	Average Spells w. Scan[a]	Percent Change[b]
	Son Preference ($\alpha = 0.5$)											
k = 12	0.0	0.0	.	0.0	0.0	.	0.0	0.0	.	0.0	0.0	.
k = 14	1.5	0.0	13.2	0.0	0.0	.	0.0	0.0	.	0.0	0.0	.
k = 16	6.2	0.1	3.4	4.7	0.1	25.6	0.0	0.0	.	0.0	0.0	.
k = 18	12.6	0.1	0.9	11.8	0.1	6.4	0.0	0.0	.	0.0	0.0	.
k = 20	25.1	0.3	0.8	23.6	0.3	6.4	0.0	0.0	.	0.0	0.0	.
k = 22	49.5	0.5	1.6	25.0	0.5	50.3	0.0	0.0	.	0.0	0.0	.
	Son Preference ($\alpha = 0.55$)											
k = 12	0.3	0.0	26.8	0.0	0.0	.	0.0	0.0	.	0.0	0.0	.
k = 14	3.1	0.0	8.4	1.2	0.0	27.5	0.0	0.0	.	0.0	0.0	.
k = 16	12.4	0.1	3.9	6.2	0.1	3.4	4.7	0.1	25.6	0.0	0.0	.
k = 18	25.2	0.3	1.1	22.1	0.3	22.7	11.8	0.1	6.4	6.3	0.1	49.6
k = 20	48.7	0.5	6.2	25.2	0.3	0.5	24.4	0.3	3.2	18.9	0.3	25.0
k = 22	50.3	0.5	0.1	50.1	0.5	0.4	48.7	0.5	3.2	25.0	0.5	50.3
	Son Preference ($\alpha = 0.6$)											
k = 12	5.0	0.1	41.4	0.2	0.0	48.2	0.0	0.0	.	0.0	0.0	.
k = 14	35.0	0.5	24.5	5.4	0.1	25.7	1.2	0.0	27.5	0.0	0.0	.
k = 16	69.1	0.7	7.0	18.7	0.3	41.8	9.1	0.2	42.5	4.7	0.1	25.6
k = 18	105.3	1.2	13.2	25.2	0.3	1.1	24.3	0.3	7.0	11.8	0.1	6.4
k = 20	50.3	0.5	0.1	50.1	0.5	1.0	47.1	0.5	12.1	24.9	0.3	1.8
k = 22	50.4	0.5	0.1	50.3	0.5	0.1	50.1	0.5	0.4	49.5	0.5	1.6
	Son Preference ($\alpha = 0.65$)											
k = 12	55.9	0.9	39.5	3.9	0.1	50.0	0.0	0.0	.	0.0	0.0	.
k = 14	127.6	1.4	9.0	42.1	0.5	21.3	8.3	0.2	50.1	0.8	0.0	50.3
k = 16	174.7	2.0	11.4	72.0	0.7	4.0	43.1	0.6	33.1	10.6	0.1	25.1
k = 18	124.8	1.2	0.8	119.3	1.2	4.2	47.0	0.5	12.2	24.7	0.3	4.0
k = 20	114.8	1.1	0.0	50.3	0.5	0.1	50.2	0.5	0.5	49.7	0.5	2.0
k = 22	50.4	0.5	0.0	50.4	0.5	0.1	50.3	0.5	0.1	50.1	0.5	0.4

Note. Simulations based on 50,000 individuals, 15 periods, $I = 200$, and a probability of a son of 0.5.
[a] Percent of spells where prenatal scan was initially used but birth is the result of pregnancy without prenatal scan.

Table A.8: Abortions and Change in Abortion Use by Cost of Children and prenatal Sex Determination

	Discount rate ($d = 0.85$) Cost of Prenatal Sex Determination (p_s) 12			16			20			24		
Cost of children	Abortions per 100 Women	Average Spells w. Scan[a]	Percent Change[b]	Abortions per 100 Women	Average Spells w. Scan[a]	Percent Change[b]	Abortions per 100 Women	Average Spells w. Scan[a]	Percent Change[b]	Abortions per 100 Women	Average Spells w. Scan[a]	Percent Change[b]
	Son Preference ($\alpha = 0.5$)											
k = 12	0.0	0.0	.	0.0	0.0	.	0.0	0.0	.	0.0	0.0	.
k = 14	0.8	0.0	50.3	0.0	0.0	.	0.0	0.0	.	0.0	0.0	.
k = 16	5.8	0.1	15.2	0.0	0.0	.	0.0	0.0	.	0.0	0.0	.
k = 18	12.2	0.1	3.5	0.0	0.0	.	0.0	0.0	.	0.0	0.0	.
k = 20	24.9	0.3	1.8	0.0	0.0	.	0.0	0.0	.	0.0	0.0	.
k = 22	18.9	0.2	0.0	0.0	0.0	.	0.0	0.0	.	0.0	0.0	.
	Son Preference ($\alpha = 0.55$)											
k = 12	0.1	0.0	55.7	0.0	0.0	.	0.0	0.0	.	0.0	0.0	.
k = 14	2.4	0.0	43.7	0.0	0.0	.	0.0	0.0	.	0.0	0.0	.
k = 16	6.3	0.1	1.9	5.2	0.1	28.9	0.0	0.0	.	0.0	0.0	.
k = 18	23.7	0.3	12.0	12.2	0.1	3.5	0.0	0.0	.	0.0	0.0	.
k = 20	25.3	0.3	0.2	24.9	0.3	1.8	12.6	0.3	50.4	0.0	0.0	.
k = 22	50.3	0.5	0.2	49.1	0.5	3.2	0.0	0.0	.	0.0	0.0	.
	Son Preference ($\alpha = 0.6$)											
k = 12	0.6	0.0	54.8	0.0	0.0	.	0.0	0.0	.	0.0	0.0	.
k = 14	13.7	0.2	39.1	1.5	0.0	13.2	0.0	0.0	.	0.0	0.0	.
k = 16	18.9	0.3	40.7	6.2	0.1	3.4	3.9	0.1	50.0	0.0	0.0	.
k = 18	25.3	0.3	0.2	24.4	0.3	6.7	12.2	0.1	3.5	0.0	0.0	.
k = 20	50.2	0.5	0.5	44.0	0.6	22.7	24.9	0.3	1.8	22.0	0.3	12.5
k = 22	50.4	0.5	0.1	50.3	0.5	0.2	49.9	0.5	0.9	34.4	0.6	45.1
	Son Preference ($\alpha = 0.65$)											
k = 12	10.3	0.1	24.3	0.0	0.0	.	0.0	0.0	.	0.0	0.0	.
k = 14	50.8	0.7	31.2	5.8	0.1	15.2	0.8	0.0	50.3	0.0	0.0	.
k = 16	73.7	0.7	2.3	43.2	0.6	32.7	9.1	0.2	42.5	1.6	0.0	51.2
k = 18	123.8	1.2	1.5	44.0	0.6	22.7	24.7	0.3	4.0	11.8	0.1	6.4
k = 20	50.4	0.5	0.1	50.3	0.5	0.3	49.5	0.5	3.4	24.9	0.3	1.8
k = 22	50.4	0.5	0.0	50.3	0.5	0.1	50.3	0.5	0.2	49.9	0.5	0.9

Note. Simulations based on 50,000 individuals, 15 periods, $I = 200$, and a probability of a son of 0.5.
[a] Percent of spells where prenatal scan was initially used but birth is the result of pregnancy without prenatal scan.

Table A.9: Average and Maximum Spacing by Cost of Children and prenatal Sex Determination

	Discount rate ($d = 1.0$) Son Preference ($\alpha = 0.5$)											
	k = 12		k = 14		k = 16		k = 18		k = 20		k = 22	
Parity	Average	Max	Average	Max	Average	Max	Average	Max	Average	Max	Average	Max
	Cost of Prenatal Sex Determination ($p = 12$)											
1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
2	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.50	10
3	1.00	1	1.00	1	1.00	1	1.25	7	1.50	10	.	.
4	1.00	1	1.00	1	1.12	6	1.01	3	.	.	.	.
5	1.00	1	1.00	1	1.03	3	.	.	.	.	.	.
6	1.00	1	1.08	5	1.00	1	.	.	.	.	.	.
7	1.00	1	1.03	2	.	.	.	.	.	.	.	.
8	1.01	2	1.00	1	.	.	.	.	.	.	.	.
9	1.20	2	.	.	.	.	.	.	.	.	.	.
10	1.00	1	.	.	.	.	.	.	.	.	.	.
	Cost of Prenatal Sex Determination ($p = 16$)											
1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
2	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.50	8
3	1.00	1	1.00	1	1.00	1	1.22	4	1.50	8	.	.
4	1.00	1	1.00	1	1.09	3	1.10	4	.	.	.	.
5	1.00	1	1.00	1	1.18	4	.	.	.	.	.	.
6	1.00	1	1.06	3	1.00	1	.	.	.	.	.	.
7	1.00	1	1.10	2	.	.	.	.	.	.	.	.
8	1.00	1	1.00	1	.	.	.	.	.	.	.	.
9	1.00	1	.	.	.	.	.	.	.	.	.	.
10	1.00	1	.	.	.	.	.	.	.	.	.	.
	Cost of Prenatal Sex Determination ($p = 20$)											
1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
2	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.49	6
3	1.00	1	1.00	1	1.00	1	1.13	2	1.49	6	.	.
4	1.00	1	1.00	1	1.00	1	1.32	5	.	.	.	.
5	1.00	1	1.00	1	1.44	4	.	.	.	.	.	.
6	1.00	1	1.00	1	1.00	1	.	.	.	.	.	.
7	1.00	1	1.25	2	.	.	.	.	.	.	.	.
8	1.00	1	1.00	1	.	.	.	.	.	.	.	.
9	1.00	1	.	.	.	.	.	.	.	.	.	.
10	1.00	1	.	.	.	.	.	.	.	.	.	.
	Cost of Prenatal Sex Determination ($p = 24$)											
1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
2	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.44	4
3	1.00	1	1.00	1	1.00	1	1.00	1	1.47	5	.	.
4	1.00	1	1.00	1	1.00	1	1.43	4	.	.	.	.
5	1.00	1	1.00	1	1.37	3	.	.	.	.	.	.
6	1.00	1	1.00	1	1.00	1	.	.	.	.	.	.
7	1.00	1	1.00	1	.	.	.	.	.	.	.	.
8	1.00	1	1.00	1	.	.	.	.	.	.	.	.
9	1.00	1	.	.	.	.	.	.	.	.	.	.
10	1.00	1	.	.	.	.	.	.	.	.	.	.

Note. Simulations based on 50,000 individuals, 15 periods, $I = 200$, and a probability of a son of 0.5.

Table A.10: Average and Maximum Spacing by Cost of Children and prenatal Sex Determination

	Discount rate ($d = 1.0$) Son Preference ($\alpha = 0.55$)											
	k = 12		k = 14		k = 16		k = 18		k = 20		k = 22	
Parity	Average	Max	Average	Max	Average	Max	Average	Max	Average	Max	Average	Max
					Cost of Prenatal Sex Determination ($p = 12$)							
1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
2	1.00	1	1.00	1	1.00	1	1.38	3	1.50	10	1.50	12
3	1.00	1	1.00	1	1.24	6	1.06	8	1.00	2	.	.
4	1.00	1	1.12	5	1.40	4	1.00	1	.	.	.	.
5	1.03	2	1.21	3	1.00	1	1.00	1	.	.	.	.
6	1.01	3	1.10	2	1.00	1	.	.	.	.	.	.
7	1.04	2	1.00	1	.	.	.	.	.	.	.	.
8	1.00	1	1.00	1	.	.	.	.	.	.	.	.
9	1.00	1	.	.	.	.	.	.	.	.	.	.
10	1.00	1	.	.	.	.	.	.	.	.	.	.
11	1.00	1	.	.	.	.	.	.	.	.	.	.
					Cost of Prenatal Sex Determination ($p = 16$)							
1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
2	1.00	1	1.00	1	1.00	1	1.00	1	1.49	7	1.50	10
3	1.00	1	1.00	1	1.19	3	1.25	8	1.02	4	.	.
4	1.00	1	1.09	3	1.03	5	1.00	2	.	.	.	.
5	1.00	1	1.01	2	1.00	1	1.00	1	.	.	.	.
6	1.00	1	1.18	2	1.00	1	.	.	.	.	.	.
7	1.01	2	1.00	1	.	.	.	.	.	.	.	.
8	1.00	1	1.00	1	.	.	.	.	.	.	.	.
9	1.00	1	.	.	.	.	.	.	.	.	.	.
10	1.00	1	.	.	.	.	.	.	.	.	.	.
11	1.00	1	.	.	.	.	.	.	.	.	.	.
					Cost of Prenatal Sex Determination ($p = 20$)							
1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
2	1.00	1	1.00	1	1.00	1	1.00	1	1.47	5	1.50	9
3	1.00	1	1.00	1	1.00	1	1.25	7	1.06	5	.	.
4	1.00	1	1.00	1	1.12	5	1.01	2	.	.	.	.
5	1.00	1	1.03	2	1.03	2	1.00	1	.	.	.	.
6	1.00	1	1.03	3	1.00	1	.	.	.	.	.	.
7	1.00	1	1.00	1	.	.	.	.	.	.	.	.
8	1.00	1	1.00	1	.	.	.	.	.	.	.	.
9	1.00	1	.	.	.	.	.	.	.	.	.	.
10	1.00	1	.	.	.	.	.	.	.	.	.	.
11	1.00	1	.	.	.	.	.	.	.	.	.	.
					Cost of Prenatal Sex Determination ($p = 24$)							
1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
2	1.00	1	1.00	1	1.00	1	1.00	1	1.38	3	1.50	8
3	1.00	1	1.00	1	1.00	1	1.24	5	1.20	6	.	.
4	1.00	1	1.00	1	1.09	3	1.03	2	.	.	.	.
5	1.00	1	1.00	1	1.16	3	1.00	1	.	.	.	.
6	1.00	1	1.04	2	1.00	1	.	.	.	.	.	.
7	1.00	1	1.00	1	.	.	.	.	.	.	.	.
8	1.00	1	1.00	1	.	.	.	.	.	.	.	.
9	1.00	1	.	.	.	.	.	.	.	.	.	.
10	1.00	1	.	.	.	.	.	.	.	.	.	.
11	1.00	1	.	.	.	.	.	.	.	.	.	.

Note. Simulations based on 50,000 individuals, 15 periods, $I = 200$, and a probability of a son of 0.5.

Table A.11: Average and Maximum Spacing by Cost of Children and prenatal Sex Determination

	Discount rate ($d = 1.0$) Son Preference ($\alpha = 0.6$)											
	k = 12		k = 14		k = 16		k = 18		k = 20		k = 22	
Parity	Average	Max	Average	Max	Average	Max	Average	Max	Average	Max	Average	Max
Cost of Prenatal Sex Determination ($p = 12$)												
1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
2	1.00	1	1.00	1	1.49	6	1.50	10	1.50	12	1.50	13
3	1.00	1	1.25	7	1.57	5	1.74	8	1.18	2	1.00	1
4	1.12	5	1.47	6	1.27	5	1.00	1	1.00	1	.	.
5	1.25	4	1.47	4	1.00	1	1.00	1	.	.	.	.
6	1.17	2	1.00	1	1.00	1	.	.	.	.	.	.
7	1.06	2	1.00	1	.	.	.	.	.	.	.	.
8	1.00	1	1.00	1	.	.	.	.	.	.	.	.
9	1.00	1	.	.	.	.	.	.	.	.	.	.
10	1.00	1	.	.	.	.	.	.	.	.	.	.
Cost of Prenatal Sex Determination ($p = 16$)												
1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
2	1.00	1	1.00	1	1.44	4	1.50	8	1.50	11	1.50	12
3	1.00	1	1.24	5	1.03	5	1.65	5	1.00	1	1.00	1
4	1.09	3	1.32	3	1.36	6	1.00	1	1.00	1	.	.
5	1.01	2	1.06	3	1.00	1	1.00	1	.	.	.	.
6	1.10	3	1.00	1	1.00	1	.	.	.	.	.	.
7	1.00	1	1.00	1	.	.	.	.	.	.	.	.
8	1.00	1	1.00	1	.	.	.	.	.	.	.	.
9	1.00	1	.	.	.	.	.	.	.	.	.	.
10	1.00	1	.	.	.	.	.	.	.	.	.	.
11	1.00	1	.	.	.	.	.	.	.	.	.	.
Cost of Prenatal Sex Determination ($p = 20$)												
1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
2	1.00	1	1.00	1	1.25	2	1.49	6	1.50	9	1.50	11
3	1.00	1	1.19	3	1.12	5	1.45	4	1.00	2	1.00	1
4	1.00	1	1.02	3	1.33	4	1.00	1	1.00	1	.	.
5	1.03	2	1.16	3	1.00	1	1.00	1	.	.	.	.
6	1.01	2	1.00	1	1.00	1	.	.	.	.	.	.
7	1.00	1	1.00	1	.	.	.	.	.	.	.	.
8	1.00	1	1.00	1	.	.	.	.	.	.	.	.
9	1.00	1	.	.	.	.	.	.	.	.	.	.
10	1.00	1	.	.	.	.	.	.	.	.	.	.
11	1.00	1	.	.	.	.	.	.	.	.	.	.
Cost of Prenatal Sex Determination ($p = 24$)												
1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
2	1.00	1	1.00	1	1.00	1	1.44	4	1.50	8	1.50	10
3	1.00	1	1.00	1	1.24	5	1.03	5	1.00	2	1.00	1
4	1.00	1	1.09	3	1.19	2	1.00	1	1.00	1	.	.
5	1.00	1	1.01	2	1.00	1	1.00	1	.	.	.	.
6	1.00	1	1.00	1	1.00	1	.	.	.	.	.	.
7	1.00	1	1.00	1	.	.	.	.	.	.	.	.
8	1.00	1	1.00	1	.	.	.	.	.	.	.	.
9	1.00	1	.	.	.	.	.	.	.	.	.	.
10	1.00	1	.	.	.	.	.	.	.	.	.	.
11	1.00	1	.	.	.	.	.	.	.	.	.	.

Note. Simulations based on 50,000 individuals, 15 periods, $I = 200$, and a probability of a son of 0.5.

Table A.12: Average and Maximum Spacing by Cost of Children and prenatal Sex Determination

	Discount rate ($d = 1.0$) Son Preference ($\alpha = 0.65$)											
	k = 12		k = 14		k = 16		k = 18		k = 20		k = 22	
Parity	Average	Max	Average	Max	Average	Max	Average	Max	Average	Max	Average	Max
Cost of Prenatal Sex Determination ($p = 12$)												
1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.99	8
2	1.00	1	1.50	8	1.50	10	1.50	12	1.50	12	1.90	6
3	1.25	7	1.72	7	1.75	9	1.75	10	1.91	7	1.00	1
4	1.47	6	1.74	6	1.79	7	1.00	1	1.00	1	.	.
5	1.55	5	1.45	4	1.00	1	.	.	.	.	.	.
6	1.44	4	1.00	1	.	.	.	.	.	.	.	.
7	1.12	2	1.00	1	.	.	.	.	.	.	.	.
8	1.00	1	.	.	.	.	.	.	.	.	.	.
9	1.00	1	.	.	.	.	.	.	.	.	.	.
Cost of Prenatal Sex Determination ($p = 16$)												
1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.94	5
2	1.00	1	1.49	7	1.50	9	1.50	11	1.50	12	1.53	8
3	1.24	5	1.65	5	1.72	7	1.74	8	1.78	5	1.00	1
4	1.40	4	1.41	3	1.66	5	1.00	1	1.00	1	.	.
5	1.37	3	1.14	3	1.00	1	1.00	1	.	.	.	.
6	1.00	1	1.00	1	1.00	1	.	.	.	.	.	.
7	1.07	2	1.00	1	.	.	.	.	.	.	.	.
8	1.00	1	1.00	1	.	.	.	.	.	.	.	.
9	1.00	1	.	.	.	.	.	.	.	.	.	.
10	1.00	1	.	.	.	.	.	.	.	.	.	.
Cost of Prenatal Sex Determination ($p = 20$)												
1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.50	2
2	1.00	1	1.47	5	1.50	8	1.50	9	1.50	11	1.25	11
3	1.22	4	1.45	3	1.64	5	1.72	7	1.50	3	1.00	1
4	1.19	2	1.10	3	1.40	3	1.00	1	1.00	1	.	.
5	1.06	2	1.19	3	1.00	1	1.00	1	.	.	.	.
6	1.09	2	1.00	1	1.00	1	.	.	.	.	.	.
7	1.00	1	1.00	1	1.00	1	.	.	.	.	.	.
8	1.00	1	1.00	1	.	.	.	.	.	.	.	.
9	1.00	1	1.00	1	.	.	.	.	.	.	.	.
10	1.00	1	.	.	.	.	.	.	.	.	.	.
11	1.00	1	.	.	.	.	.	.	.	.	.	.
Cost of Prenatal Sex Determination ($p = 24$)												
1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
2	1.00	1	1.44	4	1.49	6	1.50	8	1.50	10	1.50	11
3	1.13	2	1.27	2	1.57	4	1.65	5	1.00	1	1.00	1
4	1.03	2	1.16	3	1.04	2	1.00	1	1.00	1	.	.
5	1.09	2	1.00	1	1.00	1	1.00	1	.	.	.	.
6	1.00	1	1.00	1	1.00	1	.	.	.	.	.	.
7	1.00	1	1.00	1	1.00	1	.	.	.	.	.	.
8	1.00	1	1.00	1	.	.	.	.	.	.	.	.
9	1.00	1	1.00	1	.	.	.	.	.	.	.	.
10	1.00	1	.	.	.	.	.	.	.	.	.	.
11	1.00	1	.	.	.	.	.	.	.	.	.	.

Note. Simulations based on 50,000 individuals, 15 periods, $I = 200$, and a probability of a son of 0.5.

Table A.13: Descriptive Statistics by Education Level and Beginning of Spell

		No Education			1–7 Years of Education			8+ Years of Education		
		1972–1984	1985–1994	1995–2006	1972–1984	1985–1994	1995–2006	1972–1984	1985–1994	1995–2006
First Spell	Boy born	0.467	0.438	0.363	0.476	0.447	0.368	0.483	0.453	0.377
		(0.499)	(0.496)	(0.481)	(0.499)	(0.497)	(0.482)	(0.500)	(0.498)	(0.485)
	Girl born	0.427	0.410	0.352	0.439	0.429	0.356	0.454	0.420	0.353
		(0.495)	(0.492)	(0.478)	(0.496)	(0.495)	(0.479)	(0.498)	(0.494)	(0.478)
	Censored	0.106	0.152	0.284	0.085	0.124	0.276	0.063	0.127	0.270
		(0.308)	(0.359)	(0.451)	(0.279)	(0.330)	(0.447)	(0.243)	(0.333)	(0.444)
	Urban	0.181	0.176	0.200	0.366	0.334	0.322	0.690	0.604	0.561
		(0.385)	(0.381)	(0.400)	(0.482)	(0.472)	(0.467)	(0.463)	(0.489)	(0.496)
	Age	15.854	16.301	16.871	16.983	17.470	17.844	19.516	20.036	20.766
		(2.482)	(2.643)	(2.858)	(2.733)	(3.041)	(3.221)	(3.331)	(3.614)	(3.916)
	Owns land	0.589	0.578	0.540	0.500	0.497	0.482	0.321	0.387	0.414
		(0.492)	(0.494)	(0.498)	(0.500)	(0.500)	(0.500)	(0.467)	(0.487)	(0.493)
	Sched. caste/tribe	0.357	0.395	0.441	0.170	0.227	0.318	0.071	0.119	0.175
		(0.479)	(0.489)	(0.497)	(0.376)	(0.419)	(0.466)	(0.257)	(0.324)	(0.380)
	Number of quarters	330,315	257,757	75,841	108,463	108,863	54,704	102,238	154,582	116,272
	Number of women	30,004	27,669	9,684	11,162	13,104	7,510	11,271	19,072	16,620
Second Spell	Boy born	0.490	0.444	0.359	0.477	0.437	0.338	0.457	0.399	0.285
		(0.500)	(0.497)	(0.480)	(0.500)	(0.496)	(0.473)	(0.498)	(0.490)	(0.451)
	Girl born	0.451	0.413	0.327	0.462	0.413	0.319	0.426	0.351	0.239
		(0.498)	(0.492)	(0.469)	(0.499)	(0.492)	(0.466)	(0.495)	(0.477)	(0.427)
	Censored	0.059	0.143	0.314	0.061	0.150	0.344	0.117	0.251	0.476
		(0.236)	(0.350)	(0.464)	(0.239)	(0.357)	(0.475)	(0.321)	(0.433)	(0.499)
	One boy	0.527	0.515	0.508	0.519	0.513	0.505	0.513	0.520	0.515
		(0.499)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)
	One girl	0.473	0.485	0.492	0.481	0.487	0.495	0.487	0.480	0.485
		(0.499)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)
	Urban	0.181	0.180	0.212	0.370	0.348	0.345	0.697	0.628	0.578
		(0.385)	(0.384)	(0.409)	(0.483)	(0.476)	(0.475)	(0.459)	(0.483)	(0.494)
	Age	17.774	18.357	18.870	18.620	19.200	19.581	20.988	21.589	22.252
		(2.743)	(3.054)	(3.284)	(2.864)	(3.206)	(3.373)	(3.371)	(3.621)	(3.901)
	First spell length	25.630	29.145	29.133	21.924	24.513	24.787	20.608	22.154	22.217
		(20.345)	(25.044)	(27.216)	(18.142)	(22.027)	(23.204)	(15.371)	(18.651)	(19.176)
	Owns land	0.590	0.572	0.528	0.497	0.492	0.468	0.313	0.369	0.402
		(0.492)	(0.495)	(0.499)	(0.500)	(0.500)	(0.499)	(0.464)	(0.483)	(0.490)
	Sched. caste/tribe	0.353	0.390	0.430	0.164	0.218	0.304	0.068	0.110	0.169
		(0.478)	(0.488)	(0.495)	(0.371)	(0.413)	(0.460)	(0.251)	(0.313)	(0.374)
	Number of quarters	176,227	231,546	68,455	67,432	103,656	49,236	77,416	164,752	119,864
	Number of women	21,171	28,251	9,428	8,209	12,449	6,542	8,204	16,601	13,610

Note. Means without parentheses and standard deviation in parentheses. Interactions between variables, baseline hazard dummies and squares not shown. Quarters refer to number of 3 month periods observed.

Table A.13: (Continued) Descriptive Statistics by Education Level and Beginning of Spell

		No Education			1-7 Years of Education			8+ Years of Education		
		1972–1984	1985–1994	1995–2006	1972–1984	1985–1994	1995–2006	1972–1984	1985–1994	1995–2006
Third Spell	Boy born	0.478	0.425	0.319	0.455	0.388	0.261	0.353	0.264	0.163
		(0.500)	(0.494)	(0.466)	(0.498)	(0.487)	(0.439)	(0.478)	(0.441)	(0.369)
	Girl born	0.442	0.393	0.306	0.423	0.357	0.239	0.313	0.214	0.128
		(0.497)	(0.488)	(0.461)	(0.494)	(0.479)	(0.426)	(0.464)	(0.410)	(0.334)
	Censored	0.080	0.182	0.376	0.121	0.255	0.500	0.334	0.521	0.709
		(0.271)	(0.386)	(0.484)	(0.326)	(0.436)	(0.500)	(0.472)	(0.500)	(0.454)
	Two boys	0.276	0.257	0.243	0.248	0.245	0.232	0.266	0.244	0.238
		(0.447)	(0.437)	(0.429)	(0.432)	(0.430)	(0.422)	(0.442)	(0.429)	(0.426)
	One boy, one girl	0.490	0.502	0.506	0.508	0.501	0.515	0.489	0.510	0.527
		(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.499)
	Two girls	0.234	0.241	0.252	0.243	0.254	0.253	0.245	0.247	0.235
		(0.424)	(0.428)	(0.434)	(0.429)	(0.435)	(0.435)	(0.430)	(0.431)	(0.424)
	Urban	0.179	0.182	0.208	0.378	0.354	0.343	0.693	0.646	0.568
		(0.383)	(0.386)	(0.406)	(0.485)	(0.478)	(0.475)	(0.461)	(0.478)	(0.495)
	Age	19.978	20.693	21.278	20.794	21.453	21.998	22.963	23.825	24.548
		(2.895)	(3.196)	(3.551)	(2.937)	(3.239)	(3.618)	(3.405)	(3.748)	(4.067)
	First spell length	24.547	27.575	27.099	20.971	23.901	23.532	19.991	21.246	21.236
		(18.832)	(22.779)	(24.364)	(16.875)	(20.378)	(21.155)	(14.646)	(16.835)	(17.363)
	Owns land	0.602	0.575	0.538	0.503	0.503	0.490	0.320	0.369	0.421
		(0.490)	(0.494)	(0.499)	(0.500)	(0.500)	(0.500)	(0.467)	(0.483)	(0.494)
	Sched. caste/tribe	0.344	0.392	0.432	0.159	0.218	0.298	0.067	0.107	0.169
		(0.475)	(0.488)	(0.495)	(0.366)	(0.413)	(0.457)	(0.251)	(0.310)	(0.375)
	Number of quarters	109,026	206,988	70,391	43,434	87,537	41,400	49,799	126,733	79,068
	Number of women	13,196	25,135	9,355	4,960	9,775	5,034	4,316	10,688	7,927
Fourth Spell	Boy born	0.463	0.384	0.291	0.403	0.347	0.233	0.310	0.227	0.170
		(0.499)	(0.486)	(0.454)	(0.491)	(0.476)	(0.423)	(0.462)	(0.419)	(0.376)
	Girl born	0.408	0.363	0.268	0.391	0.303	0.198	0.298	0.197	0.113
		(0.491)	(0.481)	(0.443)	(0.488)	(0.460)	(0.399)	(0.458)	(0.397)	(0.316)
	Censored	0.130	0.254	0.441	0.206	0.350	0.569	0.392	0.576	0.717
		(0.336)	(0.435)	(0.497)	(0.405)	(0.477)	(0.495)	(0.488)	(0.494)	(0.450)
	Three boys	0.134	0.124	0.111	0.107	0.105	0.102	0.106	0.101	0.082
		(0.341)	(0.329)	(0.315)	(0.309)	(0.307)	(0.303)	(0.308)	(0.302)	(0.275)
	Two boys, one girl	0.374	0.357	0.346	0.348	0.323	0.308	0.358	0.304	0.289
		(0.484)	(0.479)	(0.476)	(0.476)	(0.468)	(0.462)	(0.480)	(0.460)	(0.453)
	One boys, two girls	0.362	0.389	0.400	0.400	0.413	0.423	0.393	0.439	0.469
		(0.481)	(0.488)	(0.490)	(0.490)	(0.492)	(0.494)	(0.489)	(0.496)	(0.499)
	Three girls	0.129	0.130	0.142	0.145	0.159	0.167	0.143	0.156	0.159
		(0.335)	(0.337)	(0.350)	(0.353)	(0.365)	(0.373)	(0.350)	(0.363)	(0.366)
	Urban	0.171	0.181	0.197	0.363	0.346	0.325	0.670	0.601	0.511
		(0.377)	(0.385)	(0.398)	(0.481)	(0.476)	(0.469)	(0.470)	(0.490)	(0.500)
	Age	21.926	22.885	23.608	22.611	23.519	24.317	24.257	25.472	26.061
		(3.019)	(3.332)	(3.711)	(2.894)	(3.364)	(3.759)	(3.171)	(3.702)	(4.143)
	First spell length	23.281	26.609	26.460	20.495	23.069	24.215	19.106	20.826	21.423
		(17.481)	(21.556)	(23.272)	(15.546)	(19.078)	(21.244)	(13.991)	(16.277)	(16.585)
	Owns land	0.610	0.587	0.557	0.523	0.530	0.509	0.339	0.414	0.466
		(0.488)	(0.492)	(0.497)	(0.500)	(0.499)	(0.500)	(0.474)	(0.493)	(0.499)
	Sched. caste/tribe	0.338	0.403	0.442	0.154	0.224	0.297	0.085	0.113	0.193
		(0.473)	(0.491)	(0.497)	(0.361)	(0.417)	(0.457)	(0.280)	(0.316)	(0.395)
	Number of quarters	54,446	151,285	56,756	18,852	49,108	23,209	14,287	43,339	23,586
	Number of women	6,832	18,436	7,637	2,201	5,564	2,768	1,347	3,933	2,459

Note. Means without parentheses and standard deviation in parentheses. Interactions between variables, baseline hazard dummies and squares not shown. Quarters refer to number of 3 month periods observed.

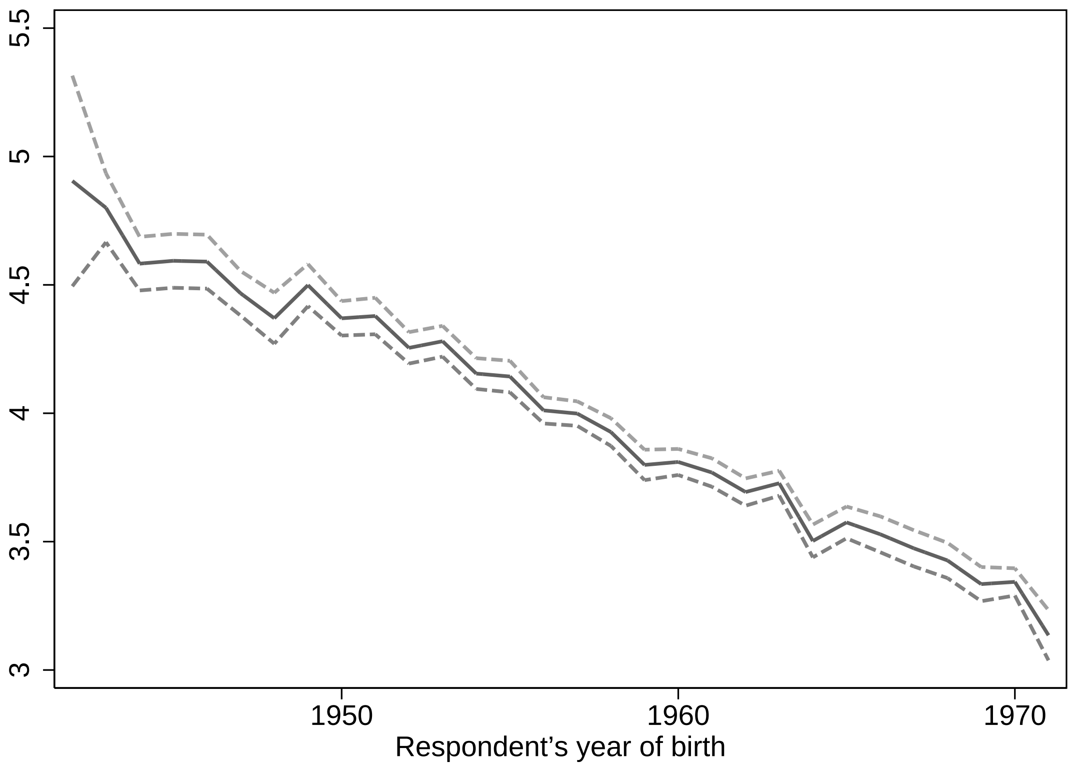

Figure A.1: Children ever born at age 35

Table A.14: Predicted Fertility Behavior, Sex Ratio, and Abortions for Women with No Education

	1972-1984				1985-1994				1995-2006			
	Births (%) / fertility[a]	Abortions per 100 births[b]	Abortions per 100 women[c]	Boys (%)	Births (%) / fertility[a]	Abortions per 100 births[b]	Abortions per 100 women[c]	Boys (%)	Births (%) / fertility[a]	Abortions per 100 births[b]	Abortions per 100 women[c]	Boys (%)
Urban												
Spell 2	93.2	1.8	1.6	52.2	92.4	1.5	1.3	52.0	90.0	1.4	1.2	52.0
Spell 3	93.8	4.6	4.3	53.6	91.1	−1.2	−1.1	50.7	85.6	−4.7	−4.0	48.8
Spell 4	87.1	5.5	4.8	54.1	84.4	2.3	2.0	52.5	75.3	5.6	4.2	54.1
Overall[d]	3.6	2.8	9.8	52.9	3.5	0.6	2.0	51.7	3.3	0.3	0.9	51.2
Rural												
Spell 2	94.5	1.7	1.6	52.1	93.7	1.0	1.0	51.7	92.9	3.4	3.2	53.0
Spell 3	95.1	1.5	1.4	52.0	93.4	1.9	1.7	52.2	91.3	−0.5	−0.5	51.0
Spell 4	91.1	3.4	3.1	52.9	87.3	0.1	0.1	51.3	83.3	0.1	0.1	51.3
Overall[d]	3.7	1.6	5.7	52.3	3.6	0.7	2.7	51.7	3.5	0.8	2.8	51.5

Note. Predictions are based on estimates of equations (11) and (12). The samples consist of all women from the data no education who married during the indicated period using the estimation results for that periods and the women's characteristics at the start of their marriage. All numbers presented are for women predicted to have one or more births. Birth/progression rates are based on the ratio of women predicted to have a birth by the end of each spell. Abortion rates within each spell are based on the predicted number of abortions each woman would have if she went through the entire spell. To generate conditions such as sex composition and fecundity for second and higher spells each woman is randomly assigned outcomes based on the estimation results and her characteristics as follows. For each quarter, her probabilities of having a boy, a girl, or no birth is calculated. She is assigned one of these outcomes based on a random draw from a uniform distribution. The first quarter where she has a draw that results in a birth she leaves the spell and the quarter reached is used to calculate her starting age for the subsequent spell. If she has no draw that result in a birth within a spell her childbearing stops and she does not enter the next spell. Results are averaged over 1,000 repetitions.

[a] For individual spells the column shows the percent of women who started the spell and ended up with a birth by the end of the spell period covered. For the "Overall" row, the number is the expected number of children born per woman over the first four spells, conditional on having at least one birth.

[b] For individual spells the column shows the number of abortions per 100 births predicted to take place by the end of the spell. For the "Overall" row, the number is the total number of abortion per 100 births predicted to take place over all four spells.

[c] For individual spells the column shows the number of abortions predicted to take place by the end of the spell per 100 women who started the spell . For the "Overall" row, the number is the total number of abortion predicted to take place over all four spells per 100 women who had at least one child.

[d] Covers first through fourth spells.

Table A.15: Predicted Fertility Behavior, Sex Ratio, and Abortions for Women with 1 to 7 Years of Education

	1972-1984				1985-1994				1995-2006			
	Births (%) / fertility[a]	Abortions per 100 births[b]	Abortions per 100 women[c]	Boys (%)	Births (%) / fertility[a]	Abortions per 100 births[b]	Abortions per 100 women[c]	Boys (%)	Births (%) / fertility[a]	Abortions per 100 births[b]	Abortions per 100 women[c]	Boys (%)
Urban												
Spell 2	93.4	−2.1	−2.0	50.1	89.7	−0.1	−0.1	51.2	84.5	−0.9	−0.7	50.7
Spell 3	89.2	1.4	1.3	52.0	82.5	1.4	1.2	51.9	71.1	2.4	1.7	52.4
Spell 4	79.0	3.4	2.7	52.9	70.9	1.0	0.7	51.7	61.9	6.8	4.2	54.7
Overall[d]	3.4	0.4	1.4	51.7	3.2	0.5	1.5	51.7	2.8	1.1	3.2	51.9
Rural												
Spell 2	94.6	−1.3	−1.2	50.5	93.0	0.4	0.4	51.4	91.6	2.2	2.0	52.3
Spell 3	92.8	0.6	0.6	51.5	88.0	1.0	0.8	51.7	80.7	3.5	2.8	53.0
Spell 4	86.2	−2.2	−1.9	50.1	80.3	4.5	3.6	53.5	68.0	3.6	2.5	53.1
Overall[d]	3.6	−0.7	−2.4	51.0	3.4	1.2	4.1	51.6	3.2	2.0	6.4	52.1

Note. Predictions are based on estimates of equations (11) and (12). The samples consist of all women from the data with 1 to 7 years of education who married during the indicated period using the estimation results for that periods and the women's characteristics at the start of their marriage. All numbers presented are for women predicted to have one or more births. Birth/progression rates are based on the ratio of women predicted to have a birth by the end of each spell. Abortion rates within each spell are based on the predicted number of abortions each woman would have if she went through the entire spell. To generate conditions such as sex composition and fecundity for second and higher spells each woman is randomly assigned outcomes based on the estimation results and her characteristics as follows. For each quarter, her probabilities of having a boy, a girl, or no birth is calculated. She is assigned one of these outcomes based on a random draw from a uniform distribution. The first quarter where she has a draw that results in a birth she leaves the spell and the quarter reached is used to calculate her starting age for the subsequent spell. If she has no draw that result in a birth within a spell her childbearing stops and she does not enter the next spell. Results are averaged over 1,000 repetitions.

[a] For individual spells the column shows the percent of women who started the spell and ended up with a birth by the end of the spell period covered. For the "Overall" row, the number is the expected number of children born per woman over the first four spells, conditional on having at least one birth.

[b] For individual spells the column shows the number of abortions per 100 births predicted to take place by the end of the spell. For the "Overall" row, the number is the total number of abortion per 100 births predicted to take place over all four spells.

[c] For individual spells the column shows the number of abortions predicted to take place by the end of the spell per 100 women who started the spell . For the "Overall" row, the number is the total number of abortion predicted to take place over all four spells per 100 women who had at least one child.

[d] Covers first through fourth spells.