The Demand for Sex Selective Abortions*

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PRELIMINARY

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Abstract

One of the major changes that have taken place in India over the last two decades is a significant shift in the sex ratio at birth, as techniques for prenatal sex determination have become more widely available. There has, however, been little analysis of which factors influence the decision to abort female fetuses at the individual level. Furthermore, the sparse literature does not address the relationship between fertility, spacing and the demand for sex selective abortions, which may lead to biased estimates. Using data from the three rounds of the National Family and Health Survey this paper relies on the observed spacing between births to examine the determinants of the demand for sex selective abortions. By employing a discrete hazard model it is possible to simultaneously control for the fertility and abortion decisions, while taking account of censoring and unobservable characteristics that might affect either.

JEL: J1, O12, I1

1 Introduction

During the last century India has experienced an almost continuous increase in her sex ratio, measured as the the number of males to females (Dyson 2001). This increase is widely believed to be the result of excess mortality for girls compared to boys, which has been tied to a strong preference for boys in especially the northern states (Murthi, Guio, and Dreze 1995; Arnold, Choe, and Roy 1998). In addition to the increase in the overall sex ratio due to excess mortality of girls, there is evidence that the sex ratio at birth has also been changing over the last two decades due to the spread of sex selective abortion (Das Gupta and Bhat 1997; Sudha and Rajan 1999). India is not alone in showing this pattern of change; in both China and South Korea, ultrasound and other methods for determining the sex of a fetus have become more widely available and affordable and this has led to a significant change in the sex ratio at birth (Zeng, Tu, Gu, Xu, Li, and Li 1993; Park and Cho 1995; Chu 2001).

The change in the sex ratio at birth, combined with the excess mortality of girls and a changing fertility pattern, is likely to have profound effects on virtually every aspect of India's social and economic development. The suggested effects run the gamut from very positive to catastrophic. Among the positive, Goodkind (1996) discusses the possibility that with sex selective abortion female children will be less discriminated against because they are more likely to be wanted. Davies and Zhang (1997) examines a model of parental choice of their children's consumption with and without "gender control" and find that girls' consumption may increase. This positive effect is, however, disputed by Das Gupta and Bhat (1997). Leung (1994) and Seidl (1995) provide discussions of the effect on fertility, arguing that sex selection may or may not decrease overall fertility, depending on the cost of determining the sex of the fetus. Park and Cho (1995) examine various aspects, among those the possibility of a marriage squeeze, with a significant shortage of brides.[1] In India a marriage squeeze may result in the decline of the price of dowry, which have otherwise been increasing according to Rao (1993).[2] Edlund (1999) also discuss the relation between marriage and sex selection and suggests that it may result in the development of a female underclass.

It is, however, very difficult to establish what the effects of the changing sex ratio will be without information on the extent to which sex selective abortion is used and, more importantly, by whom it is used. There has, however, so far been relatively few studies of how much sex selective abortion is being used. Furthermore, there has been virtually no research on who is using it. Chu (2001), who interviewed 820 women in China, is one of the few example, if not the only one, of trying to determine who uses prenatal sex determination.[3] One of the reasons for this lack of research is the absense

[1] Park and Cho (1995) note that the possible marriage squeeze in the South Korean case is more a result of fertility decline than sex selection.

[2] There is anecdotal evidence that this might already be happening (Lancaster 2002).

[3] Ahn (1995) attempts to estimate how much sex selection will be used in Korea, based on data collected in 1980, although this is not the primary purpose of that paper.

of direct information on the use of sex determination and selection. As Goodkind (1996) discusses there are not many questionnaires that contain questions specifically about the use of prenatal sex determination and those that do show signs of serious underreporting.[4]

Hence, this paper has two purposes. First, to present methods that can be used to analyse which factors determine the use of sex selective abortion even when there is no direct information on the availability or use of prenatal sex determination techniques. Secondly, to present evidence on use of sex selective abortion in India, focusing on how its use is affected by birth order, sibling composition, the relative return of investing in boys versus girls and the characteristics of the family. I use the three rounds of the National Family and Health Survey (NFHS 1-3). The main reason for using NFHS is that they contain a detailed fertility history for each woman.[5]

The first method for indirectly determining the use of sex selective abortion is based on the fact that the types of families who are more likely to use prenatal sex determination and selection will also be more likely to have a child of the desired sex (in the case of India most likely a boy). Hence, provided that the fertility history is correct one can use the probability that the next child is a boy as a proxy for the demand for sex selective abortions and

[4] Before prenatal sex determination became widely available McClelland (1983), argued that measures based on behaviour, such as parity progression, are insufficient to estimate the potential number of users of sex selective abortion, and consequently calls for more reliance on measures of intent.

[5] The latest rounds also contains information on still births, spontaneous and induced abortions, although there is no information on the reasons for choosing to end a pregnancy.

can thereby estimate the impact of household and local characteristics, such as the different returns to investing in boys and girls, on the demand. This is the method used in the previous literature, but it fails to take account of the fertility and spacing decisions of the household and may underestimate the number of abortions that take place. It also is very data intensive as discussed below making it more difficult to precisely estimate the determinants.

To overcome these problems the second method relies on the spacing between births (or the duration from last birth if the spell is censored). This can be used since, as shown below, an abortion will add 12 months or more to the spells. Hence, the second method uses a discrete hazard model to estimate the determinants of spacing with factors that lengthen the spells can be used to identify the use of sex selective abortions. This method has a number of advantages over the standard method of looking at the sex of the children born. First, it directly incorporate the fertility decision. Second, it will better capture if multiple abortions have taken place and can directly deal with censoring. Finally, it is possible to combine the spell length and the outcome to provide more precise estimates and to allow for unobservable heterogeneity.

The structure of the paper is as follows. First, I review the literature on the causes and effects of son preferences in India. Section 3 discusses the different biological factors influencing the sex of a fetus and medical technologies available for prenatal sex determination. A dynamic model of fertility decision is presented in Section 4. I discuss the data and preliminary evidence on how the sex ratio has changed over time and between states in Sections 6 and 7. The discussion of the estimation strategy follows in Section 8 and the results in Section 9. Finally, Section 10 concludes with a summary of results and suggestions for future research.

2 Son Preference in India

This section reviews some of the possible reasons for parents wanting more sons than daughters and the effects of these reasons.[6] There are four major factors which are thought to drive the preference for sons in India: The structure of the marriage system, the differences in wage rates between men and women, the need for old age insurance and cultural factors. With respect to the effects of son preferences I look at fertility, mortality, educational investments and others.

The structure of the marriage market in India is possibly one of the main driving forces behind the preference for sons and the discrimination against girls as discussed by Rao (1993) and Foster and Rosenzweig (1999). As in many other societies the tradition is for girls to leave the parental household to join her husband's. Most marriages take place within well-defined social groups or castes and are arranged for both the groom and bride by their parents.[7] An important feature is that dowry, that is a transfer from the

[6] See Leung (1991) and Haughton and Haughton (1998) for discussions of different tests for son preference.

[7] On the latter see Rosenzweig and Stark (1989) and Deolalikar and Rao (1998) for discussions.

bride's parents to the groom's parents, is widespread. According to Rao (1993) and Bloch and Rao (2000) the size of the dowry paid has increased significantly as population growth has created a marriage squeeze with more females than males in the marriageable age groups, even with the higher mortality rates for females.[8] This has happened to the extent that places that before had a bride price now have dowries instead. Furthermore, the size of the dowry is sufficiently large to present a real problem for many households, which may explain why there has not been a large improvement in girls' survival chances. It may also drive the demand for sex selective abortion. This is made clear by the slogan: "Better Rs 500 today than Rs 500,000 tomorrow," which was used to advertise sex determination clinics in the beginning of the 80s. (as quoted in Sudha and Rajan 1999, p. 599).[9]

There are, however, other factors than the size of the dowry, which may affect parents' preference for boys. Rosenzweig and Schultz (1982) suggest that the relative return to investment in boys' versus girls' education is an important determinant of survival probabilities. They show that in areas where relative wages between men and females are more equal there is also less discrimination against girls as measured by their survival chances. It is not immediately clear, however, that this effect is not caused by women gaining more bargaining power within the household when they receive higher

[8] Bloch and Rao (2000) discuss the use of violence against brides by their husbands to extract more transfer from the bride's family after the dowry has been paid.

[9] In comparison the wage of a skilled agricultural worked was Rs 25 in Punjab and Rs 18 in Haryana according to Sudha and Rajan (1999).

relative wages. This would cause the same effect on survival if women had a stronger preference for girls' survival. Unni (1998) documents the differences in how much schooling boys and girls receive [discussion of returns?].

India is, like many other developing countries, characterised by either missing or imperfect capital and insurance markets. In a series of papers Cain (1981, 1983, 1990) discuss the possibility that parents' fertility decisions are partly driven by the lack of access to insurance. He argues that parents have more children than they would in areas with a well-functioning insurance market, because children can act as an imperfect substitute for insurance against a number of different outcomes. These are not restricted to old age, but can, for example, also include crop loss in the case of flooding. In the latter there is a need for replanting and since other household in the area will also be hit the household stand the best chance if it can command sufficient amount of labour and one way to securing that is by having more children. Given the patrilocal marriage system it is clear that the parents would prefer more boys than girls to help secure their old age. Vlassoff (1990) have, however, argued that even those household that are not in as much need of old age insurance still have a preference for boys [check!!].

[effects on fertility] Larsen, Chung, and Das Gupta (1998), Clark (2000). Dreze and Murthi (2001), Arnold, Choe, and Roy (1998)

[effects on mortality] Arnold, Choe, and Roy (1998) Murthi, Guio, and Dreze (1995) Bourne and Walker (1991) [Bhuiya and Streatfield (1991) on Bangladesh] Das Gupta and Bhat (1997) Rose (1999) Dreze and Murthi

(2001)

[intra-household allocation and other effects] Behrman, Pollak, and Taubman (1986); Behrman (1988a) Deolalikar and Rose (1998) on effect of sex of birth on savings.

3 The Technology of Sex Determinations and Selection

The “natural” sex ratio, that is the number of boys to one hundred girls without interventions, will be around 105 to 100 [ADD REFERENCES]. Hence, parents can expect a son with a probability of about 0.512. This sections discuss various factors which are thought to affect the sex of a fetus and medical technologies available for prenatal sex determination and their availability in India.

As James (1983) discusses there has been a long standing interest in what determines whether a women will have a boy or a girl and ways of influencing this outcome. While there does not appear to be much evidence for genetic differences in the probability of having a child of a specific sex, there are many folk suggestions for way to ensure having either a boy or a girl. Even if there was an effect of “natural” methods on the sex of the fetus, they are likely to be too imprecise for an individual family who has a desire for sons. Hence, an alternative is to use prenatal sex determination techniques and then abort the fetus if the child is not of the desired sex.[10] There are currently three well-developed technologies, which can be used to determine the sex of a fetus: Chorionic villus sampling, amniocentesis and ultrasound. Between them there is a trade-off between reliability, length of gestation necessary and the cost of the procedure.

Chorionic villus sampling is the method that can be applied after the shortest period of gestation at about eight to twelve weeks. This is the most complicated and reliable technique and have the advantage that a unwanted fetus can be aborted in the first trimester. The main disadvantage is, however, the cost of the procedure; in Korea it can cost USD 625 or more. Even if the cost would be less in India, due to lower labour costs of doctors, it is still likely to be out of reach everybody but the very rich.

Amniocentesis can be performed after fourteen weeks, but requires three to four weeks before the result is available. This means that an abortion cannot be performed until more than midways through the second trimester when using this technique. The technique is very reliable, although there is some discussion about the potential for an increase in the risk of a spontaneous abortion following the procedure.[11] Compared to chorionic villus sampling the cost of amniocentesis appear to be less. In Korea, Park and Cho (1995) quote a price in 1984 of around USD 250 to 375. Amniocentesis has been available in India since 1975, although the cost of it likely have

[10] The following is based on Park and Cho (1995) and Sudha and Rajan (1999).

[11] Park and Cho (1995) states that it is not always safe, but according to Kobrin and Potter (1983, p. 50) this risk is not "noticeably elevated".

prevented its use in the beginning.

The final procedure is ultrasound, which has the advantages of being noninvasive and relatively cheap. In Korea the cost is around USD 75, while in India it is between Rs 500 to over Rs 1000, which is between USD 11 and 24. It is not clear how precise this method is in the field, but according to Chu (2001) the sex of a fetus can be determined in the third month of gestation if it is a boy and the fourth month if it a girl. In the fifth month or later it should be almost 100 per cent accurate. As describe in Sudha and Rajan (1999) the first reports of private clinics offering sex determination for a fee came in 1982-83 and mobile clinics, which can reach small towns in remote areas, have been available since the mid-1980 in India.

Abortion itself has been legal in India since 1971 and still is. Since amniocentesis quickly became known as a method of prenatal sex determination, its use for the purpose of abortion became a penal offense. The government of Maharashtra was the first to pass a law on this and in 1994 the Central Government passed a law making determining and communicating the sex of a fetus illegal. According to Sudha and Rajan (1999) there are a substantial amount of leeway in the law, which for all intent and purposes allows private clinics to operate with little risk of legal action. This is partly due to the fact that the law does not cover ultrasound clinics to the same extent that it covers the use of amniocentesis. [EXPAND]

4 Theory

Parental decisions on sex selective abortion cannot be considered separately from other decisions on child outcomes. The two most prominent of those are fertility and investment in the children's human capital or consumption. This section presents a theoretical framework that can be used to examine how parents respond to the introduction of sex selection technology and to changes in price, income, preferences and sibling composition. Focus is on fertility, the use of sex selective abortions and investments in human capital. I first examine a model where parents care only about the number of boys and girls and there are no investments in children. The model is then extended to allow for human capital investments in children.[12] For each I first look at the case without access to sex selective abortions and then compare that to the situation where pre-natal sex determination is available.

4.1 The Basic Model

Assume that parents derive utility from the number of boys, B, and girls, G, they have and parental consumption. Parents' utility is separable between

[12] A maintained assumption throughout is that all boys are alike and all girls are alike within a family. Alternatively, one could incorporate a child-specific individual genetic endowment that was observed by the parents at birth, possibly with different distributions for boys and girls. This could reflect characteristics valued by the marriage market, such as height or beauty. Ejrnæs and Pörtner (2004) use a model similar to the one used here with child-specific endowments to examine the effect of birth order on intra-household allocation when fertility is endogenous.

these outcomes and is[13]

$$U(C) + B^{\beta} + G^{\gamma}. \tag{1}$$

Previous work on fertility decisions, both with and without preferences for a specific sex, have often explicitely made the utility function time dependent.[14] This, however, makes it difficult to analyse the interaction between human capital investments and fertility decision when extending the model. Instead parents here decide on fertility sequentially; that is, they decide whether to have a child, observe whether the child is a boy or a girl and then decide whether to have an additional child and so on. This captures the nature of the decision making process without making the model overly complicated.[15]

Parents' lifetime income, Y, is constant and there is a fixed cost, k, of supporting a child to adulthood.[16] Hence, the basic budget constraint is given by

$$C + (B + G)k \leq Y. \tag{2}$$

Is is possible to extend the budget constraint to include transfers that occur later in life, such as dowries. The simplest way to incorporate dowries is to

[13] I discuss the values of β and γ below.

[14] For a review see Arroyo and Zhang (1997). The utility function could then, for example, be $E_0\{\sum_{t=1}^{T} U(C_t) + B_t^{\beta} + G_t^{\gamma}\}$.

[15] This does, however, clearly not allow for parents to have preferences for their first-born being a specific sex and also ignores the additional utility gained from having a child of the desired sex for longer. I will deal with this and other issues below.

[16] Is it also possible to add a cost of a pregnancy, but since that cost is likely to be small relative to the cost of a scanning and abortion and the cost of bringing up a child this is ignored here.

assume that they enter directly into the life-time budget constraint as

$$C + (B + G)k + BD_B + GD_G \leq Y, \tag{3}$$

where D_G is the dowry paid to marry a daugther and D_B is the dowry received when a son marries. This implicitly assumes that there are perfect capital markets and that dowries received enter into the parents' "child budget constraint" instead of going directly to the son's household. When I extend the model to allow for human capital investments the dowries will depend on the amount of human capital.

Assume, as mentioned above, that parents decide on fertility sequentially. In the simplest case without pre-natal sex determinantion parents decide whether to have a child, observe the sex of the child and then decide whether to have an additional child and so on. This process goes on for T periods after which the parents can have no more children.[17] Parents all face the same probabilities of having girls and boys and these probabilities are independent of parity. The probability of having a boy is π and correspondingly the probability of having a girl is $(1 - \pi)$. This assumption does not change when sex selection is introduced. Pre-natal sex determinantion simply allows parents earlier information on the sex of the fetus.

[advantages of this model: realistic discrete number of children, relatively simple to work with/focus on fundamentals] [disadvantages: cannot be solved

[17]When human capital investments are introduced below resources are distributed at this time.

explicitly, but have to rely on simulation for "comparative static", ignores the decision on timing of marriage (changes in T), models births instead of conception behaviour]

4.2 Introducing Human Capital Investments

Assume that parents derive utility from the number of boys and girls they have, the human capital of their children and other outcomes such as parental consumption. The parents utility function is separable between parental consumption and the other outcomes and the subutility function that relates to the children is

$$U = \begin{cases} n_b^{\beta} + n_g^{\gamma} + \mu(n_b a_b H_b^c + n_g a_g H_g^c)^{1/c} & c \leq 1,\ c \neq 0 \\ n_b^{\beta} + n_g^{\gamma} + \mu H_b^{n_b a_b} H_g^{n_g a_g} & c = 0 \end{cases}. \tag{4}$$

The parents' inequality aversion is given by c, with a higher c indicating that parents are less averse to inequality. The parameters a_b and a_g reflect the weights parents place on boys' and girls' human capital respectively.[18] If $a_b = a_g$ parents' exhibit equal concern for boys and girls (Behrman 1988b).

For each child born the parent incur a fixed cost k which is independent of whether the child is a boy or a girl. To marry a daugther way there is a dowry of D_G and D_B is the dowry received when a son marries.[19] There is a

[18] Note that it is not possible to distinguish between the effects of differential returns to human capital for boys and girls and parental weights on boys' and girls' human capital.

[19] This obviously ignores the potential differences in who receives the money and whether that matters, i.e. whether the transfer is to/from the parents or the groom.

cost p_E of investing E unit of schooling into a child's human capital. Finally, pre-natal sex determination carries a cost p_s and the number of pregnancies where sex determinantion has taken place is s. With R resources devoted to fertility related decisions and human capital investments in children the parents' budget constraint is

$$(n_b + n_g)k + n_b D_b + n_g D_g + (n_b E_b + n_g E_g)p_E + sp_s \leq R. \tag{5}$$

The human capital production take one input schooling E and has diminishing marginal return to schooling ($\alpha < 1$)

$$H_i = \omega_i E_i^{\alpha} \quad i = b, g, \tag{6}$$

where ω captures differential effects by sex of schooling on the outcome of interest. One possible interpretation of this could be the marginal return of education if parents were mainly interested in life-time income (measured by H). In that case ω would be the marginal effect on life-time income from one extra year of education.[20] It is possible to allow for different productivity of schooling inputs depending on the inate abilitilies of different children, but this is beyond the scope of this paper since the primary interest here is the different treatment of boys and girls.

[20] Note that there really only is a difference between the effect of changing a and ω in the case where $c < 0$, that is, when parents compensate their children. Since Ejrnæs and Pörtner (2004) show that in this case parents will only have one child there is little reason to keep both in the model.

Parents all face the same probabilities of having girls and boys and these probabilities are independent of parity. The probability of having a boy is π and correspondingly the probability of having a girl is $(1 - \pi)$. This assumption does not change when sex selection is introduced. Pre-natal sex determinantion simply allows parents earlier information on the sex of the fetus.

5 Parents' Decision on Fertility and Schooling

To simplify the model assume that parents decide on fertility sequentially. In the simplest case without pre-natal sex determinantion parents decide whether to have a child, observe the sex of the child and then decide whether to have an additional child and so on. Once the fertility decision is completed they decide on the distribution of the human capital inputs. While this obviously ignores a number of aspects of the actually decision process it makes the model substantially more tractable while still retaining the idea of a trade-off between the number of children and the resources invested in them.

For a given number of boys and girls the optimal distribution of education for the individual child is

$$E_g = \frac{R - k(n_b + n_g) - n_b D_b - n_g D_g}{p_E} \left(\frac{a_g^{\frac{1}{1-\alpha c}} \omega_g^{\frac{c}{1-\alpha c}}}{n_b a_b^{\frac{1}{1-\alpha c}} \omega_b^{\frac{c}{1-\alpha c}} + n_g a_g^{\frac{1}{1-\alpha c}} \omega_g^{\frac{c}{1-\alpha c}}} \right) \quad (7)$$

$$E_b = \frac{R - k(n_b + n_g) - n_b D_b - n_g D_g}{p_E} \left(\frac{a_b^{\frac{1}{1-\alpha c}} \omega_b^{\frac{c}{1-\alpha c}}}{n_b a_b^{\frac{1}{1-\alpha c}} \omega_b^{\frac{c}{1-\alpha c}} + n_g a_g^{\frac{1}{1-\alpha c}} \omega_g^{\frac{c}{1-\alpha c}}} \right). \quad (8)$$

Utility is then

$$U = n_b^{\beta} + n_g^{\gamma} + \mu \left(\frac{R - k(n_b + n_g) - n_b D_b - n_g D_g}{p_E} \right)^{\alpha} \times \left(n_b a_b^{\frac{1}{1-\alpha c}} \omega_b^{\frac{c}{1-\alpha c}} + n_g a_g^{\frac{1}{1-\alpha c}} \omega_g^{\frac{c}{1-\alpha c}} \right)^{\frac{1-\alpha c}{c}} \quad (9)$$

Let $R^* = R - k(n_b + n_g) - n_b D_b - n_g D_g$ and $\omega_i = 1$, then the optimal stopping rule for the parents is

[Relation between the decision to have another child and the dowry sizes]

6 Data

The data are 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, respectively.[21] All are based on the Demographic and Health Survey Model B, with NFHS-1 using the DHS II questionnaire while NFHS-2 and NFHS-3 using, respectively, the DHSIII questionnaire and the Measure DHS

[21] NFHS-2 also has a small number of observation collected in 2000, due to a delay in the survey for Tripura.

questionnaire. All three 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. They were collected by the International Institute for Population Sciences in Mumbai and have nationwide coverage.

[VARIABLES - DEPENDENT]

[ISSUES] NFHS-1 is missing detailed information on the timing of marriage (gauna issue) and spacing since partners began living together to first birth [NEED TO EXPAND ON THIS]

[VARIABLES - INDEPENDENT]

In 2000 three new states were created in India: Uttaranchal, Jharkhand and Chhattisgarh. To ensure consistency across the three surveys each are included in the state these areas used to belong to.[22]

While the first round of the NFHS asked only about membership of either a scheduled caste or tribe the later rounds were expanded to also ask about membership of other backward castes. To ensure consistency the only two variables used are dummies for whether a woman belongs to a scheduled caste or a scheduled tribe, respectively. Another question that has been changed from the first round is on religion. The NFHS-1 only gave five options (Hindu, Muslim, Christian, Sikh and Other), while NFHS-2 and

[22]Uttaranchal was formerly part of Uttar Pradesh, Jharkhan was part of Bihar and Chhattisgarh was part of Madhya Pradesh.

NFHS-3 had twelve and elleven options, respectively. I use seven dummies for religious affiliation (Hindu, Muslim, Christian, Sikh, Buddhist, Jain and Other[23]) with "Other" being the excluded category. While this means that some of the women from NFHS-1 that are either Buddhist or Jain will be included in the category "Other" because those categories were not available these groups are important enough in terms of size and/or expected effect that they are still included.

[DATA REDUCTION - FINAL SAMPLE] In NFHS-1 a total of 89,777 women were interview. Out of those 6424 were visitors to the household in which they were interviewed and therefore dropped. Furthermore, 1538 women who has been married more than once were dropped and 42 were dropped because they had inconsistent information on their age of marriage.[24]

In NFHS-2 a total of 90,303 were interviewed, with 5955 dropped since they were visitors and 1569 because they were married more than once.

Finally, 124,385 women were originally interviewed in NFHS-3. Of those, 5528 are deleted here since they were visitors and 29,668 because they were never married.[25] Furthermore, 1994 were excluded since they had been married more than once.

Both the mother's and the father's education is measured in years. All

[23]Included in "Other" are Jewish, Parsi/Zoroastrian, Doni-Polo, Sanamahi and no religion.

[24]Dropping the latter is necessary in NFHS-1 because it, contrary to NFHS-2 and NFHS-3 do not calculate month of marriage and it therefore had to be imputed from age at first marriage.

[25]The latter category also include married women if gauna had not been performed at the time of the survey.

observations where the education of the mother is missing are dropped.[26]

3147 women were dropped since they had at least one set of multiple births leaving a total sample of 191,883 women.

[DROPPED BECAUSE TOO SHORT SPACING]

6.1 Recall Error and the Sex Ratio

An important questions is to what extent birth histories are reliable. There are two reasons for this. First, I need to establish when sex selective abortion techniques became widely available, which can only be done if there is not a significant amount of recall error of children of a specific sex. Secondly, my estimation methods relies heavily on good quality data being present both before and after sex selective abortion was introduced. I shall discuss that potential problem in more detail in Section 8. The main issue is likely to be recall error, which here refers to any children who are missed during the collection of a woman's birth history. In recognition of this potential problem the DHS III schedule, which is used for NFHS-2, have the interviewer probe about any missing births if there is four or more years between two births reported as consecutive. This is done ignoring the months of births and hence the actual spacing may therefore be less than 48 months.

The most probably reason a child is not being counted is that he or she did not survive for long after birth. In the absence of preferences for a specific

[26] In NFHS-1 253 observations are dropped, while 36 and 6 are dropped from NFHS-2 and NFHS-3, respectively.

sex recall error should bias an estimate of the sex ratio towards girls, since boys are more likely than girls to die early and therefore not be counted. In India, however, there are two effects which bias the results in the opposite direction. First, as discussed above there is a significantly higher mortality risk for girls than for boys. Hence, even if all births had an equal chance of being remembered this would tend to bias the results toward a higher sex ratio. Secondly, the preference for boys, which leads to the higher mortality for girls, is also likely to lead to more boys than girls being remembered. This would further bias the estimated sex ratio upward.

If recall error increases with the time elapsed since a birth the birth history becomes less and less reliable the further back we look. This makes an analysis of the spread of sex determinations techniques less precise, since there may appear to be little change in the sex ratio over time even though the actual sex ratio has increased. With the high mortality risk for girls we may even find that the pattern is the reverse of the expected.

One possible solution to the problem is to drop observations which are considered too far from the survey. The problem then is to find the ideal trade-off between sample size and the recall error. To determine how important the recall error is I use the fact that there are births from the two surveys which falls in the same periods. As discussed above the earliest reliable method of sex determination of a fetus was amniocentesis and that was not released until 1975. Hence, it is reasonable to assume that sex selective abortion could not have had a significant effect on the sex ratio at birth until the end of that decade. The means for births taking place twenty or more years before the year of interview show no significant difference between the two surveys, although both show a substantial male bias. The two means are 0.5260 and 0.5283 for NFHS-1 and NFHS-2, respectively, which leads to a t-statistics for equality of 0.743.[27] Compare this to the significant difference between the two survey when using births that fall in the period 1972 to 1979. The means are then 0.5147 and 0.5262, which leads to a t-statistics of 3.807.[28] The sex ratio, calculated from NFHS-1, is 106 boys per 100 girls, which is what we would expect without recall error and sex selective abortion, while the sex ratio based on NFHS-2 for exactly the same period is 111 boys per 100 girls. The implication of this is that I discard all observations for which the first birth took place more than twenty years before the survey for all three data sets. This lead to 56422 [CHANGE] women being dropped. [FINAL SAMPLE]

7 Spatial and Temporal Patterns in the Sex Ratio

This section looks at how the sex ratios differ between states in India and how it has developed over time. Beside the value of describing the pattern of sex ratios it also serves to focus the empirical analysis. I begin with the

[27]The periods covered are before 1972-73 and 1978-79 and there are 48,925 and 50,780 observations.

[28]There are 72,012 and 43,401 observations, respectively.

geographical differences.

Table 1 presents the estimated sex ratio by state for three decades. Children who were born more than twenty years before the survey were not used in creating Table 1. As discussed above there seems to be generally agreement that the technology for sex selective abortion was not widely available until the mid-eighties. In spite of this and the restriction on the distance between the survey and birth, Table 1 shows higher than natural sex ratios for many states for both the seventies and the eighties.[29] As shown in Tables 2-4 most of these do not, however, exhibit a distribution which is significantly different from the expected 0.512.

Not surprisingly there is little evidence of a masculine sex ratio in the Southern states, while the Northern states have significantly higher sex ratios than the expected of 105-106 boys per 100 girls. The pattern is more mixed in the rest of the states. The three states, Gujarat, Madhya Pradesh and Maharashtra all have significantly higher than expected sex ratios in the eighties, although they are not significant for the nineties. For the Northeast of India the three states of Meghalaya, Arunachal Pradesh and Assam show sex ratios that are significantly higher than 105 boys per 100 girls in either the eighties, nineties or both.

[Table 1 about here.]

[Table 2 about here.]

[29] Using all available observations tended to distort the sex ratio even further for the seventies. This pattern was even more pronounced for the sixties, which are not shown here.

[Table 3 about here.]

[Table 4 about here.]

8 Estimation Strategy

As discussed in Section 4 there are two implications that follows from parents' decision to use sex selective abortion. The first is that parents who use ultrasound will have a higher probability of their next child being a son. The second is that, because there is an approximately fifty per cent chance of the fetus being female, there should be an additional waiting time to next birth compared to what is expected when sex selective abortion is not available. Both of these implications can in principle be tested and used to establish who uses sex selective abortion. This section discusses the econometric specifications and the potential problems.

The first method simply consists of estimating the probability of a family having a boy conditional on a set of explanatory variables. If there is no sex selective abortion this should be a completely random event and hence there should not be any significant parameters. I estimate the probability of having a son for parity one through three, both before and after 1985. The choice of 1985 is based on the discussions in Sudha and Rajan (1999). [This should in principle be done using either logit or probit, but for ease of interpretation I use standard OLS at the moment.]

There are a number of potential estimation issues to consider. First there is the problem of recall error as discussed above. If a family has a preference for boys and therefore a higher mortality for girls, then a girl who dies soon after birth is more likely not be reported and this increases the "probability" of observing a boy instead. Since mortality is likely to be higher among poorer families this will bias upwards the estimated use of sex selective abortion among the poor. One way to assess the extent of recall error and for which types of families it is more likely to be a problem is to use the method described above and estimate what determines the probability of observing a boy for those births that took place twenty or more years ago.

Secondly, as discussed above parents may still end up with a girl as their next child even through they have used sex selective abortion. If this is the case in a substantial number of households then our estimates may only be a lower bound estimate. This is why the second method is also of interest since it relies on the duration between births and therefore should be better at estimating how many abortions there have taken place between two births.

Thirdly, for parity two and above there may be a selection problem. If parents are able to select the sex of their children or at least abort fetuses of an unwanted sex and the composition of older siblings are included as an explanatory variables, this may lead to a bias in the estimates. The same is the case if the samples on which the determinants of the probability of having a boy are estimated are selected on the basis of the family composition. For both cases the problem is the difficulty in finding a identifying variables. All variables that affect the decision on whether to abort a female fetus or not are the same for all parities.

The final problem, and potentially the most serious, the precision and number of data points needed. In a population with 10,000 births we would expect about 5,122 of them to be boys in the absence of sex selective abortion. If the use of sex selective abortion drives the sex ratio up to 110 boys per 100 girls, we would expect 5,238 boys instead. That is only an increase of 116 boys in a population of 10,000. The implication of this is that the data requirements are relatively intensive and it may be difficult to explain much of the variation in the sex of the children. It should still, however, be possible to establish which factors have a significant effect on the probability having a son.

[problems: possibility of genetic differences that affect the likelihood of having a boy; other methods; unobservable factors that might influence fertility and demand for ultrasound (such as low fecundity)]

While the first method is in principle easy to implement it may not provide a very precise estimate of the use of sex selective abortion because it only looks at the birth outcomes. The second method instead uses the increase in spacing between children that is expected if sex selective abortion is used. As described above there is at least a three months period between the beginning of the pregnancy and the time where reliable tests to determine the sex of the fetus can be carried out. Furthermore, in case a pregnancy is terminated the uterus need at least two menstural cycles to recover before conception can be attempted again. Finally, the expected time to conception is about six months. Hence, the use of sex selective abortion is likely to delay the birth of a child by more than a year.

This "delay" can be used to identify whether sex selection has taken place. Hence, what is important here is not just the outcome, i.e. whether a girl or a boy is born, but the length of time until the outcome. The duration between marriage and first birth and between births partly reflects the strength of demand for a specific outcome.

[CENSORING] [substantial number of observations are censored in that we only observed the time from the last birth but neither the completed length to the next nor the outcome. This is especially important in this context, where there has been a push towards lower fertility and where the availability and use of sex selective abortions have increased duration, hence making censored observations more likely.] [EMPHASISE THE FERTILITY ASPECT SINCE THIS METHOD CAN TAKE ACCOUNT OF THE FERTILITY DECISION - CENSORING CAN OCCUR EITHER BECAUSE THEY WANT NO MORE CHILDREN OR BECAUSE THEY ARE WAITING LONGER/ABORTING MORE]

[METHOD] The method used to estimate the duration between births is the discrete hazard model. A discrete-time approach has two substantial advantages over the standard continuous time hazard models. First, the duration is measured in months for most of the sample and while information on the day of birth is sometimes available it is likely to be measured with more error. Secondly, given that the duration is measured in months a substantial number of ties (observations with same duration) is likely, which can lead to serious bias if a Cox proportional hazard model is used. [THIRD ADVANTAGE? Finally, it is substantially easier to incorporate competing risks and address unobserved heterogeneity.]

[STEPS] Three models are estimated. The first model allows only for the duration from marriage or previous birth to the next birth or censoring. The second model extends the first model by explicitly allowing for multiple exit states (boy or girl). The final model adds unobservable heterogeneity to the second model by looking at repeated spells for each women. [explain why important - differences in fecundity, demand for boys, etc]

[BASIC MODEL] The basic model examines only the duration between births (or between marriage and the first birth). For each married woman ($i = 1, \ldots, n$) in the data we observe at least one spell. All spells are measured in months ($t = 1, 2, 3, \ldots$) and the first spell begins at the time of marriage and subsequent spells at the birth of a child [OR RISK OF CONCEPTION?]. The starting point for each spell is $t = 1$ and it continues until time t_i at which point a birth occurs or the survey takes place (the observation is censored).[30] The variable δ_i is equal to one if i is uncensored (the woman has a child in the given spell); otherwise it is zero. In addition to information about the spell length there is information about various individual, household and community characteristics, which included in the vector of explanatory

[30] The time of censoring is assumed independent of the hazard rate as is standard in the literature on hazard models. Furthermore, there is no left censoring in this case since the birth histories are retrospective from the time of marriage.

variable X_{it}, which may vary with time.

The discrete time hazard rate h_{it} is define as

$$h_{it} = \Pr(T_i = t \mid T_i \geq t; \mathbf{X_{it}}), \tag{10}$$

where T is a discrete random variable that captures the month at which a birth occurs.[31] It is the distribution of T which is of primary interest here. To complete the model specify the hazard rate as

$$h_{it} = \frac{1}{1 + \exp\left(-\alpha_t - \beta' \mathbf{X_{it}}\right)}, \tag{11}$$

or in its logit form

$$\log\left[\frac{h_{it}}{1 - h_{it}}\right] = \alpha_t + \beta' \mathbf{X_{it}} \tag{12}$$

where α_t is the baseline hazard (the hazard when $\mathbf{X_{it}} = 0$). This is the logistic hazard model and as shown in Allison (1982) and Jenkins (1995) this specification leads the likelihood function to be of the same form as the standard binary logit model, if the data are transformed so the unit of analysis is spell month rather than the individual woman. In the reorganised data set the outcome variable is zero if the woman does not have a child in that month and equal to one if she does have a child in that month. An alternative specification is the complementary log-log, which is a proportional hazards model. The logistic model converges to the complementary log-log

[31] This and the following paragraphs draw on Allison (1982) and Jenkins (1995).

model if the hazard rate is sufficiently small and since the logistic model is more easily extendable to more advanced model like multiple exit states it is preferable here.

To estimate (11) one must also specify the functional form for the baseline hazard function. The possible forms runs from a simple constant to the completely non-parametric. The non-parametric consist of as many dummies as there are time periods and is obviously the most flexible and lead to the best fitting model. The main drawbacks of the non-parametric version are that it requires events to occcur in each month, that it may fluctuate erratically across months because of nothing more than sampling variation and that with long spells it requires inclusion of a large number of unknown parameters. Alternatives to the non-parametric form is the piece-wise constant baseline hazard rate, which includes dummies equal to one for months that are expected to have the same hazard, and the polynomial specifications

$$\alpha_t = \alpha_0 1 + \sum_{k=1}^{p} \alpha_k (t-c)^k, \tag{13}$$

where p decides the order of the polynomial. [THE CHOSEN FORM WILL BE DISCUSSED IN THE RESULT SECTION BELOW]

[time varying explanatory variables: Changes in sex ratios (probably cannot be identified because of ten years between censa), changes in legal environment, economic variables)] [unlikely to be any individual or household specific variables that we can use for time varying variables]

[MULTIPLE EXIT STATES] While the basic model is a useful starting point and an improvement on previous studies of what determines sex selective abortions it ignores the information that comes from the sex of the child when it is born. Loosely speaking if a son is born after a long spell it provides more evidence of the use of sex selection than if a girl was born, all else equal. [MODEL PREDICTION OF GIRLS BEING BORN AFTER LONG SPELLS EVEN WITH PREFECT TECHNOLOGY] [the outcome is an important aspect, although the model indicates that sex selective abortions can have taken place and parents can still end up with a girl because the utility of having a girl outweights the cost of waiting another round - more likely the older the women] Here there are two kinds of events ($j = 1, 2$), with one being girl and two boy, and J_i is a random variable indicating which event took place.[32] First, define the discrete time hazard rate for each kind of events

$$h_{itj} = \Pr(T_i = t, J_i = j \mid T_i \geq t; \mathbf{X_{it}}). \tag{14}$$

The logistic model above can be generalised to the following hazard rate

$$h_{itj} = \frac{\exp(\alpha_{jt} + \beta_j' \mathbf{X_{it}})}{1 + \sum_l \exp(\alpha_{jt} + \beta_l' \mathbf{X_{it}})} \quad j = 1, 2. \tag{15}$$

The advantage of this specification is that it leads the same likelihood function as for a multinomial logit model in the same way that the basic model

[32] In principle a third exit state exists, which is sterilisation [NOT SURE IF ENOUGH INFORMATION IS AVAILABLE].

lead to the binary logit model. Hence, it is straigthforward to estimate the case with where the sex of the child born after a spell is incorporated by multinomial logit procedure. One issue to keep in mind with this approach is that interpretation of the results is no longer straightforward. First, the estimated parameters measure the change in probabilities relative to the censored outcome rather than simply the probability of an event as in the basic model. Secondly, an increase in a variable with a positive coefficient may not increase the probability that the associated event occur since the probability of another event(s) may increase even more.[33]

[problem with IIA assumption (independence of irrelevant alternatives] A more significant problem with the competing risks model above is that it assumes that alternative exit states are stochastically independent, also know as the Independence of Irrelevant Alternatives (IIA) assumption. This rules out any individual-specific unmeasured or unobservable risk factors that affect both the hazard of having a girl and the hazard of having a boy. In other words, the assumption requires that the hazard of having a boy relative to not having a child is uncorrelated with the corresponding relative hazard of having a girl.[34] There are two important factors that are generally unobservable and which may affect both hazards: Fecundity and the preference for boys. To see how this work, assume that a couple has low fecundity. This obviously reduces the chance of having a boy, but the assumption requires that

[33] See Thomas (1996) for an illustration of this problem in a continuous time setting.

[34] See Hill, Axinn, and Thornton (1993) for a more thorough and formal discussion of the issues involved and a suggested method for estimating a more general model.

the couple's chance of having a girl relative to not having a child is the same as for high fecundity couples which is obviously a very unattractive assumption. In the same vein, if some couples has very strong preferences for boys the assumption implies that the couples would distribute themselves between having a girl and having no children in the same proportions as those who had much lower preference for boys. [THIS IS NOT VERY CLEAR YET]

[ALTERNATIVE TO THE COMPLICATED VERSION BELOW: THE BASIC MODEL WITH UNOBSERVED HETEROGENEITY]

[REPEATED SPELLS/UNOBSERVABLE HETEROGENEITY] [RANDOM OR FIXED EFFECTS] [STEELE, DIAMOND AND WANG '96]

[ISSUES WITH METHOD] [Better health status lead to higher birth hazard, which will lower the duration between births. Higher demand for sex selective abortion will increase length. Over the time period covered by the data there has been both increased health of women and higher demand for sex selective abortion. The better health will, all else equal, bias downward the estimates and make it more difficult to find evidence of sex selective abortion. A related issue is increased labour force participation which may also affect the spacing between children, independently of the demand for sex selective abortions]

9 Estimation Results

For the moment I have chosen the following explanatory variables. For both the mother and the father I have divided their education into five group: No education, which is the excluded variable, 1 to 5 years of education, 6 to 9 years of education, 10 to 14 years of education and finally 15 or more years of education. There are three land variables used. A dummy for whether the household own any agricultural land, which is used for urban households and the number of acres of irrigated and non-irrigated land the household own. The latter two are used for rural households. The predominate religion in India is Hindi, which is the excluded religion variable. There are also dummies for being Muslim, Christian, Sikh and others.

For urban household the place of residence can be located in either a large or capital city, the excluded variable, or in a small city or a town. The geographical dummies follow those used above. The ratio of the mean of women's education over men's education is supposed to measure equality of the sexes until a better variable can be found (see below).

There is three dummies for year of birth: 1985-1989, which is the excluded variable, 1990-1994 and 1995-1999. Furthermore, the variable "No Boys" takes the value one if there are no surviving boys at the time of birth of the child in question. Likewise, "One Boy" take the value one if there is exactly one boy alive at the time of birth of the child. Both of these refer only to older siblings; multiple births have been dropped from the sample.

There are a number of variables that it would be of great interest to include. One is some measure of the relative return to investing in boys versus girls. An example could be the relative wage rate between women and men as used in Rosenzweig and Schultz (1982), although this may actually measure the relative bargaining power of women and not the return to investment.

Another variable is one that can capture the ”feedback mechanism” from a changing sex ratio on the use of sex selective abortions. At one point parents must realise that the current dowry system will not continue, which must affect the demand. A possible measure of this could be the ratio of marriage-aged girls to marriage-aged boys [census?]. Furthermore, it may be possible to trace the effect of making the use of ultrasound for sex determination illegal

There are variables which have been excluded even through they seem appropriate at first glance. Chief among these is measures of son preference. I tried two measure: Whether the family wants more boys than girls and whether it wants more than half their children to be boys. The reason for excluding these measures is evidence of a very strong effect from actual sex composition of children to these measures.

Related to this is the exclusion of a number of wealth variables that turned out to be endogenous. An example is livestock, which, if included, is very significant in the 1970-1984 sample of rural households when looking at first borns, while nothing else is. That must be because those household that were “lucky” enough to have a son (as first born) in the period 1970-84 can now cash in on their dowry (which may be in the form of livestock or be converted to livestock). It is an open question whether the land variable suffer from the same problem, but it appears to be of a lesser degree if it does.

9.1 Probability of Having a Boy

[NEED TO INCLUDE NFHS-3 IN RESULTS]

Tables 5 and 6 presents the results of the estimation of the effects of the explanatory variables on the probability of having a son. One of the most interesting features of these results is the major difference in which factors and important and which sign they have between first births and subsequent births.

[Table 5 about here.]

[Table 6 about here.]

9.2 Spacing between Births

[THESE ARE PRELIMINARY RESULTS FROM A PREVIOUS TESTED METHOD - TO BE REPLACED WITH DISCRETE HAZARD MODEL RESULTS]

Before presenting the estimation results for the spacing between births it is worthwhile examining how spacing varies over time and space. Figure 1 presents non-parametric plots of the hazard of having another child by parity and by the sex of the last child, while Figure 2 shows the same hazard by the number of boys alive for women in urban areas divided by roughly North and South of India.[35] As has also been shown in other research, the hazard of another birth is higher if the last child was a girl or if there are few or no boys alive for a given parity. What is new is that the spikes are substantially higher for if the last child was a girl or there are relatively few boys. While one would expect a certain uneven pattern, owing to biological factors that lead to a premature termination of the pregnancy, there larger spikes spaced about 12 months apart is preliminary evidence of the use of sex selective abortion.

[Figure 1 about here.]

[Figure 2 about here.]

Tables 7 and 9 show the results for estimating the effects of the factors discussed above on the spacing measured in months between the first and the second birth and the second and the third birth for urban and rural households respectively. As expected the presence of one or more boys lead to a longer period between births. If there are no boys among the two children when looking at the duration between second and third births, there is a very substantial reduction in the expected spell. Tables 8 and 10 show the results for the estimation using the difference between the observed duration between

[35] This obviously does not capture the substantial variation within India. There are areas in the southern part of India which appear to have a strong son preference, such as Salem, while there are also areas in the north that does not show much of a son preference.

births and the predicted length of time. As discussed above I expect that factors that lead a household to use sex selective abortion should increase the expected duration between births. This is supported by the results on the differences. If there, for example, are no boys presents the actual spacing after 1985 is significantly longer than the predicted using the pre-1985 data, which most likely reflects the increase in spell length between birth that are the result of the use of sex selective abortion.

[Table 7 about here.]

[Table 8 about here.]

[Table 9 about here.]

[Table 10 about here.]

10 Conclusion

[to be added]

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Table 1: Estimated Sex Ratios (M/F)

	1970-79	1980-89	1990-00
	North / Northwest		
Haryana	107.0	111.4	116.0
Himachal Pradesh	105.3	108.0	114.0
Jammu	109.8	106.3	110.0
Punjab	106.3	117.8	117.1
Rajasthan	112.0	112.0	108.6
Uttar Pradesh	108.4	111.3	105.3
New Delhi	105.2	110.8	114.1
	Central		
Bihar	104.5	105.6	106.1
Goa	106.7	100.6	110.1
Gujarat	109.2	108.4	104.6
Madhya Pradesh	107.1	109.1	107.0
Maharashtra	108.1	109.2	106.5
Orissa	104.2	105.9	106.6
	East / Northeast		
Assam	104.1	108.3	105.4
Manipur	115.3	102.9	97.9
Meghalaya	113.8	111.6	111.1
Mizoram	108.1	98.8	105.0
Nagaland	95.4	104.0	105.1
Sikkim	91.5	101.3	111.2
West Bengal	100.5	102.3	104.5
Arunachal Pradesh	111.7	106.6	118.2
Tripura	114.8	108.0	102.6
	South		
Andhra Pradesh	104.7	103.4	106.4
Karnataka	103.5	105.5	105.3
Kerala	98.2	102.0	107.0
Tamil Nadu	104.6	106.4	101.9

Table 2: Estimated Means and Standard Errors

	1970-79	1980-89	1990-00
	North		
Haryana	0.5169	0.5270***	0.5370***
	(0.0106)	(0.0056)	(0.0071)
Himachal Pradesh	0.5129	0.5193	0.5327***
	(0.0095)	(0.0060)	(0.0078)
Jammu	0.5233	0.5154	0.5239**
	(0.0103)	(0.0058)	(0.0070)
Punjab	0.5152	0.5408***	0.5395***
	(0.0100)	(0.0058)	(0.0076)
Rajasthan	0.5282**	0.5283***	0.5206**
	(0.0075)	(0.0038)	(0.0045)
New Delhi	0.5127	0.5255**	0.5328***
	(0.0105)	(0.0058)	(0.0076)
	West		
Goa	0.5163	0.5015	0.5241
	(0.0096)	(0.0075)	(0.0113)
Gujarat	0.5219	0.5201*	0.5113
	(0.0089)	(0.0051)	(0.0066)
Maharashtra	0.5194	0.5219**	0.5158
	(0.0085)	(0.0047)	(0.0059)
	Central		
Madhya Pradesh	0.5173	0.5218***	0.5170
	(0.0065)	(0.0037)	(0.0045)
Uttar Pradesh	0.5202**	0.5267***	0.5128
	(0.0048)	(0.0028)	(0.0035)
	Northeast		
Assam	0.5101	0.5199*	0.5130
	(0.0095)	(0.0053)	(0.0067)
Manipur	0.5356*	0.5071	0.4946
	(0.0167)	(0.0086)	(0.0098)
Meghalaya	0.5323	0.5274*	0.5264*
	(0.0173)	(0.0093)	(0.0099)
Mizoram	0.5194	0.4970	0.5122
	(0.0169)	(0.0097)	(0.0112)
Nagaland	0.4883	0.5098	0.5124
	(0.0160)	(0.0094)	(0.0110)
Sikkim	0.4778	0.5031	0.5264
	(0.0529)	(0.0132)	(0.0133)
Arunachal Pradesh	0.5277	0.5160	0.5417***
	(0.0205)	(0.0097)	(0.0104)
Tripura	0.5344	0.5193	0.5065
	(0.0177)	(0.0094)	(0.0119)
	East		
Bihar	0.5110	0.5136	0.5147
	(0.0074)	(0.0037)	(0.0043)
Orissa	0.5103	0.5144	0.5159
	(0.0087)	(0.0048)	(0.0060)
West Bengal	0.5013	0.5057	0.5110
	(0.0080)	(0.0048)	(0.0067)
	South		
Andhra Pradesh	0.5115	0.5083	0.5155
	(0.0083)	(0.0052)	(0.0071)
Karnataka	0.5086	0.5133	0.5129
	(0.0082)	(0.0048)	(0.0063)
Kerala	0.4954	0.5049	0.5170
	(0.0087)	(0.0059)	(0.0085)
Tamil Nadu	0.5113	0.5155	0.5047
	(0.0085)	(0.0054)	(0.0069)

NOTE: Children are coded 1 for boys and 0 for girls
Standard errors in parentheses

Table 3: Estimated Means and Standard Errors – Urban

	1970-79	1980-89	1990-00
	North		
Haryana	0.4846	0.5283^{*}	0.5532^{***}
	(0.0183)	(0.0101)	(0.0138)
Himachal Pradesh	0.5342	0.5309^{*}	0.5427^{**}
	(0.0183)	(0.0115)	(0.0157)
Jammu	0.5242	0.5055	0.5428^{**}
	(0.0191)	(0.0114)	(0.0143)
Punjab	0.5038	0.5310^{**}	0.5579^{***}
	(0.0195)	(0.0104)	(0.0143)
Rajasthan	0.5219	0.5425^{***}	0.5210
	(0.0165)	(0.0084)	(0.0104)
New Delhi	0.5123	0.5252^{**}	0.5334^{***}
	(0.0108)	(0.0060)	(0.0080)
	West		
Goa	0.5115	0.5037	0.5396^{*}
	(0.0143)	(0.0111)	(0.0173)
Gujarat	0.5136	0.5297^{**}	0.5293^{*}
	(0.0153)	(0.0086)	(0.0111)
Maharashtra	0.5151	0.5283^{**}	0.5124
	(0.0131)	(0.0069)	(0.0082)
	Central		
Madhya Pradesh	0.5266	0.5250^{**}	0.5212
	(0.0130)	(0.0076)	(0.0097)
Uttar Pradesh	0.5138	0.5251^{**}	0.5115
	(0.0108)	(0.0063)	(0.0086)
	Northeast		
Assam	0.5078	0.5182	0.5004
	(0.0162)	(0.0103)	(0.0150)
Manipur	0.5300	0.5082	0.5099
	(0.0297)	(0.0156)	(0.0182)
Meghalaya	0.4750	0.5025	0.5074
	(0.0396)	(0.0206)	(0.0248)
Mizoram	0.5286	0.4828	0.4981
	(0.0244)	(0.0137)	(0.0156)
Nagaland	0.4764	0.5138	0.5311
	(0.0344)	(0.0208)	(0.0279)
Sikkim	0.6667	0.5486	0.5278
	(0.2108)	(0.0416)	(0.0483)
Arunachal Pradesh	0.5455	0.4985	0.6008^{***}
	(0.0571)	(0.0279)	(0.0305)
Tripura	0.6013^{**}	0.5085	0.4954
	(0.0397)	(0.0231)	(0.0341)
	East		
Bihar	0.5100	0.5180	0.5010
	(0.0158)	(0.0095)	(0.0131)
Orissa	0.5111	0.5138	0.5101
	(0.0167)	(0.0097)	(0.0130)
West Bengal	0.5040	0.5012	0.5022
	(0.0170)	(0.0094)	(0.0124)
	South		
Andhra Pradesh	0.5120	0.5013	0.5243
	(0.0158)	(0.0103)	(0.0140)
Karnataka	0.5042	0.5217	0.5120
	(0.0154)	(0.0087)	(0.0115)
Kerala	0.4995	0.4950	0.5248
	(0.0165)	(0.0115)	(0.0166)
Tamil Nadu	0.5040	0.5328^{***}	0.5164
	(0.0149)	(0.0088)	(0.0107)

NOTE: Children are coded 1 for boys and 0 for girls
Standard errors in parentheses

Table 4: Estimated Means and Standard Errors – Rural

	1970-79	1980-89	1990-00
	North		
Haryana	0.5332*	0.5264**	0.5313**
	(0.0130)	(0.0067)	(0.0082)
Himachal Pradesh	0.5050	0.5150	0.5293**
	(0.0112)	(0.0070)	(0.0091)
Jammu	0.5230	0.5188	0.5180
	(0.0123)	(0.0067)	(0.0080)
Punjab	0.5192	0.5452***	0.5324**
	(0.0116)	(0.0070)	(0.0089)
Rajasthan	0.5299**	0.5246***	0.5205**
	(0.0084)	(0.0043)	(0.0050)
New Delhi	0.5197	0.5293	0.5273
	(0.0445)	(0.0202)	(0.0261)
	West		
Goa	0.5201	0.4996	0.5128
	(0.0128)	(0.0101)	(0.0149)
Gujarat	0.5261	0.5149	0.5012
	(0.0109)	(0.0064)	(0.0083)
Maharashtra	0.5226	0.5162	0.5194
	(0.0113)	(0.0065)	(0.0085)
	Central		
Madhya Pradesh	0.5141	0.5208**	0.5158
	(0.0075)	(0.0042)	(0.0051)
Uttar Pradesh	0.5218**	0.5271***	0.5131
	(0.0054)	(0.0031)	(0.0038)
	Northeast		
Assam	0.5114	0.5205*	0.5162
	(0.0118)	(0.0062)	(0.0075)
Manipur	0.5382*	0.5065	0.4883
	(0.0201)	(0.0103)	(0.0117)
Meghalaya	0.5459**	0.5337**	0.5301*
	(0.0192)	(0.0104)	(0.0109)
Mizoram	0.5110	0.5111	0.5273
	(0.0234)	(0.0136)	(0.0160)
Nagaland	0.4915	0.5088	0.5089
	(0.0181)	(0.0106)	(0.0120)
Sikkim	0.4643	0.4981	0.5263
	(0.0547)	(0.0139)	(0.0139)
Arunachal Pradesh	0.5251	0.5184	0.5341**
	(0.0220)	(0.0103)	(0.0111)
Tripura	0.5186	0.5214	0.5081
	(0.0197)	(0.0102)	(0.0127)
	East		
Bihar	0.5112	0.5128	0.5164
	(0.0084)	(0.0041)	(0.0046)
Orissa	0.5100	0.5146	0.5174
	(0.0102)	(0.0055)	(0.0067)
West Bengal	0.5005	0.5073	0.5147
	(0.0091)	(0.0057)	(0.0080)
	South		
Andhra Pradesh	0.5113	0.5107	0.5124
	(0.0098)	(0.0060)	(0.0082)
Karnataka	0.5103	0.5098	0.5133
	(0.0097)	(0.0057)	(0.0075)
Kerala	0.4938	0.5084	0.5142
	(0.0103)	(0.0069)	(0.0099)
Tamil Nadu	0.5148	0.5052	0.4962
	(0.0103)	(0.0068)	(0.0091)

NOTE: Children are coded 1 for boys and 0 for girls
Standard errors in parentheses

Table 5: Determinants of Having a Son – Urban Households

	1st Born	2nd Born	3rd Born
Father: 1-5 Years Educ.	0.0339*	−0.0181	−0.0286
	(0.0189)	(0.0188)	(0.0201)
Father: 6-9 Years Educ	0.0393**	−0.0235	0.0000
	(0.0170)	(0.0173)	(0.0187)
Father: 10-14 Years Educ.	0.0419**	−0.0388**	−0.0039
	(0.0174)	(0.0177)	(0.0193)
Father: 15+ Years Educ.	0.0556***	−0.0297	−0.0125
	(0.0212)	(0.0221)	(0.0270)
Mother: 1-5 Years Educ.	−0.0247	0.0102	0.0050
	(0.0157)	(0.0157)	(0.0171)
Mother: 6-9 Years Educ.	−0.0169	0.0110	−0.0005
	(0.0145)	(0.0151)	(0.0172)
Mother: 10-14 Years Educ.	−0.0220	0.0267*	0.0422**
	(0.0152)	(0.0159)	(0.0194)
Mother: 15+ Years Educ.	−0.0622***	0.0488**	0.0822**
	(0.0201)	(0.0222)	(0.0340)
Own Agricultural Land	0.0262**	0.0172	0.0057
	(0.0109)	(0.0117)	(0.0140)
Muslim	−0.0175	−0.0270**	−0.0094
	(0.0127)	(0.0132)	(0.0148)
Christian	0.0188	−0.0376	−0.0927*
	(0.0286)	(0.0330)	(0.0505)
Sikh	−0.0132	0.0119	0.0130
	(0.0222)	(0.0229)	(0.0301)
Other Religion	0.0234	0.0534*	0.0176
	(0.0269)	(0.0288)	(0.0364)
Small City	0.0165	0.0017	0.0181
	(0.0119)	(0.0127)	(0.0157)
Town	−0.0014	−0.0119	0.0578***
	(0.0112)	(0.0120)	(0.0151)
Women's to Men's Educ.	−0.0075	−0.0683	0.1527**
	(0.0563)	(0.0595)	(0.0725)
Born 1990-1994	−0.0086	0.0073	−0.0130
	(0.0096)	(0.0103)	(0.0125)
Born 1995-1999	−0.0154	0.0182	−0.0084
	(0.0123)	(0.0131)	(0.0163)
West	−0.0154	0.0064	−0.0193
	(0.0109)	(0.0117)	(0.0147)
Central	−0.0052	−0.0018	−0.0174
	(0.0122)	(0.0130)	(0.0152)
No Boys		0.0338***	0.0622***
		(0.0093)	(0.0164)
One Boy			0.0255*
			(0.0153)
Constant	0.5172***	0.5640***	0.3846***
	(0.0439)	(0.0467)	(0.0573)
Observations	13195	11649	7787
R-squared	0.00	0.00	0.01

NOTE: * significant at 10%; ** significant at 5%; *** significant at 1%
Standard errors in parentheses

Table 6: Determinants of Having a Son – Rural Households

	1st Born	2nd Born	3rd Born
Father: 1-5 Years Educ.	−0.0074	−0.0192*	−0.0026
	(0.0100)	(0.0100)	(0.0106)
Father: 6-9 Years Educ	0.0071	−0.0164*	−0.0027
	(0.0089)	(0.0092)	(0.0101)
Father: 10-14 Years Educ.	−0.0018	0.0039	−0.0019
	(0.0094)	(0.0098)	(0.0110)
Father: 15+ Years Educ.	0.0120	0.0247	0.0279
	(0.0185)	(0.0200)	(0.0244)
Mother: 1-5 Years Educ.	−0.0038	0.0037	0.0022
	(0.0096)	(0.0099)	(0.0112)
Mother: 6-9 Years Educ.	0.0120	0.0044	0.0138
	(0.0106)	(0.0117)	(0.0142)
Mother: 10-14 Years Educ.	0.0257**	−0.0269*	0.0292
	(0.0130)	(0.0149)	(0.0210)
Mother: 15+ Years Educ.	0.0056	0.0164	0.0727
	(0.0346)	(0.0433)	(0.0796)
Acres of Irrigated Land	0.0003*	0.0000	0.0003
	(0.0002)	(0.0002)	(0.0002)
Acres of Nonirr. Land	0.0001	−0.0002	−0.0003
	(0.0003)	(0.0003)	(0.0004)
Muslim	0.0278**	0.0022	−0.0287**
	(0.0115)	(0.0119)	(0.0126)
Christian	0.0142	−0.0129	−0.0234
	(0.0282)	(0.0322)	(0.0420)
Sikh	−0.0410***	0.0032	−0.0053
	(0.0154)	(0.0163)	(0.0196)
Other Religion	−0.0082	−0.0126	0.0351
	(0.0346)	(0.0374)	(0.0408)
Women's to Men's Educ.	0.0388	0.0267	−0.0025
	(0.0290)	(0.0304)	(0.0346)
Born 1990-1994	0.0077	−0.0118	−0.0014
	(0.0069)	(0.0072)	(0.0080)
Born 1995-1999	0.0055	−0.0066	−0.0042
	(0.0089)	(0.0093)	(0.0103)
West	−0.0175	−0.0172	−0.0363***
	(0.0107)	(0.0111)	(0.0128)
Central	0.0003	−0.0042	−0.0140
	(0.0075)	(0.0078)	(0.0086)
No Boy		0.0108*	0.0253**
		(0.0065)	(0.0107)
One Boy			0.0128
			(0.0101)
Constant	0.4969***	0.5170***	0.5243***
	(0.0128)	(0.0138)	(0.0167)
Observations	25900	23619	19028
R-squared	0.00	0.00	0.00

NOTE: * significant at 10%; ** significant at 5%; *** significant at 1%
Standard errors in parentheses

Table 7: Determinants of Spacing between Births – Urban Households

	1st to 2nd	2nd to 3rd
Father: 1-5 Years Educ.	−2.5820**	−1.9400
	(1.1987)	(1.9315)
Father: 6-9 Years Educ	−3.0945***	−3.4411*
	(1.1222)	(1.8318)
Father: 10-14 Years Educ.	−0.9787	3.3060*
	(1.1274)	(1.8413)
Father: 15+ Years Educ.	1.2815	8.8317***
	(1.4468)	(2.4103)
Mother: 1-5 Years Educ.	−0.4234	1.2695
	(0.9942)	(1.6178)
Mother: 6-9 Years Educ.	−2.2742**	4.8221***
	(1.0298)	(1.6975)
Mother: 10-14 Years Educ.	−0.2833	24.7817***
	(1.0930)	(1.8139)
Mother: 15+ Years Educ.	4.7312***	56.8025***
	(1.6663)	(2.9276)
Own Agricultural Land	0.8953	−0.5053
	(0.8103)	(1.3430)
Muslim	−3.2836***	−5.6167***
	(0.9344)	(1.5490)
Christian	−0.0190	−3.0959
	(2.1637)	(3.7299)
Sikh	−0.9493	6.7559**
	(1.5609)	(2.6474)
Other Religion	1.1357	−0.4152
	(1.9186)	(3.2377)
Small City	−2.5384***	−5.5136***
	(0.8446)	(1.4058)
Town	−2.2887***	−2.8504**
	(0.8162)	(1.3640)
Women's to Men's Educ.	−3.7754	34.2459***
	(3.8802)	(6.4251)
Age of Mother	−0.3002***	−0.0749
	(0.0604)	(0.1136)
Age of Mother Squared	0.0008***	0.0005***
	(0.0001)	(0.0002)
West	4.8402***	5.5893***
	(0.7994)	(1.3367)
Central	0.6061	−4.7269***
	(0.8695)	(1.4280)
Boy	3.7008***	
	(0.6260)	
No Boys		−24.4397***
		(1.4655)
One Boy		−7.5427***
		(1.2794)
Constant	65.0988***	14.8062
	(8.1897)	(16.4989)
Observations	13501	11188
R-squared	0.04	0.20

NOTE: * significant at 10%; ** significant at 5%; *** significant at 1%
Standard errors in parentheses

Table 8: Determinants of Difference between Actual and Predicted Spacing – Urban Households

	1st to 2nd	2nd to 3rd
Father: 1-5 Years Educ.	2.2575***	2.0475*
	(0.8082)	(1.1287)
Father: 6-9 Years Educ	3.4001***	3.9121***
	(0.7287)	(1.0378)
Father: 10-14 Years Educ.	2.0739***	−0.8954
	(0.7475)	(1.0605)
Father: 15+ Years Educ.	4.2905***	1.5656
	(0.9095)	(1.3261)
Mother: 1-5 Years Educ.	0.5344	0.8058
	(0.6713)	(0.9440)
Mother: 6-9 Years Educ.	2.2671***	−0.0735
	(0.6265)	(0.9103)
Mother: 10-14 Years Educ.	0.7184	−15.7966***
	(0.6699)	(0.9791)
Mother: 15+ Years Educ.	−0.6595	−39.8656***
	(0.9032)	(1.3840)
Own Agricultural Land	−1.1521**	0.7576
	(0.4669)	(0.6998)
Muslim	2.1306***	4.5536***
	(0.5441)	(0.7939)
Christian	−1.2267	4.4910**
	(1.2372)	(1.9909)
Sikh	1.0951	−5.0426***
	(0.9524)	(1.3759)
Other Religion	−0.4287	0.5728
	(1.1542)	(1.7242)
Small City	0.1722	2.9162***
	(0.5113)	(0.7630)
Town	1.6552***	4.6686***
	(0.4822)	(0.7207)
Women's to Men's Educ.	17.0251***	8.7459**
	(2.4220)	(3.5783)
Age of Mother	0.1108***	0.2274***
	(0.0323)	(0.0500)
Age of Mother Squared	−0.0004***	−0.0007***
	(0.0001)	(0.0001)
West	−2.1590***	−2.9945***
	(0.4682)	(0.7055)
Central	0.1803	4.2080***
	(0.5250)	(0.7814)
Born 1990-1994	−8.3608***	−16.8124***
	(0.4137)	(0.6172)
Born 1995-1999	−17.7583***	−33.8263***
	(0.5284)	(0.7853)
Boy	−1.4668***	
	(0.3732)	
No Boys		14.0462***
		(0.7998)
One Boy		5.2547***
		(0.6818)
Constant	−19.3666***	−26.8875***
	(4.7914)	(7.9794)
Observations	13195	11649
R-squared	0.13	0.42

NOTE: * significant at 10%; ** significant at 5%; *** significant at 1%
Standard errors in parentheses

Table 9: Determinants of Spacing between Births – Rural Households

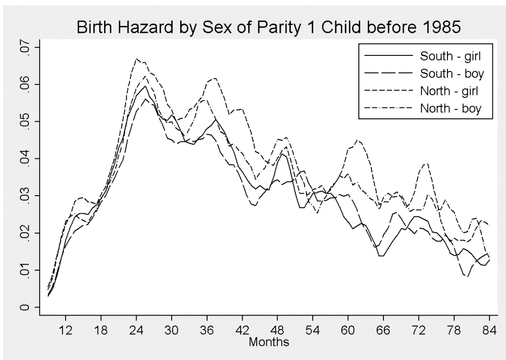
	1st to 2nd	2nd to 3rd
Father: 1-5 Years Educ.	0.1337	0.6347
	(0.5525)	(0.8155)
Father: 6-9 Years Educ	−0.9872*	−0.6537
	(0.5611)	(0.8423)
Father: 10-14 Years Educ.	0.1904	3.6764***
	(0.6072)	(0.9126)
Father: 15+ Years Educ.	−1.5532	6.4121***
	(1.3445)	(2.1284)
Mother: 1-5 Years Educ.	−0.7698	1.7677*
	(0.6216)	(0.9398)
Mother: 6-9 Years Educ.	−1.9079**	2.8209**
	(0.8491)	(1.3244)
Mother: 10-14 Years Educ.	0.4292	15.2183***
	(1.1789)	(1.9058)
Mother: 15+ Years Educ.	1.4415	59.3354***
	(4.0602)	(7.3007)
Acres of Irrigated Land	−0.0064	0.0098
	(0.0088)	(0.0125)
Acres of Nonirr. Land	−0.0264	−0.0507*
	(0.0201)	(0.0285)
Muslim	−0.9671	−4.2139***
	(0.7436)	(1.1262)
Christian	1.4039	2.3889
	(1.7625)	(2.6695)
Sikh	−2.1773**	2.5905*
	(0.9901)	(1.4704)
Other Religion	0.9536	−1.3258
	(2.0124)	(2.9488)
Women's to Men's Educ.	−0.8174	17.2698***
	(1.8235)	(2.7165)
Age of Mother	−0.3893***	−0.1699**
	(0.0413)	(0.0664)
Age of Mother Squared	0.0010***	0.0006***
	(0.0001)	(0.0001)
West	3.2012***	3.5150***
	(0.6685)	(1.0013)
Central	1.6608***	−0.1390
	(0.4839)	(0.7243)
Boy	2.5334***	
	(0.3914)	
No Boys		−15.6793***
		(0.8254)
One Boy		−9.0535***
		(0.7257)
Constant	70.6350***	47.6191***
	(5.0783)	(9.0243)
Observations	24956	21177
R-squared	0.02	0.06

NOTE: * significant at 10%; ** significant at 5%; *** significant at 1%
Standard errors in parentheses

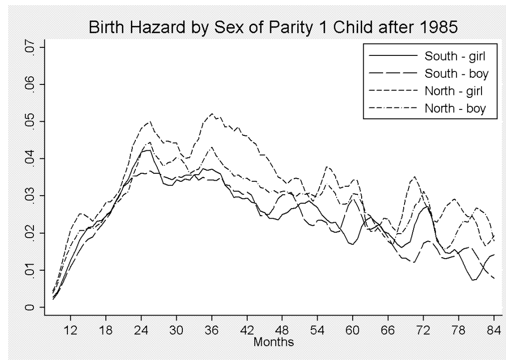
Table 10: Determinants of Difference between Actual and Predicted Spacing – Rural Households

	1st to 2nd	2nd to 3rd
Father: 1-5 Years Educ.	0.1644	0.3896
	(0.3466)	(0.4798)
Father: 6-9 Years Educ	0.5915*	1.5260***
	(0.3098)	(0.4417)
Father: 10-14 Years Educ.	−0.5336	−2.0865***
	(0.3272)	(0.4714)
Father: 15+ Years Educ.	3.8237***	0.2455
	(0.6444)	(0.9558)
Mother: 1-5 Years Educ.	0.6723**	0.2689
	(0.3327)	(0.4746)
Mother: 6-9 Years Educ.	1.6159***	0.1543
	(0.3713)	(0.5611)
Mother: 10-14 Years Educ.	−0.0617	−10.8607***
	(0.4591)	(0.7203)
Mother: 15+ Years Educ.	4.0870***	−54.2781***
	(1.2138)	(2.0850)
Acres of Irrigated Land	0.0079	−0.0031
	(0.0064)	(0.0088)
Acres of Nonirr. Land	0.0338***	0.0259**
	(0.0090)	(0.0128)
Muslim	1.0674***	2.0497***
	(0.4001)	(0.5690)
Christian	2.5208**	−2.1648
	(0.9916)	(1.5533)
Sikh	−0.0907	−4.8647***
	(0.5356)	(0.7792)
Other Religion	−0.2813	1.2570
	(1.2038)	(1.7900)
Women's to Men's Educ.	6.4094***	2.8638**
	(1.0121)	(1.4566)
Age of Mother	0.2306***	0.0357
	(0.0206)	(0.0302)
Age of Mother Squared	−0.0006***	−0.0002***
	(0.0000)	(0.0001)
West	−3.4291***	−5.6445***
	(0.3752)	(0.5328)
Central	−0.6395**	−0.4867
	(0.2619)	(0.3768)
Born 1990-1994	−6.9764***	−9.8331***
	(0.2393)	(0.3447)
Born 1995-1999	−13.0785***	−20.2990***
	(0.3102)	(0.4430)
Boy	−1.9209***	
	(0.2160)	
No Boys		6.0690***
		(0.4442)
One Boy		3.2063***
		(0.3903)
Constant	−22.6829***	1.7570
	(2.6581)	(4.3053)
Observations	25900	23619
R-squared	0.12	0.19

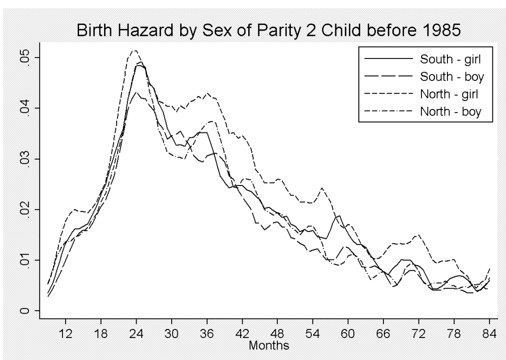
NOTE: * significant at 10%; ** significant at 5%; *** significant at 1%
Standard errors in parentheses



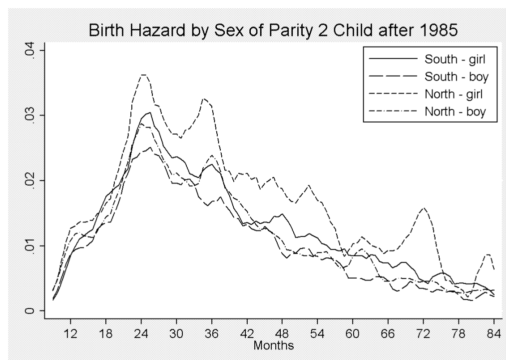
(a) Parity 1 - Before 1985



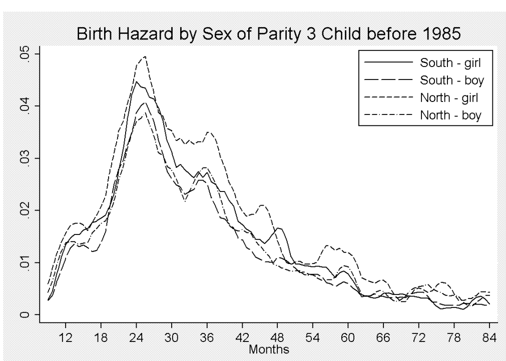
(b) Partiy 1 - After 1985



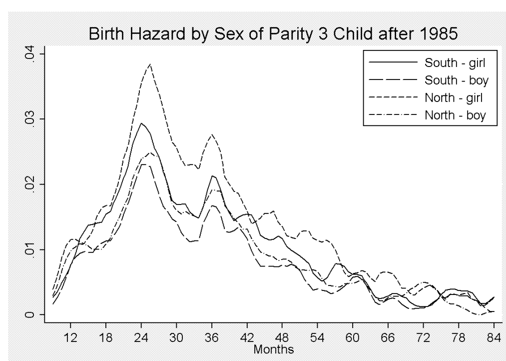
(c) Parity 2 - Before 1985



(d) Parity 2 - After 1985

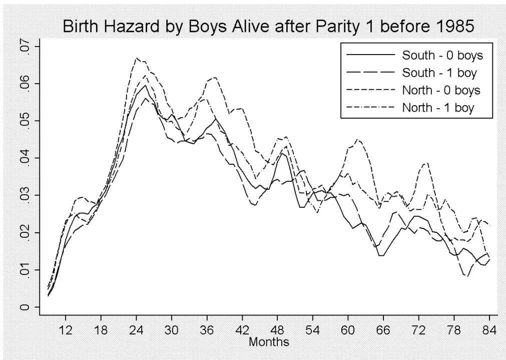


(e) Parity 3 - Before 1985

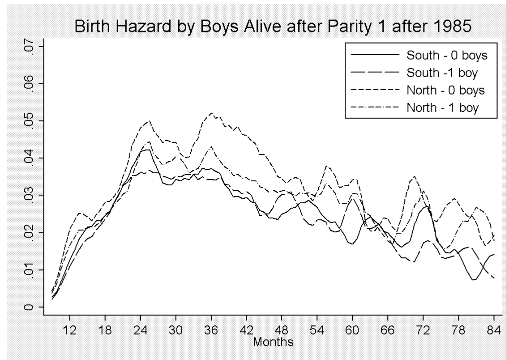


(f) Parity 3 - After 1985

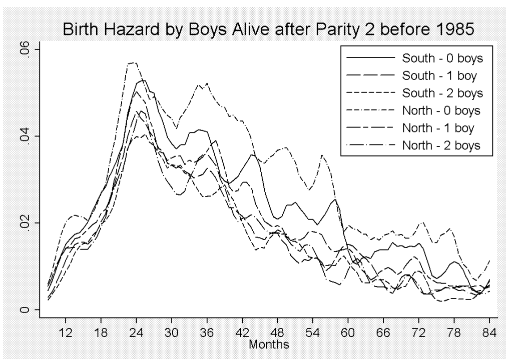
Figure 1: Birth Hazard by Last Child's Sex - Urban



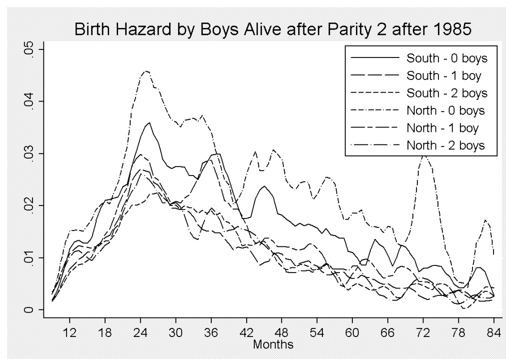
(a) Parity 1 - Before 1985



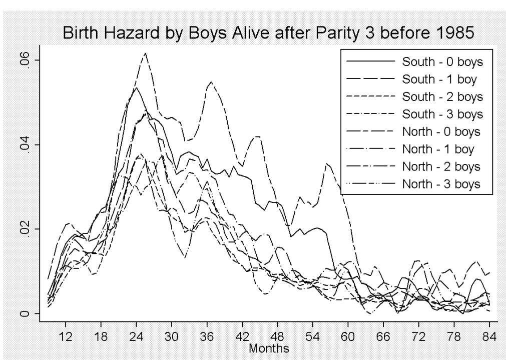
(b) Parity 1 - After 1985



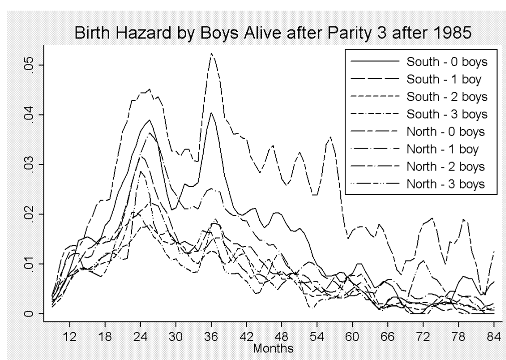
(c) Parity 2 - Before 1985



(d) Parity 2 - After 1985



(e) Parity 3 - Before 1985



(f) Parity 3 - After 1985

Figure 2: Birth Hazard by Number of Boys Alive - Urban