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DAUGHTER DISCRIMINATION AND FUTURE SEX RATIO AT BIRTH IN INDIA

Tarun K. Roy and **Aparajita Chattopadhyay**

This paper examines recent trends in sex ratio at birth in all the major states of India, based on three rounds of the National Family Health Survey. It finds evidence of an increase in the ratio, particularly at the second-order birth among women having a first daughter in many states in the northwestern region of the country. Also, there are signs of daughter aversion emerging in Odisha, an eastern state. Based on parity progression ratios and the trend in sex selection, an attempt is made to estimate the peak of sex ratio at birth in India. With moderate intensification in sex selection in the northwestern region, sex ratio at birth is expected to reach a peak of 117–119 males per 100 females around the period 2021–2026. If, in addition, sex selection spreads further in the southeastern region, the sex ratio at birth in India could even increase to a level of 124.

KEYWORDS: sex ratio at birth; discrimination; parity progression ratio; projection; India

Introduction

The Indian census of 2011 shows a considerable deficit of girls compared to boys in the age group 0–6. In fact, the past four censuses also portray a dismal secular increase in child sex ratio (males per 100 females) in the country. The sex ratio at birth (SRB) in India has also gone past its normal range of 102–106. The presence of discrimination against female children in India is well-documented. According to a recent study, the conditional sex ratio for second-order births when the first-born was a girl in the country increased from 110 in 1990 to 120 in 2005 (Jha *et al*. 2011). It is widely believed that such a shortfall is mainly due to an increase in sex-selective abortions.

What is less studied, however, is whether the discrimination is spreading gradually throughout the country or is still localised in a few northern and western states, as well as the future course of this unfortunate trend. Will it continue to rise unabated, and if so, for how long? Is there a possibility that it will reach a plateau in the near future? What will be the likely level around which it will peak? There are reasons to feel optimistic that the situation might improve, and at the same time, there are causes for despair. A reason for optimism is that there is evidence of such a turnaround in one of the Asian countries. In South Korea, the sex ratio reached a plateau at around the level of 114 males per 100 female births and then returned to the normal level of 106 in 2007 (Chung & Das Gupta 2007). South Korea's rapid development had a role in the normalisation of its sex ratio. In another recent paper on Asia, it was mentioned that the SRB had also been flattened in Taiwan, and had been reaching the level of normalcy in Singapore (Guilmoto 2009). India, if not equally, is also progressing well on the path of development. An analysis, based on the SRB from the country's Sample Registration System, indicated a decline in the ratio

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(Kulkarni 2010). Comparing the situation in China and India, Das Gupta *et al*. (2009) showed optimism that in both countries, the sex ratio would soon reach a plateau and follow the pattern of South Korea. Their confidence was based on the fact that both these countries had additional supporting public policies to increase gender equity. In fact, in China, although the SRB apparently increased slightly between 2000 and 2005, a decline was suggested when the rate was standardised by birth order (Goodkind 2008). With the help of trends in the sex ratio of children aged 0–6 during the period 1981–2001, it has been observed that the ratios are starting to decline in many subnational areas in India, as stated by Das Gupta *et al*. (2009). Another significant reason for optimism comes from the study of Retherford and Roy (2003), made based on the first two rounds of the National Family Health Survey (NFHS), which is equivalent to the Demographic Health Survey in India. The study showed that there had been a reported decline in son preference in the country. The recent round of the NFHS survey, done in 2006, reinforces the same trend. It shows a secular decline in the proportion of women having no son who express desire for more children.

There are public policies towards promoting gender equity in India. However, it may be added, in this context, that the two regulations, i.e. minimum age at marriage and dowry prohibition, does not yield any perceptible change in the behaviour of the population (Guilmoto 2009). The central government has also passed the *Prenatal Diagnostic Techniques Regulations and Prevention of Misuse Act* in 1994, which covers all of India. This Act imposes restrictions on activities relating to diagnostic techniques that can be used to assess the sex of a foetus. This act does not seem to have a desirable effect on reducing sex-selective abortions though (Garg & Nath 2008; Guilmoto 2009).

Thus far, studies have revealed the existence of discrimination mainly in some specific states located in the northern and western regions of the country. With increasing accessibility to sex determination and abortion, it is difficult to rule out the possibility that sex selection would not spread in other areas. After all, son preference exists throughout the country, though its degree varies. Fertility decline can exert additional pressure to accommodate the desired sex composition of children to fit in with declining family size composition. Fertility squeeze, along with son preference, can jointly foster a resort to sex selection (Arnold & Parasuraman 2009; Guilmoto 2009).

The states in India where fertility is still high constitute more than two-fifth of the country's population. To gauge the future trend in SRB, it is vital to understand what is happening and likely to happen in these populous states. It is also true, as mentioned earlier, that the notion of son preference is declining in the country. However, to what extent this declining preference will translate into actual practice in reducing sex selection is doubtful. Utilising longitudinal data from the second round of the NFHS and a specifically designed follow-up survey four years later, it has been shown that in the presence of son preference, the credibility of family size preference indicators in predicting future fertility reduces substantially (Roy *et al*. 2008). That is, women who do not have a son and indicate a desire to stop having children tend, in reality, to have more children. Interestingly, the propensity to go for sex-selective abortion is high among women in the higher socio-economic strata, which more than compensates for the lower level of son preference (Retherford & Roy 2003). The socio-economic rise may enhance the productive role of men more than women due to male-centric developmental programmes. Gender inequality widens during socio-economic development despite the rise in developmental indicators, unless it is consciously addressed during the planning process (Razavi & Miller

1995). Thus, the potential for sex-selective abortion is very high in states where fertility is still high, where the actual SRB is normal but the ideal sex ratio is very unfavourable to female children, and further, where modernisation has yet to happen.

As such, the future scenario of SRB still remains uncertain. Can the development that the country is witnessing and the effort towards empowering women, including the recent *Women's Reservation Bill*, take care of discrimination against female children and herald a new future path of declining sex ratio for the country?[1] In the absence of a reliable civil registration data on births in the country, a survey that provides information on birth histories of women can be a potential tool for undertaking such investigations. The NFHS that provides such information has been repeated three times at an interval of approximately six years each. The present study utilises the information from all the three surveys to examine the trends in SRB in the country. In particular, considering the socio-cultural and demographic diversity in the country, a complex statistical analysis has been attempted to reveal the trends in the SRB in the major states in India. Based on parity progression ratios by sex composition of children already born, which can also be estimated from the birth history data, and utilising the findings on trends in SRB, a further attempt is made to project the peak level of the SRB that the country is likely to attain.

Data and Methods

The study is based on the three rounds of the NFHS (NFHS-1, NFHS-2 and NFHS-3) conducted in India (International Institute for Population Sciences (IIPS) 1995, 2000, 2007). The first survey, NFHS-1, was conducted during the period 1992–1993, the second, NFHS-2, in the period 1998–1999, and the last, NFHS-3, in the period 2005–2006. This provides an excellent opportunity to examine the trends in the discrimination against female children. It is well known that there can be under-enumeration of births, particularly in retrospective surveys. In the Indian context, there exists the possibility of an under-enumeration of female births (Visaria 1971). If such under-reporting is present but becomes less marked over the years, this can distort analyses of both the levels, as well as the trends, in sex selection. It is likely to overestimate the effect, but underestimate the trend in sex selection, and hence, the SRB.

Adequate care was taken, in all three rounds of the NFHS, to minimise the under-reporting of births. Bhat (1995), in an analysis of the quality of birth history data in the survey, observed that these data were largely free of the under-reporting of births, although there was some error in the reporting of their timings. It may also be mentioned, in this context, that among women with at least 10 years of marriage, the percentage of women having girls for both their first- and second-order births has been found to be close to 24 in all the three surveys. The theoretical probability for such an event (considering a SRB of 105) is 24 per cent. If there was a significant under-enumeration of female children (in first and/or second order), this was unlikely to have happened.

To facilitate the analysis, the data from the three surveys were combined. Births to a woman were classified, according to the time of occurrence of her first-order birth, into three different periods as: (i) prior to 1981; (ii) during the period 1981–1990; and (iii) after 1990, i.e. during the period 1991–2005. Although discrimination in the form of differential mortality could be present throughout, there was practically no evidence of sex determination at birth in the first period, i.e. before 1981 (Guilmoto 2009). Various public

policies to promote gender equity have been largely introduced during the 1990s. It is also true that the economic upturn in the country started after the liberalisation policy in 1991, and during this period, the availability of sex determination techniques registered a manifold increase due to the production of ultrasound machines in the country (George 2006). It was hence felt that should there be any change in the pattern of discrimination, it would be less in the pre-1991 period compared to the 1991–2005 period.

Considering the immense demographic diversity, including the existence of son preference in the country, the analysis was done at the state level. Even the design of the NFHS was geared toward providing estimates at the state level; the present study considered all the major states of India, i.e. those having a population of six million or more in 2001, except Jammu and Kashmir.[2] For the purpose of the present study, the states were broadly classified into two: the Southeast and the Northwest. This is largely based on the evidence of differences in the extent of sex discrimination and of son preference prevailing between states in these two regions.

Sex selection was examined through variation in the SRB of birth orders 1 and 2. The two-child family norm has long been propagated by the family planning programme, and in fact, the majority of the states have already achieved or nearly reached replacement-level fertility. Moreover, as will be discussed later, the SRB has been projected at a time when the country, as a whole, has reached replacement-level fertility. Hence, the emphasis is on gauging the trends in sex selection at the first two orders of birth. The detailed analysis of sex differentials in birth was undertaken by employing logistic regression with the dichotomous dependent variable taking a value of '1' for a male child, i.e. SRB of a particular birth order. The major independent variables considered included the time of occurrence of a birth. Two dummy variables, TIME1 and TIME2, denoted the periods 1981–1990 and after 1990, respectively, with births occurring before 1981 acting as the reference. In the case of second-order births, an additional variable, GIRL1, was used as a representation of whether the previous child was a female. To gauge the presence of discrimination in urban areas, a variable, URBAN, which took a value of '1' if the residence was urban, and zero if otherwise, was also considered. Among the socio-cultural variables, the education, religion and caste of a woman were included. A dichotomous variable, EDU, represented the better educated women, i.e. women with at least 10 years of schooling. The lesser-educated group was assigned a value of '0'. Similarly, REL denoted religious groups other than Hindus, and CASTE, the scheduled caste and scheduled tribe.[3] The reference categories for REL and CASTE were Hindus and the general caste, respectively. These socio-economic variables vary considerably by state. In most of the states, except Punjab, Muslims constitute a sizable proportion of the population, next to Hindus. In Punjab, two major religious groups are Sikhs and Hindus. Since the analysis was performed at the state level, the dichotomous variable, REL, while keeping the analysis simple, captured the variation in the religious composition of the population. For example, in most states, the value of REL would indicate the extent to which SRB differed among Muslims in comparison to Hindus, whereas for Punjab, it would indicate the differentials between Sikhs and Hindus.

If the birth history data for women of completed fertility were available, the SRB could be computed by obtaining the total male and female births in a given period of time. An alternative approach to obtain SRB, which is advantageous for projecting it in future, is to estimate it with the help of parity progression ratios by the sex composition of children already born. In other words, in addition to estimating how many women of parity i progressed to parity $i+1$, these progressions were computed by the sex

composition of children already born to women of parity i. The following two parameters were estimated: R_i^{jk} denoting proportion of women of parity i having j sons and k daughters ($j + k = i$) progressing to parity $i + 1$, and B_i^{jk} indicating proportion of female births in i^{th} order among women having j sons and k daughters ($j + k = i - 1$). These two parameters help in estimating the proportion of women of parity i having j sons and k daughters ($i = j + k$), denoted as p_i^{jk}. For example:

$$p_3^{21} = B_1^{00} R_1^{01} (1 - B_2^{01}) R_2^{11} (1 - B_3^{11}) (1 - R_3^{21}) + (1 - B_1^{00}) R_1^{10} B_2^{10} R_2^{11} (1 - B_3^{11}) (1 - R_3^{21}) + (1 - B_1^{00}) R_1^{10} (1 - B_2^{10}) R_2^{20} B_3^{20} (1 - R_3^{21}) \quad (1)$$

The parity distribution with the specification of the sex composition of children helps in the estimation of SRB. For example, the SRB among women of parity 1 to 3 (SRB_{1-3}) was obtained as:

$$= [(p_1^{10} + p_2^{11} + p_3^{12}) + 2(p_2^{20} + p_3^{21}) + 3p_3^{30}]/[(p_1^{01} + p_2^{11} + p_3^{21}) + 2(p_2^{02} + p_3^{12}) + 3p_3^{03}] \quad (2)$$

The above formulae can be extended in a straightforward manner to include the higher parity women. This method underpins the projections of future national-level SRB.

Results and Discussions

At the outset, Table 1 provides some information on fertility and SRB by states, as recorded in the Sample Registration System (Registrar General and Census Commissioner of India 2011). This would facilitate our subsequent discussion on the projection of SRB. It can be seen that except for Bihar, all other states in the Southeast have either already reached or are about to reach replacement fertility. The northwestern region includes three larger states having a total fertility rate of 3–4 children. It may be mentioned that the southeastern and northwestern regions support more or less equal proportions of the population, i.e. 46 and 50 per cent, respectively. The SRB is also high, higher than the national average, in all the states in the Northwest except Himachal Pradesh. None of the states in the Southeast has a SRB exceeding 110. It may be mentioned that the extent of son preference is higher among the states in the Northwest compared to that in the Southeast. Considering the proportion of women wanting more boys than girls as an index to measure son preference, Bhat and Zavier (2003) showed a similar picture regarding variation in son preference in the country.

Results of the analysis based on the NFHS data will be presented in two different sections as follows: variations in SRB; and projection of SRB in India.

Variations in SRB

As mentioned earlier, the trend in SRB has been examined in consideration of the first two orders of birth. It is possible that some sex selection has been happening at the third or higher orders of birth, but its prevalence in the first two orders will decide the future course of SRB in the country. As fertility falls, women who desire to fulfil both sex and family size composition are likely to resort to sex selection, if necessary, at the time of their second-order birth. Moreover, an examination of changes in SRB requires a sufficient sample size. For many states, the number of third-order births may not be adequate to conduct a fruitful analysis. The purpose behind the elaborate state-level analysis is two-fold—first, to

TABLE 1
Total fertility rate (TFR) and sex ratio at birth (SRB) by states[a].

Region	States	TFR in 2009	SRB in 2007–2009
Southeast	Andhra Pradesh	1.9	109
	Assam	2.6	107
	Bihar	3.7	109
	Karnataka	2.0	106
	Kerala	1.7	103
	Odisha	2.4	106
	Tamil Nadu	1.7	108
	West Bengal	1.9	106
Northwest	Gujarat	2.5	111
	Haryana	2.5	118
	Himachal Pradesh	1.9	106
	Maharashtra	1.9	112
	Madhya Pradesh	3.2	106
	Punjab	1.9	120
	Rajasthan	3.3	114
	Uttar Pradesh	3.7	114
	India	**2.6**	**110**

Source: Registrar General and Census Commissioner of India (2011): compendium of India's fertility and mortality indicators—2007–2009, based on the Sample Registration System (SRS).
Notes:
[a]The figures for Bihar and Madhya Pradesh refer to undivided states, i.e. the weighted average of Bihar and Jharkhand for the former, and the average of Madhya Pradesh and Chhattisgarh for the latter.

facilitate making reasonable assumption regarding future changes in SRB, and second, to observe the intensification or spreading of daughter aversion over time.

Variations at first-order birth. The logistic regression analysis for first-order birth shows no significant increase in SRB in any of the states. For brevity, the results are not presented. It can be assumed that there is no statistical evidence of sex selection at first birth. (To give some mention here about the sample size available for the state-level analysis, Haryana had the lowest size of 6942 women). There are studies that have also indicated the absence of sex selection at first-order birth (Arnold *et al*. 2002; Jha *et al*. 2011; Retherford & Roy 2003). Welcoming a first child, be it a girl or a boy, seems to agree well with the cultural practices prevalent in the country. After marriage, one major concern of the majority of couples is to provide evidence of their fertility as soon as possible. There is also the belief that if the first-born is a girl, it means that *Laxmi*—the goddess among the Hindus who brings prosperity and wealth—has arrived. As the local proverb, *'pahali beti dhanachi peti'*, goes, the first daughter is a treasure of wealth. There can be another advantage to having a daughter as a first child. Since a girl's marriage usually requires 'dowry', parents, in many cases, prefer to have the marriage sooner rather than later, while they are still working and therefore, more able to make the necessary provisions. The finding on no evidence of sex selection at first birth is a major assumption in the projection of SRB. As discussed later, this is the basis for the assertion that the overall level of SRB in the country is likely to have a peak and would not continue to have an increasing trend for a long period of time.

Variations at second-order birth. Tables 2a and 2b provide the results of the analysis for the states in the northwestern and southeastern regions, respectively, for second-order

TABLE 2a
Variations in log odds of a boy at second birth: coefficients from independent logistic regressions for each state in the northwestern region[a].

Variable/ state	Gujarat	Haryana	Himachal Pradesh	Maharashtra	Madhya Pradesh	Punjab	Rajasthan	Uttar Pradesh
TIME1	.007	.013	−.047	.029	.012	−.004	.021	−.064*
(1981–1990)	(.054)	(.061)	(.061)	(.046)	(.039)	(.060)	(.044)	(.031)
TIME2 (after	.161	−.091	−.166	−.196*	−.161*	−.078	−.158	−.186**
1990)	(.108)	(.118)	(.129)	(.096)	(.072)	(.154)	(.084)	(.056)
Before 1981 (ref)								
URBAN	.001	.054	.034	.012	.046	−.006	.095	−.002
	(.059)	(.072)	(.072)	(.050)	(.048)	(.070)	(.058)	(.040)
Rural (ref)								
Religion	−.182*	−.131	.033	−.022	−.079	.030	−.048	−.097
other than	(.090)	(.099)	(.134)	(.055)	(.071)	(.064)	(.077)	(.044)
Hindu (REL)								
Hindu (ref)								
SC and ST	.073	−.008	−.010	−.016	.013	.051	.020	−.005
caste (CASTE)	(.062)	(.074)	(.071)	(.057)	(.042)	(.069)	(.048)	(.040)
Other than SC and ST (ref)								
Better	.098	−.080	.078	.011	.042	−.009	−.149	−.011
educated	(.063)	(.082)	(.072)	(.051)	(.060)	(.071)	(.080)	(.047)
(EDU)								
Lesser educated (ref)								
1st girl child	.087	−.077	−.164**	.004	.024	.154**	−.016	−.003
(GIRL1)	(.053)	(.061)	(.059)	(.046)	(.039)	(.059)	(.044)	(.031)
Otherwise (ref)								
URBAN X	.024	.088	−.002	.010	.102	.138	−.286*	.056
TIME2	(.118)	(.144)	(.139)	(.091)	(.087)	(.140)	(.117)	(.071)
GIRL1 X	.091	.307**	.356**	.192*	.107	.267*	.093	.215**
TIME2	(.109)	(.120)	(.119)	(.083)	(.073)	(.118)	(.091)	(.059)
EDU X TIME2	.022	.175	.025	.045	.037	.197	.596**	.015
	(.119)	(.138)	(.132)	(.090)	(.095)	(.130)	(.139)	(.075)
REL X TIME2	.149	−.050	.031	.032	−.030	−.087	.319*	.083
	(.184)	(.187)	(.277)	(.099)	(.136)	(.127)	(.153)	(.081)
CASTE X	−.222	.077	−.126	.025	.043	−.026	−.030	−.026
TIME2	(.122)	(.145)	(.142)	(.100)	(.079)	(.133)	(.101)	(.074)
Sample size	**7518**	**5921**	**6114**	**11102**	**15058**	**6237**	**10916**	**23013**
−2 Log likelihood	**10380**	**8171**	**8454**	**15346**	**20816**	**8566**	**15051**	**31831**

Notes:
[a]Numbers in parentheses are standard errors of the coefficients.
Women having twins in first- or second-order birth are excluded from the analysis.
*$p < .05$; **$p < .01$.

birth. The analysis includes few interaction terms, such as between variables GIRL1, URBAN, EDU, REL and CASTE with TIME2, indicated as the corresponding product terms. They specify whether the effect of these variables has changed over time. For example, coefficient of GIRL1 indicates the variation in SRB at the second order of birth among those who have had a girl as a first-born compared to those who have had a boy. This variation is irrespective of time. The interaction between GIRL1 and TIME2, on the other hand, shows whether the variation in SRB at second-order birth among those with a first girl

TABLE 2b
Variations in log odds of a boy at second birth: coefficients from independent logistic regressions for each state in the southeastern region[a].

Variable/state	Andhra Pradesh	Assam	Bihar	Karnataka	Kerala	Odisha	Tamil Nadu	West Bengal
TIME1	−.081	−.018	−.042	−.013	−.021	.066	−.024	−.135**
(1981–1990)	(.050)	(.062)	(.042)	(.050)	(.058)	(.051)	(.052)	(.050)
TIME2	.022	−.122	.002	.013	.085	.016	.011	−.039
(after 1990)	(.092)	(.141)	(.076)	(.096)	(.215)	(.106)	(.100)	(.117)
Before 1981 (ref)								
URBAN	−.058	−.084	−.102	.002	−.027	.022	.103	.073
	(.057)	(.072)	(.055)	(.057)	(.062)	(.061)	(.056)	(.056)
Rural (ref)								
Religion other	.100	−.124	.093	.083	.018	−.001	−.083	.032
than Hindu (REL)	(.071)	(.074)	(.056)	(.074)	(.059)	(.133)	(.080)	(.062)
Hindu (ref)								
SC and ST caste	.085	−.046	.032	−.034	−.112	.189**	.066	.016
(CASTE)	(.061)	(.077)	(.052)	(.063)	(.104)	(.056)	(.062)	(.064)
Other than SC and ST (ref)								
Better educated	−.063	.052	.116	−.034	−.098	.108	.006	−.016
(EDU)	(.069)	(.073)	(.061)	(.061)	(.060)	(.069)	(.060)	(.063)
Lesser educated (ref)								
1st girl child	−.006	−.055	−.048	−.019	−.067	−.011	−.065	.028
(GIRL1)	(.049)	(.061)	(.041)	(.049)	(.056)	(.050)	(.051)	(.050)
Otherwise (ref)								
URBAN X TIME2	−.010	−.019	.074	−.016	.061	.260*	−.013	−.007
	(.103)	(.153)	(.101)	(.109)	(.137)	(.126)	(.102)	(.114)
GIRL1 X TIME2	.131	.120	.018	−.026	.028	.001	−.091	−.029
	(.092)	(.126)	(.080)	(.095)	(.127)	(.104)	(.097)	(.104)
EDU X TIME2	−.059	.087	−.087	.016	−.092	.074	.038	−.071
	(.109)	(.138)	(.103)	(.107)	(.200)	(.124)	(.103)	(.120)
REL X TIME2	−.105	−.004	−.099	.034	.012	−.644*	.221	−.009
	(.121)	(.156)	(.103)	(.141)	(.134)	(.305)	(.151)	(.132)
CASTE X TIME2	−.057	.143	.019	.057	.225	−.134	.103	−.034
	(.113)	(.149)	(.096)	(.117)	(.199)	(.114)	(.114)	(.129)
Sample size	**9337**	**5620**	**12767**	**8978**	**6339**	**8309**	**8543**	**8391**
−2 Log likelihood	**12916**	**7759**	**17676**	**12434**	**8778**	**11459**	**11814**	**11610**

Notes:
[a]Numbers in parentheses are standard errors of the coefficients.
Women having twins in first- or second-order birth are excluded from the analysis.
*$p < .05$; **$p < .01$.

has changed in the recent period (TIME2) compared to that in the reference period (prior to 1981).

Although there is no evidence of a significant increase in the overall sex ratio at the second-order birth in any of the states, the interaction term, GIRL1 X TIME2, is significant and positive for quite a few states in the northwestern region (Table 2a). Six states in this region, barring Gujarat and Madhya Pradesh, show clear signs of sex selection and its increase over time. The interaction is positive and significant in five of them, namely, Haryana, Himachal Pradesh, Maharashtra, Punjab and Uttar Pradesh. The odds of a boy in the second-order birth when the first-born is a girl are higher in the recent period (after 1990), compared to the pre 1981 period, by 35 per cent, 43 per cent, 21 per cent,

31 per cent and 24 per cent, respectively, in the five abovementioned states. The sixth state is Rajasthan, where the propensity of sex selection at the second birth order is higher among the educated group of women in the recent period compared to the pre-1981 period, and the interaction between the variables, EDU and TIME2, is positive and highly significant. Sex selection in Rajasthan is also indicated by Agnihotri (2000).

In the southeastern states, although sex selection in favour of a boy is rarely visible, Odisha is emerging as a budding place for selective abortion at the second order of birth, mainly among the urban class (Table 2b)—an observation which has also been pointed out by Agnihotri (2003). In Andhra Pradesh, Bihar, Karnataka, Kerala and Tamil Nadu, none of the factors considered in the model exhibit any significant relationship with the sex ratio. In West Bengal, the factor, TIME1, is significant but negative. In other words, more girls compared to boys were born in the state during the 1981–1990 period compared to pre-1981 period.

The present study, to a great extent, supports the observation by Sen (2005) that anti-female bias is present in western and northern Indian states. Bhat (2010) had distinctly marked a diagonal line bifurcating India into two parts, i.e. SRB of 105 and above, and otherwise. Therefore, in the context of an emerging male sex bias in urban Odisha, the typical northwestern versus southeastern divide may not exist in the near future. On the question of what it is that really accounts for the similarity in having a lesser extent of son preference in the South and the East compared with the West and the North, one broad similarity that seems to exist is that these areas are, by and large, dominated by a culture of rice consumption, and hence, its cultivation, which demands high labour participation from women (Bardhan 1984a, 1984b). Again, the strong implementation of land reform in some of these states has helped to propagate the equity of land distribution among farmers. As a consequence, farmers in these states do not posses unusually large plots of land, and hence, do not panic about losing this family property in their next generation, which perhaps diminishes the tendency of preferring sons. On the contrary, the rural elites of northern India still preserve and extend their power by utilising land-based, immovable property to acquire new opportunities that arise from time to time. The major land-owning castes, like the Jaths in Punjab and the Rajputs in Rajasthan, are having the most imbalanced sex ratios (Das Gupta 1987). Females are the most marginalised lot in northern and western India, particularly after the modernisation of the agricultural system through the green revolution. It may not be out of place to mention here that two very influential and respectable images in the East are that of Goddess *Durga* and *Kali*, both of whom embody female authority and supremacy. The values laid down by the reformers, in addition to religious values, might have nurtured and promoted a more balanced gender outlook in the eastern region. However, the absence of discrimination against female children in the South and the East does not necessarily mean that the preference for having a son is absent there (Sudha & Rajan 1998.). However, it can be said that any manipulation to have a male child is small enough to escape statistical screening, given the considerably large sample size available for the study.

Projection of Sex Ratio at Birth in India

The projection of SRB is based on the two parameters, R_i^{jk} and B_i^{jk}. The base level data for the two parameters can be estimated with the help of the birth history data from the survey. To make assumptions for the future, it would be useful to understand how

fertility, son preference and sex selection influence SRB through the two parameters. For simplicity, as well as practical considerations (as will be discussed later), the estimation of SRB is considered separately for the following two constituents, based on women, of: (i) parity 1 to 3 (SRB_{1-3}); and (ii) parity 4 or more (SRB_{4+}).

Effect of fertility, son preference and sex selection on the two parameters and SRB. The parity progression ratio (R_i) is an index of fertility. For a given parity, the progression to higher parity, if son preference is absent, would not depend on the sex composition of children already born. That is, R_i^{jk} will be equal to R_i. The existence of son preference creates a gap between the progressions according to the sex composition of children. Those with girls, instead of stopping, would be more likely to proceed to a higher parity in search of sons (for example, see Clark 2000). That is, R_i^{jk} would be higher if the number of daughters (k) exceeds the number of sons (j). Son preference directly affects neither B_i^{jk} nor R_i. Fertility also does not have an independent influence on B_i^{jk}. It can have an indirect effect in the sense that a declining fertility can create additional pressure for those having a son preference to go for the selection. The effect of sex selection on the progression ratios is not straightforward. Let us consider a woman with one daughter who has an urge to have a son. If she does not go for sex selection and has a daughter again at second birth, her chances of progressing further will accord with R_2^{02}. However, if she goes for sex selection and has a son at second birth, she might stop childbearing, or at the most, her chances of progressing further will accord with R_2^{11}. Since, R_2^{11} is less than R_2^{02}, the overall level of R_2 will decline, which in turn would reduce fertility.

To understand the inter-linkage with SRB, let us first consider a population where only son preference exists, but where there is no sex selection. The level of fertility is also assumed to be high, with a completed family size averaging around 4–5 children. In fact, this resembles closely the situation that prevailed in the country prior to 1981.

$$\text{Now, } SRB = W * SRB_{1-3} + (1 - W) * SRB_{4+,}$$

where 'W' is the proportion of total births that occur to women of parity 1–3. The value of W depends on the proportion of women who progresses to parity 4 and above, and the number of additional children they have beyond four, that is, the average parity among these women. As fertility is high, the majority would progress to parity 4 and above, irrespective of whether or not their desired sex composition of children has been attained, and W will be quite small. SRB will be largely determined by $SRB4_{+.}$ SRB_{1-3} is likely to be higher than the normal level of 105.

Due to the presence of son preference, the number of boys is expected to be more than girls at each of the first three parities. Hence, for those who stop at one child, the proportion having one son ($1\text{-}R_1^{10}$) is expected to be more than the proportion having one daughter ($1\text{-}R_1^{01}$). Similarly, for those who stop at two children, the proportion of those with two sons will be higher than the proportion of those with two daughters. For the same reason, i.e. the progression ratio being higher among women with more girls than boys, the SRB_{4+} will be lower than 105, though only marginally because of high fertility. SRB is, therefore, expected to be close to 105. When fertility declines, particularly if it is near the replacement level, W will increase substantially and the contribution of SRB_{1-3} to the overall level of SRB would exceed SRB_{4+}. SRB_{1-3} is also expected to increase because R_2^{0i} will be higher than R_2^{0i} ($i = 1$ to 3). Since the majority of women would stop at two children, the progression to higher parity would largely be restricted to those having girls

only. Those with girls only will experience a dilemma to choose between adherence to family size preference or adherence to son preference, the choice of which will influence the rate of progression to higher parity. The stronger the son preference in relation to family size preference, the higher will be the rate of progression and the larger will be the gap between SRB_{1-3} and SRB_{4+}. That is, the former will be higher and the latter will be lower than 105. However, since W is greater than its converse, the overall SRB is likely to get closer to SRB_{1-3}. In other words, SRB is expected to show an increasing trend.

So, in the presence of son preference, declining fertility can have an effect of increasing the SRB, even in the absence of sex selection. Das Gupta and Bhat (1997) mentioned about such an effect. Sex selection, which can happen as a result of son preference, will have a direct influence in reducing B_i^{jk}, and hence, increase the SRB. It needs to be noted that son preference has been existing since a long time ago, when sex-selection techniques were not available. When sex selection became available, some of those with son preference will resort to using sex selection rather than proceeding to higher parity in search of sons. To the extent that this happens, sex selection will tend to further increase both SRB_{1-3} and W.

To better appreciate the interrelationship between R_i^{jk} and B_i^{jk} with fertility and SRB, values of the two parameters have been obtained among married women having at least 10 years of marriage for the recent period (1991–2005). For all India, the values are derived separately, one for all women and the other for the educated group of women with at least 10 years of schooling. In the northwestern and southeastern regions, only the values for the educated group of women are presented (Table 3). At the outset, it may be mentioned that the overall level of SRB of 109, estimated for India, agrees reasonably well with the estimate of 110 given by the Sample Registration System for the years 2007–2009 (Registrar General and Census Commissioner of India 2011).[4] A higher estimate of 112 for the educated women also seems to be reasonable. It is widely believed that sex selection is more prevalent among the educated women compared to the less educated group in the country (for example, see Retherford & Roy 2003). Also, the fertility among the educated women is lower than the less educated women, which would also have an increasing effect on their SRB.

It can be seen that the progression ratios, in every parity, are higher when the sex composition of children is unfavourable to boys. Not only is R_i^{0i} higher than R_i^{i0} (i = 1, 2 and 3), but R_3^{12} is also higher than R_3^{21}. This is true in both the regions. It can be noted that the ratios of R_1^{01} to R_1^{10} and R_2^{02} to R_2^{20} are higher in the Northwest than in the Southeast. Particularly noticeable is the difference in the latter ratio (R_2^{02} to R_2^{20}), which is 2.15 for the former region compared to 1.56 in the latter. In other words, a woman with two daughters has a 115 per cent higher chance of progressing to the next parity than a woman with two sons in the northwestern region. This figure is much less at 56 per cent in the southeastern region. As has been observed in the earlier analysis, there is substantial evidence of sex selection at the second order of birth when the first-born is a girl in many of the northwestern states, whereas, with the exception of urban Odisha, there is no statistical evidence of sex selection found in the Southeast. Hence, the ratio shows the effect of both sex selection as well as son preference in the Northwest, whereas in the Southeast, the effect is largely due to son preference.

Another phenomenon which has considerable relevance for the projection that emerges from Table 3 is that the value of R_1^{10}, i.e. the proportion of women with one son who proceed to have another, remains substantially high in all the populations. It is 89 and

TABLE 3
Parameters for estimating overall sex ratio at birth (SRB) in India and among educated women in the eastern, southern, northern and western regions during the period 1990–2005.

		Among educated women (after 1990)		
Parameters	**India after 1990**	**Southeast**	**Northwest**	**India**
R_1	.902	.830	.903	.870
R_1^{10}	.893	.815	.881	.853
R_1^{01}	.912	.843	.924	.887
R_2	.653	.379	.517	.462
R_2^{20}	.577	.330	.359	.356
R_2^{11}	.637	.336	.484	.427
R_2^{02}	.775	.515	.773	.657
R_3	.530	.295	.384	.363
R_3^{30}	.499	.279	.350	.332
R_3^{21}	.445	.211	.248	.245
R_3^{12}	.574	.337	.402	.395
R_3^{30}	.670	.370	.718	.576
B_1^{00}	.492	.486	.501	.493
B_2^{10}	.485	.470	.499	.484
B_2^{01}	.467	.498	.426	.461
B_3^{20}	.490	.449	.492	.469
B_3^{11}	.484	.510	.469	.484
B_3^{02}	.462	.482	.403	.427
Average parity among women with 4 or more children	4.7	4.4	4.5	4.5
SRB among women of parity 1–3 (SRB_{1-3})	124	112	131	122
SRB among women of parity 4+ (SRB_{4+})	93	85	81	83
Overall SRB	109	107	115	112

Notes:
R_1 is the proportion of women with one child who proceeds to have another; R_1^{10} is the proportion of women with one son who proceeds to have another.
R_1^{01} is the proportion of women with one daughter who proceeds to have another.
B_1^{00} is the proportion of females in first-order birth.
B_2^{10} is the proportion of females in second-order birth when the first is a son.

85 per cent, respectively, among all women and the educated women in India. It declines slightly to 82 per cent among educated women in the southeastern region. In other words, a large majority of the women have at least two children. It may be mentioned that according to the NFHS-3, the total fertility rate for educated women is that of below two children. This shows that even if fertility declines and reaches replacement level, R_1 is not likely to decline much.

Table 3 also provides separate estimates of SRB_{1-3} and SRB_{4+}. SRB_{1-3} is calculated based on equations (1) and (2) stated earlier in this paper. The derivation of SRB_{4+} based on equation (1) becomes difficult. Also, the credibility of the estimates of R_i^{jk}, for the higher-order births, reduces as a result of declining sample sizes. It is, therefore, estimated based on the actual number of male and female births to women of parity 4 and above. The differential in the values of SRB_{1-3} and SRB_{4+} is, as expected, higher in the Northwest compared to that in the Southeast.

Assumptions regarding parameters for projection. Since declining fertility tends to increase SRB, it is assumed that the peak value of SRB will be attained at a time when the country reaches the replacement level of fertility. The rationale for this assumption is discussed later. As per the latest population projection, the country is likely to reach the replacement level around the years 2021–2026 (Registrar General of India 1996). Another assumption is that when India reaches replacement fertility, R_i^{jk} will resemble what is observed at present among the educated group of women in the country (Table 3). The parity distribution implied by the R_i^{jk} shows that 13 per cent, 47 per cent and 26 per cent of educated women would be in the first three parities, respectively, and 14 per cent would be in parity 4 and above. It is also assumed that son preference will still remain and SRB_{4+} will be 90 instead of attain a value in its normal range of 102–106. Although a declining trend in son preference is observed in the country, the finding that the reliability of fertility preference indicators in predicting fertility becomes substantially weak in the presence of son preference (Roy *et al*. 2008), leading us to consider only a small increase (from its level of 83) in SRB_{4+} in the future.

The crucial ingredient in the projection is to foresee the extent of sex selection, and hence, the reduction in the proportion of female births (B_i^{jk}). Building on the empirical evidence presented earlier, it has been assumed that the proportion of females in first-order birth (B_1^{00}) will not change and the reduction will be mainly in B_2^{01}. This leads us to our assumption that the peak value of SRB will be attained along with the achievement of replacement-level fertility. Initially as fertility declines, where more and more women tend to adhere to the two-child family norm, SRB will increase as selection at second-order birth increases. However, at a later stage, when continued fertility decline results in more and more women stopping at one child, the ratio will gradually stabilise. If fertility continues to decline, after reaching replacement level, SRB will start declining. This is because of the assumption of no sex selection at first birth. The issue that it raises is whether this assumption of no selection at first birth will remain tenable when women decide to have only one child. The sample percentage of women who stop at one child is too small and is not likely to be representative of a future population in which a sizeable proportion stops at one child. They are, except perhaps in Kerala, likely to be either well educated or have some health or other personal problems.

Three different sets of projection for the peak level of SRB have been made (Table 4). The low peak projection is based on the assumption that in the future, when replacement-level fertility has been achieved in the country, the extent of sex selection at second-order birth among women having one daughter, and at third-order birth among women having two daughters, will be equal to that which is observed at present (1991–2005) among educated women in the country. It may be pointed out that the role of the assumption regarding the third-order birth is negligible. With declining fertility, the proportion of women having a third-order birth declines, and the sex selection at second-order birth further reduces the proportion among them who have two daughters.

In the medium peak, the extent of sex selection in the country is assumed to increase further. Its level, when replacement-level fertility is reached, would be as observed in the northwestern region at present. It can happen if sex selection spreads further in the Northwest, which has shown high potentials for sex selection in most of its state. For example, the assumed value of B_2^{01} of 0.43 for the country as a whole can be reached if the B_2^{01} level declines to 0.48 (from the present 0.50) in the southeastern region and 0.38 (from the present 0.43) in the northwestern region. In other words, this can happen if sex ratio at

TABLE 4
Assumptions regarding B_2^{01} and B_3^{02}, and estimated peak value of sex ratio at birth (SRB) in India.

Set	B_2^{01}	B_3^{02}	Projected value of SRB
Low peak	0.46 (117)	0.43 (133)	115
Medium peak	0.43 (133)	0.40 (150)	117
High peak	0.33 (203)	0.30 (233)	124

Notes:
The values in parenthesis are the implied SRBs of a specific order i ($=2, 3$) among women with 0 sons and $(i-1)$ daughters. The values of B_1^{00} (proportion of females in first-order birth), B_2^{10} (proportion of females in second-order birth when the first is a son), B_3^{20} (proportion of females in third-order birth when the first two are sons), and B_3^{11} (proportion of females in third-order birth when the first two are a son and daughter) are all assumed to 0.485. SRB_{4+} is assumed to be 90.

second-order birth among women having a daughter increases slightly to 108 in the southeastern, and 163 in the northwestern, region.

The high peak scenario assumes substantial fall in the value of B_2^{01}. It implies a sex ratio at second-order birth of 203 among women having one daughter. The remaining parameters, such as B_1^{00}, B_2^{10}, B_3^{11} and B_3^{20}, are all assumed to have a value of 0.485, which corresponds to a sex ratio of 106. The projected peak values of SRB are 115, 117 and 124, respectively, for the three sets of projections (Table 4).

Conclusions

State-level analysis is done initially to examine the variation in SRB. It reveals an increasing trend in the conditional SRB at second order, that is, SRB at second-order birth among those with one daughter. Of the eight states in the northwestern region, such a tendency was observed in five, namely, Haryana, Himachal Pradesh, Punjab, Uttar Pradesh and Maharashtra, constituting 32 per cent of the country's population. In another state in the same region, i.e. Rajasthan, which constitutes 6 per cent of the population, the conditional SRB at second order is found to be increasing among the educated group of women. Except Odisha, no other state in the southeastern region shows any statistical evidence of sex selection, not even in the conditional SRB at second order. In Odisha, with 4 per cent of the population, the conditional SRB has been found to be higher in urban areas than in rural areas. In other words, 41 per cent of the country's population live in areas where sex selection is prevalent and presumably increasing.

The medium projection, which seems to provide the most plausible level, gives an estimate of overall SRB of 117 boys per 100 girls during the 2021–2026 period. This is the peak level that would be attained when the country is expected to reach the replacement level of fertility. The major assumption behind this increase, from its recent level of 109 (1991–2005) is that the prevalence of sex selection at second-order birth among those with one daughter would rise. As a result of this increase, the proportion of female births in this group would reduce from 47 per cent to 43 per cent. In other words, the conditional sex ratio at second-order birth in the country would increase from 113 to 133. There exist several alternative scenarios for the increase in sex selection in the two regions, namely, the Northwest and the Southeast, resulting in an increase in the conditional SRB at second

birth at the national level. The conditional SRB at second birth for the country would become 133 if, for example, its level increases to 163 (from the current 133) in the Northwest while remaining at the normal level of 105 in the other areas. It is also possible with a lower level of 150 in the Northwest if the ratio also increases slightly to 116 in the other areas. It is felt that the first alternative presents a scenario that is more likely to happen.

The northwestern region includes three populous states with high levels of fertility, namely, Uttar Pradesh, Madhya Pradesh and Rajasthan, which, together, comprise 61 per cent of the region's population. As their fertility declines, the pressure on sex selection will increase further. Out of two types of preferences, namely, family size preference and sex preference, the need for sex selection arises mainly when one wants to accommodate children of a preferred sex within a small family size norm of two children. In other words, those not having a small family norm are not likely to resort to sex selection because they can wait till their preferred sex composition of children is achieved. For example, the chance of not having a son within the first two birth orders, with a normal SRB of 105, is 24 per cent, but it decreases steadily as the number of children increases. After all, sex selection entails a cost. Apart from economic and health costs, one has to go against the law that prohibits sex-selective abortion.[5] Overall, though, it can be expected that as fertility declines and more and more people adhere to the two-child family norm, the incidence of sex selection would increase in these three states. An indication of sex selection can already be observed in Uttar Pradesh and Rajasthan. Another state in this region, Gujarat, is also known to be prone to sex selection, although in the present analysis, no statistical evidence for this could be found.

In the projection, the value of SRB among women of parity 4 and above (SRB_{4+}) is kept at 90. It is possible that when replacement-level fertility is reached, son preference will decline considerably. Hence, among the small proportion that proceeds to have four or more children, the SRB will tend to increase to its normal level. If this happens, the projected SRB of 117 would be an underestimate. While this is possible, the effect of underestimation in SRB_{4+} on the overall level of SRB would be marginal. The size of this group, i.e. the proportion with four or more children, in the projection is 14 per cent. Moreover, it consists mainly of women having a disproportionately large number of daughters who continue reproduction in order to have sons. Hence, if son preference declines, the size of this group would reduce substantially. So, the sensitivity of the assumption on SRB_{4+} is expected to be marginal; at most, the assumption could mean that the peak value of SRB will be in the range of 117 to 119.

The achievement of the peak value of SRB is linked with the accomplishment of replacement-level fertility. If the realisation of replacement-level fertility is delayed, the time at which the peak is attained will also get shifted accordingly. Initially, as fertility declines, the distribution of women by parity shifts towards lower parity and the proportion stopping at two children increases. Due to conditional sex selection at second birth, the SRB will have an upward trend. After the two-child family is attained, if fertility declines further, a gradual decline will start in the proportion having two children with a consequent increase in the frequency of women at lower parity (women of parity 0 or 1). Since no sex selection is assumed in the first parity, the increment in SRB will stop and it will tend to decline. Whether the SRB will have a peak or continue to rise depends on two factors. One is the shape of the fertility curve beyond the replacement level, and the other is the possibility of sex selection occurring among those who decide to have only one

child. The possibility of sex selection among those who decide to have one child can have a tremendous influence on SRB. It can cause the SRB to continue to increase and to do so rapidly. Unfortunately, with the available data, further research on this was not possible.

On the question of whether fertility will be well below the replacement level in India, as has been witnessed in many countries, particularly in the developed region, is something that also requires further research. The available evidence suggests that this is not likely to happen in the near future. At least two states, namely, Kerala and Tamil Nadu, in the southern part of the country have reached replacement-level fertility almost 20 years ago. However, instead of continuing to decline, the level of fertility has more or less stabilised at around a value of two children or slightly lower than that. As has been observed, in the present analysis, the parity progression among those with only one son is substantially high, even among the educated women in the country. This means there exists a strong preference for having at least two children. It is difficult to say whether this points towards a preference of having one son and one daughter. Further research is needed to confirm this. However, one finding is worth mentioning in this regard. The propensity to stop childbearing at two among the educated women with one son and one daughter is similar to those having two sons in the southeastern region, where the extent of son preference is less. If one gets one son and one daughter, one is satisfied with both the family size as well as the sex composition of children. In the process, if one gets two sons, that is also equally satisfying, but a higher proportion disregards the family size norm in the event that the sex composition happens to be two daughters. Hence, even if replacement-level fertility is reached at around the 2021–2026 period, it would take some further time for fertility to decline to well below the replacement level. It seems likely that the level of SRB of 117–119 will remain as a peak for a while.

NOTES

1. The *Women's Reservation Bill*, ensuring 33 per cent reservation to women in Parliament and state legislative bodies, was passed in the Council of States in March 2010. The supporters of the bill stated that increased political participation of women would help them fight the abuse, discrimination and inequality to which they are subject.
2. Except the states of Jammu and Kashmir, all major states were included in the study. The data collection in NFHS 1 (1992–1993) was not held in Jammu and Kashmir. In this study, we considered an undivided Uttar Pradesh (now Uttar Pradesh and Uttaranchal), Madhya Pradesh (now divided into Madhya Pradesh and Chhattisgarh) and an undivided Bihar (inclusive of Jharkhand). States in the northwestern region include Gujarat, Haryana, Himachal Pradesh, Maharashtra, Madhya Pradesh, Rajasthan and Uttar Pradesh, while the southeastern region comprises Andhra Pradesh, Assam, Bihar, Karnataka, Kerala, Odisha, Tamil Nadu and West Bengal.
3. 'Caste', in India, is an endogamous group, where the status of an individual with reference to the group is determined by his or her birth. The four-fold classification of *Varna*, namely, Brahmin, Kshatriya, Vaishyas and Shudras, provided a traditional way of grouping the castes in terms of hierarchy, with Brahmins at the top and Shudras at the bottom. After independence, the categories of 'scheduled castes' (SCs) and 'scheduled tribes' (STs) were created under the provisions of the constitution, followed by the creation of 'other backward classes (OBCs)' in order to extend the state benefits to the SCs, STs and OBCs (Bhagat 2011).

4. The present estimation of SRB is based on cohort parity progression ratios. The Sample Registration System, on the other hand, provides estimates based on annual births. As fertility declines, the period rates are likely to be slightly higher than the cohort rates.
5. A cursory attempt was made to check whether sex selection was likely to prevail only among those with a small family size norm, and not among those who preferred a larger family size. Towards this end, we obtained the proportion of those having girls for their first two births among those with an ideal family size of: (a) two children; and (b) more than two children. Interestingly, in the northwestern region, for the period 1991–2005, it is found to be 22 per cent and 24 per cent, respectively, for the two groups. That is, for women with a family size norm of two children, the proportion having girls as their first two births is significantly (statistically) lower than the expected level of 24 per cent in the recent period. For the southeastern region, the proportion of women having girls for their first two births conforms to the theoretical expectation of 24 per cent, irrespective of their ideal family size.

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