GENDER BIAS IN SEX RATIO AT BIRTH: THE CASE OF INDIA

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Gender Bias in Sex Ratio at Birth:
The Case of India[*]

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Abstract

A deeply-rooted preference for sons may decrease the relative number of female births. Though there are variables that may help to erode the couple's preference for sons, these same variables may also increase the availability of means to ensure male births. This is the case of educational achievements. It is not difficult to assume, for example, that a higher level of education helps to erode the couple's preference for sons. However, the effect of an increase in education on female disadvantage at birth is not so straightforward. More education may increase the couple's awareness of the possibility of using prenatal sex detection. We discuss the issue throughout the paper by developing an empirical framework for the case of India.

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1 Introduction.

A growing body of literature brings to light the issue of gender bias in mortality. By estimating the additional number of females of all ages that would be alive in the absence of gender inequality - and naming them the 'missing women' - Amartya Sen (1990) calculates the cumulative impact of gender bias in mortality. In this way he shows how an alarmingly high number of women are missing as a consequence of gender inequality. As an example, the missing women number over 100 million in South Asia, West Asia, and North Africa (see Coale, 1991; Klasen and Wink, 2003, for some refinements in these calculations).

Moreover, in a large part of the world, the number of missing women is increasing dramatically. This situation is clearly illustrated by the downward trend in their sex ratio - the number of females divided by the number of males -. Studies of this downward trend have been carried out for several different countries, such as India (see Bhat, 2002a, 2002b; Dyson and Moore, 1983; Mukerjee, 1976), China (see Junhong, 2001), Korea (see Kim, 2005), Bangladesh (see D'Sourza and Chen, 1980).

This paper is focuses on the case of India, and on the 'sex ratio at birth (SRB)'. In India, the sex ratio of the total population has been steadily decreasing since the last century, as reported in the appendix (figure 1). This is also the case of the sex ratio of the child population. We refer to Mukherjee (1976) for an analysis of the downward trend of the first part of the century. The trend from 1961 to 2001 is displayed in the appendix (figure 2). All the results shown in the appendix are calculated from the provisional 2001 census of India (Government of India, 2001).

A deep-rooted preference for males is thought to be the main reason for gender bias in the sex ratio, and the sex ratio at birth in particular (see Ben-Porath and Welch, 1976; Kim, 2005). Hence, the paper begins by presenting, in section 2, the issue of the process by which parents develop their preferences with respect to the sex of their unborn children. The assumptions of the preference formation process are tested in section three using data from the 1991 Census of India at district level (Government of India, 1991, 1997, 1998, 2003). The last section presents the conclusions.

2 Preferences and autonomy.

Before exploring the effects of preference for sons, we consider the notion of 'autonomy to prefer'. This is seen as a person's ability to develop the same values that she would develop in a context where freedoms are fully guaranteed. A couple may develop a preference for sons due to a historic background of female disadvantage. These people are hardly able to attach the same value to every human life, as would be the case in an alternative context of equality. People unconsciously suppress certain potential values.

The notion of autonomy to prefer - although connected - differs from that of 'autonomy to act'. Autonomy to act is related to a person's fulfilment of her preferences. This notion is very close to the general notion of 'freedom of choice' (see Pattanaik and Xu, 1990, and literature following their seminal work). People's achievements do not fully match their preferences when they lack the instruments that would enable them to act in accordance. A couple with a preference for sons may not satisfy this preference (may have a daughter) if the technology that would enable them to ensure the sex of their future child is unavailable. Given an expansion of their freedom of choice, the couple would ensure the sex of their child. In other words, the couple may gain in their autonomy to act without experiencing any variation in their autonomy to prefer.

In a context of substantial gender differences in the autonomy to act, virtually everybody is restricted in their autonomy to prefer. A growing body of literature supports that autonomy to prefer is restricted to those who suffer disadvantage. In order to avoid suffering from the inability to fulfil a desire, people may unintentionally suppress it. Elster (1982) uses Aesop's well-known fable to illustrate the mental adaptation of humans (the process known as 'adaptive preference formation'). That is, when the fox realises it is unable to reach the bunch of ripe grapes; it tells itself that they are sour. Nussbaum (2000) illustrates the case of women's mental adaptation in contexts of gender inequality. In her words, a woman suffering disadvantage may lose "the concept of herself as a person with rights"(Nussbaum 2000: 113).

At the same time, the context of extreme gender inequality (of action) may also constrain autonomy to prefer for those who take advantage of inequality. People are more likely to develop a preference for sons in this kind of context that in contexts where freedoms are fully guaranteed. Koopmans (1964) and Kreps (1979) put forward the idea of preference for flexibility. That is, when people's present choices affect their future options, they prefer whatever current options will extend the set of future options. A child's sex plays a significant role in defining the family's future options in a context of inequality (see Dyson and Moore, 1983; Srinivasan, 2005).

There are kinship structures (dowry system, women moving away from their parents' home at marriage) in which the daughters of the family entail a higher future cost than sons do. The dowry system, for example, consists of the payment of revenue by families in order to have their daughters (not their sons) married. If they have to pay a dowry, an already poor family may be pushed into dire poverty. Although this kinship structure is now illegal in India, dowry practices continue to survive. In a recent study of India, Srinivasan (2005) highlights the importance of dowry practices in defining the family's future options. Hence, the presence of a very deeply rooted preference for males is a plausible assumption in our case study.

2.1 Effects of preference for sons.

A deeply rooted preference for males is thought as one of the main reasons for gender bias in mortality. Certainly, it is difficult to accept that parents deliberately act against their daughters. This perspective is maintained by the Government of India (1981), among other authors. They insist on there being "little evidence to support the view that there is a deliberate neglect of female babies despite the fact that there may be a preference for male children".

On the other hand, there exists evidence to show that sons are better provided for in the distribution of scarce resources than daughters are, at least in dire living conditions (see Murthi, Guio and Drèze, 1995; Rosenzweig and Schultz, 1982; Sen and Sengupta, 1983). Sen and Sengupta (1983), for example, find that the enhancement of general living conditions barely enlarges the capabilities of girls in times of disaster. They set their framework in two villages in West Bengal. These villages were selected because one of them had undergone land reform, while the other had not. Land property tends to be decentralised after reform, which leads to the enhancement of average family living conditions. After conducting a nutritional survey on children up to five, they conclude the following: while malnutrition is high in both villages, it is in fact higher in the one that has not undergone land reform. Moreover, it is also the case that improvements in child nutrition patterns are associated with higher gender inequality. While general improvements enhance nutrition patterns in boys, they hardly do so at all in the case of girls.

Another context in which to examine the (possible) satisfaction of the preference for sons is at birth. In societies in which sex selection is not practised, the distribution of SRB is relatively constant for the country as a whole. This was the assumption reached in some general studies on demographic outcomes, such as Becker (1960) and Trivers and Willard (1973). Later on, advances in prenatal sex determination transformed the scenario. The expansion of prenatal sex determination now enables families to choose the sex of their new child by practising abortion when the foetus is not of the desired sex. When sex preferences matter, some biases arise in the reported SRB, as in the case of India.

Instead of a relatively constant overall distribution of SRB, certain patterns emerge. The estimated SRB in areas of north-west India is lower than in the rest of India, as illustrated by the maps that appear in the appendix (figures 3 and 4). Maps in figures 3 and 4 correspond to urban and rural areas, respectively. Data from the 1991 Census of India are used in the estimates.

Although the 1991 Census of India does not provide SRB data at district level, it is possible to calculate it from the data actually released. The Government of India (1991), in the Primary Census Abstract (PCA) for 1991, supplies the available data for the population aged 0-6 by gender. Furthermore, the Government of India (1997) uses data from the 1991 census to estimate child mortality by gender at different ages. Estimates are based on the South Asian model life and modified via the Brass procedure. Partially guided by that report, we estimate SRB using a reverse survival technique. Similar estimates of sex ratio at birth are provided in Bhat (2002b) and Sudha and Irudaya Rajan (1998). Our calculations are displayed in the appendix (Calculations 1).

All in all, comparing figures 3 and 4, the basic patterns are largely similar. They portray higher female disadvantage for districts in Northwest India, which is consistent with earlier studies. For example, Dyson and Moore (1983) identifies northern and western districts (in Gujarat, Hymachal Pradesh, Rajasthan, Uttar Pradesh, Madhya Pradesh, Punjab and Haryana) as registering high gender bias in mortality.

At the same time, we notice that fewer women are born in urban areas than in rural ones. Certainly, urban areas currently have better access to modern medical techniques. Since Sudha and Rajan (1998) documented an expansion in the availability and use of prenatal sex determination and abortion technology in rural areas, the patterns in rural areas may be strengthened. This would occur under continuing extreme gender inequality, and hence, persistent preference for sons. In any case, the existence of patterns showing bias in mortality at birth makes us aware that son preference exists and put into practice.

In the next section we develop an empirical framework where we test the relationship between gender differences in terms of autonomy to act and bias in SRB. As discussed, it is expected that preference for sons is very deeply rooted in those districts where gender differences in autonomy to act are greater. Hence, we will hardly be surprised to find a negative relationship between the degree of inequality (in terms of autonomy to act) and the number of female births (conditional to the number of male births).

At the same time, we test to see how enlarging autonomy to act affects bias in SRB. In this case, the increment in autonomy to act is expected to decrease SRB in those districts where there is a very deeply rooted preference for sons. However, we expect the opposite effect from an increment in autonomy to prefer. An increment in autonomy to prefer is expected to erode preference for sons and then increase SRB.

3 An empirical framework.

Proceeding with this research, we now test the relationship between inequality in terms of autonomy to act and gender bias in mortality. At the risk of oversimplifying the issue, and for identification purposes, we assume this relationship to be linear. For modelling purposes, first consider the following notation,

i the district,

SRB_i the number of female births divided by the number of male births in i,

X_i the vector of variables describing gender differences in autonomy to act in i,

Y_i the vector of variables capturing the degree in autonomy to act in i.

Then, we specify the relationships among variables by using a linear regression model as follows,

$$SRB_i = \beta_0 + X_i\beta_1 + Y_i\beta_2 + \epsilon_i \tag{1}$$

where ϵ_i is the random disturbance.

Throughout the section we estimate the coefficients of the regression. Moreover, we regress two versions of the econometric model displayed in equation 1, one a reduced model, the other an extended model. In the reduced form, a measure of gender differences in access to 'independent income opportunities (IIOD)' is used as proxy for gender differences in autonomy to act. In this model, an 'index of the wealth of the region (W)' is also added as proxy for district-varying explanatory features capturing autonomy to act. Indeed, wealth helps individuals to match desires and achievements. Formally, the reduced model is written as:

$$SRB_i = \beta_0^{'} + \beta_1^{'}IIOD_i + \beta_2^{'}W_i + \epsilon_i^{'} \tag{2}$$

The extended model also accounts for the effect of 'educational achievements (E)' in the district, for the effect of variables referred to the 'presence of scheduled castes (SC)', and for the effect of access to 'medical services (MS)'. Formally,

The extended model is written as:

$$SRB_i = \beta_0^{''} + \beta_1^{''} IIOD_i + \beta_2^{''} W_i + \beta_3^{''} E_i + \beta_4^{''} SC_i + \beta_5^{''} MS_i + \epsilon_i^{''} \quad (3)$$

Medical services are used as proxy for services that could enable people to use sex-selective abortion technology, while the presence of scheduled castes indicates the proportion of people with higher access to such facilities. More comments are required for the role of education on explaining bias in SRB. The role of education in explaining bias in SRB requires further comment, because education captures not only a person's degree of autonomy to prefer, but also her autonomy to act.

On the one hand, education increases a person's autonomy to act. The Planning Commission for India (in the introduction of the 10th Five-Year Plan 2002-2007) highlights the importance of education to raise awareness of opportunities. It is recognised that the lack of education among poor people constitutes one of the main obstacles to their making use of income growth, for example. In the same way, lack of education may be a major impediment preventing individuals from making use of, say, sex-selective abortion technology.

On the other hand, education increases a person's degree of autonomy to prefer. Education provides individuals with human skills needed for independence of mind, such as reasoning and judging. It is worth noting that a large body of literature provides evidence to support the fact that increments in education erode preference for males. To give an example, Bhat and Zavier (2003) infer that education reduces son preference after estimating a multivariate regression model based on data from the Indian National Family Health Survey. The theory that daughters receive a greater share of household resources when women's opportunities are greater also finds support in the empirical results of Murthi et al. (1995).

Hence, the effect captured by parameter $\beta_3^{''}$ accounts for the effect of education on autonomy to act - and autonomy to act on SRB - and for the effect of education on autonomy to prefer - and autonomy to prefer on SRB. Once again, there are powerful reasons to believe that these two effects work in opposite directions. While an increment in autonomy to prefer is expected to erode preference for sons and then increase SRB, an increment of autonomy to act is expected to decrease SRB in the presence of preference for sons.

All in all, as noted earlier, the key issue of identification concerns the relationship between gender differences in terms of autonomy to act and gender bias in SRB. The relationship is captured by parameter β_1 in equation 1. This is done by parameters $\beta_1^{'}$ and $\beta_1^{''}$ in equations 2 and 3, respectively. The positive sign of the parameter identifies a negative relationship between the degree of gender differences in autonomy to act and the number of female births (conditional to the number of male births).

3.1 Data set and sample

The data set at district level is compiled from reports based on Indian Censuses, and referred to year 1991 (Government of India 1991, 1998, 2003). This releases information of educational achievements, labour opportunities, and other specific information about availability of resources in the districts (such as access to medical services) or other demographic features (such as the distribution of social groups).

At the same time, we focus on a sample of 333 districts for which the required information is available. Some features of the sample are listed in what follows. According to demographic studies, the expected SRB is about 950 female births per 1.000 male births (see Johansson and Nygren, 1991; Visaria 1971, among others). In 173 out of the 333 districts in the sample, the SRB takes values below .950. Furthermore, one hundred districts take values below .935. That is, a large number of the districts in the sample display gender bias in their reported SRB.

As far as the features of the population in the sample are concerned, 28 percent of the whole population are reported as having independent income opportunities, 89 percent of them are males. Regarding the educational achievements, education is extended to sixty percent of the population. Males account for sixty percent of educated people. Furthermore, in all of the districts, both the number of educated males to the total of male population and the number of males having independent income opportunities to the total of male population surpass the corresponding numbers for females.

3.2 Definition of the variables

As already noted, our dependent variable - the SRB - is estimated using a reverse survival technique based on the South Asian model life and modified via the Brass procedure. Calculations are made from the 1991 data (Government of India 1991, 1997). Our calculations are displayed in the appendix (Calculations 1).

The index for gender differences in access to independent income opportunities is defined by the difference between the ratio of female main workers to the total female population minus the same ratio for males. The calculations are based on data from Government of India (1991). Main workers are defined in the census as those engaged in paid employment for a minimum of 183 days a year. Unpaid employment, such as slavery, is not considered to be main work. Hence, the main worker variable can be considered an adequate approximation of independent income opportunities.

In order to capture district wealth, we use the wealth index, defined on the interval [0,1], and drawn from Government of India (2003). Their calculations are based on the data from the 50^{th} round of National Sample Survey Organisation's survey on household expenditure and income. Our main reason for using this wealth index is that, as far as we are aware, for 1991 at least, the Government of India has released no standard index data, such as GDP, at the district level.

As far as educational achievements are concerned, we focus on literacy standards. For societies with universal literacy, education is better represented by an elaborated educational index, such as the measure of progress toward universal primary education. As noted earlier, however, this is the case of our sample. Therefore, the literacy rate is an adequate proxy for educational achievements in our case study. Furthermore, literacy rates are calculated as the ratio of literate population to the total population. The calculations are based on data from Government of India (1991), where a person is assumed to be literate if she is aged seven years or more and can both read and write with understanding in any language.

In the case of other districts level data, it is worth noting the following. The ratio of the scheduled castes to the total population is compiled from Government of India (1991), where no-one professing a religion other than Hinduism, Sikhism or Buddhism is deemed to belong to scheduled castes. Regarding access to medical services, data on the proportion of villages with some form of medical facility is compiled from Government of India (1998). Basic statistics of these variables are displayed in the appendix (table 1).

3.3 Econometric methodology

The estimation of the parameters in the reduced and extended models (equation 2 and equation 3) raises some econometric issues. The Ordinary Least Squares (OLS) method provides efficient estimates of parameters when disturbances are normally distributed. The normality assumption is violated, however, because no relationship among variables is captured in the course of the regression. In our study case, there are reasons to suspect that gender bias in mortality is strongly associated with geographical location. On earlier maps, geographically adjacent values tend to be similar.

There are several different procedures to cope with spatial correlation bias. One of them consists in introducing dummy variables for each State. Such a model is estimated by the OLS method. When the model includes a large dummy variable set, an alternative method is to define a categorical variable and estimate the model by a fixed-effects method. We estimate the reduced and extended models using State as the categorical method. The OLS and fixed-effects estimates are displayed in the appendix (table 2).

At the same time, spatial dependence can also be captured by including a variable created by combining the SRB vector and a geographic connectivity matrix. Elements of the matrix capture spatial dependence among districts. The variable is named 'spatially lagged SRB (SLSRB)' throughout the paper because its corresponding parameter in the ordinary regression captures spatially-lagged SRB (see Berik and Bilginsoy, 2005). Following this procedure, the OLS estimates of the reduced and extended models are displayed in the appendix (table 2, columns 3 and 6).

Violation of the normality assumption may also be due to heteroskedasticity. Disturbances are heteroskedastic when they have different variances. To check disturbances for heteroskedasticity, we apply White's general test, the results of which are shown in the appendix (table 2). The hypothesis of homoskedasticity cannot be rejected on the basis of these results.

Before estimating the parameters of the regression model, the sample is checked for outliers by applying Hadi's method to measure the distance from each observation to a cluster of points. This identifies Nellore, one of the districts in Andhara Pradesh, as the only outlier. Removal of this district from our sample does not alter the parameter values, though their significance is strengthened. At the same time, for a more complete test of robustness, we compare the coefficients of the reduced and extended models. This comparison yields no variation in the sign and significance of the key parameters. Furthermore, there is no statistical variation in the dimension of the parameters. Hence, our results can be considered robust.

3.4 Main econometric results.

As formerly noted, we are interested in estimating the sign of the relationship between autonomy to act and gender bias in SRB, identified by parameter β_1. We refer comments to parameter β_1, rather than to parameters $\beta_1^{'}$ and $\beta_1^{''}$ separately, because there are no statistical differences between their estimates. Furthermore, there are no statistical differences in sign, size and significance between OLS estimates and fixed-effect estimates.

All the estimates of parameter parameter β_1 are significantly different from zero, taking values that are above zero. The result shows a negative relationship between gender inequality (in terms of autonomy to act) and the number of female births (conditional to the number of male births). In particular, preference for sons appears to be strengthened by gender inequality in autonomy to act. Fewer female births occur in areas with scarcer independent income opportunities for females. Our result is consistent with studies on the relationship between females' labour opportunities and child survival bias (see Berik and Bilginsoy, 2005; Rosenzweig and Schultz, 1982, among others).

At the same time, we examine the effect of the degree of autonomy to act in an attempt to explain bias in the SRB. Inter district variations in autonomy to act across districts are captured in the model by variables such as district wealth. The negative value of estimates capturing the effect of wealth in explaining bias in SRB reveals a negative relationship between wealth and the number of female births. The result is corroborated in the extended model.

As far as education concerns, it is worth noting the following. The estimates shows a negative relationship between educational achievements and SRB. The result evidences that the decline in female births due to awareness of new technology is greater than the increment in female births caused by a weakening of son preference. This strengthens our belief of there being a very deep-rooted preference for sons, which counteracts the (possible) positive effect of education on female survival.

An additional point of interest is the study of the effect of the enhancement of mothers' living conditions, especially as far as maternal health is concerned. Improvements in maternal health not only reduce maternal mortality, but also reduce the probability of an additional child dying at birth. Human Geography generally assumes that the probability of death at birth is higher in males than in females, therefore improvements in maternal health may raise the proportion of male births (see Bhat, 2002b; Trivers and Willard, 1973, among others). This may be used to justify the reduction in the SRB. However, it is hardly possible that (in the absence of gender bias at birth) increased maternal health brings SRB below 950 female births (per 1,000 male births). This is in fact the commonly accepted ratio in the absence of female disadvantage (see Visaria, 1971).

Finally, geography is fundamental as evidenced by the statistical significance of the parameters associated with the regional dummy variables. The close relationship among districts within the same State may conceivably be due to cultural features and factors relating to the expansion of rights (see Dyson and Moore, 1983). However, data to capture these features at district level are not available at present.

4 A remark.

Throughout the paper, we examine the effect of preference for sons on the relation of female births to male births. We prove that increasing women's opportunities (conditional to men's opportunities) increases the relative number of female births. Furthermore, we guess that female disadvantage will decrease as people gain more autonomy to prefer. Analysis of the central issue of autonomy to prefer will be facilitated by the availability of gender-desegregated data on the guarantee of entitlement over resources and rights, for instance. At present, we can only test our hypothesis against the experience of those regions of the world where raising a son or a daughter makes little difference to the family's future options. It is quite interesting to note that, currently, more girls (per 1.000 boys) are born in those regions of the world where a child's sex is not a strong determinant of the family's future options than in those societies where it has a determining effect.

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Appendix.

Table.1. Basic statistics.

Variables	Mean	Min	Max
Sex Rate at Birth (SRB) (females/males)	.944	.826	1.05
Differences in terms of Independent Income Opportunities (IIOD) (females minus males)	-.392	-.523	-.244
Wealth (W)	.518	0	1
Educational Achievements (E)	1.155	.669	1.699
Scheduled Castes (SC)	.123	.024	.322
Medical Services (MS)	.393	.035	1
Spatially Lagged Sex Rate at Birth (SRB)	.942	.868	.985

Table.2. Basic Results of a Cross-section Analysis of the Determinants of Sex Rate at Birth (SRB) in Urban Indian Districts (1991).

Independent Variables	1	2	3	4	5	6
IIPD	.079	.079	.051	.085	.085	.058
	(.029)**	(.029)**	(.021)*	(.030)**	(.030)**	(.021)**
W	-.019	-.019	-.012	-.020	-.020	-.012
	(.007)**	(.007)**	(.005)*	(.007)**	(.007)**	(.005)*
E				-.018	-.018	-.009
				(.009)*	(.009)*	(.005)
SC				-.059	-.059	-.056
				(.027)*	(.027)*	(.023)*
MS				-.013	-.013	-.003
				(.006)*	(.006)*	(.003)
constant	.921	.985	1.000	.964	.997	.173
	(.013)**	(.011)**	(.059)	(.022)**	(.015)**	(.066)**
SLSRB			.923			.868
			(.058)**			(.064)**
F-test(P-value)	.0000	.0008	.0000	.0000	.0003	.0000
White(P-value)	.915		.49	.996		.98
R sq	.57	.57	.56	.59	.59	.58
Sample size	333	333	333	333	333	333

Notes:
1: SRB reduced model estimated by OLS method.
2: SRB reduced model estimated by fix effect method.
3: SRB reduced model estimated by OLS method.
4: SRB extended model estimated by OLS method.
5: SRB extended model estimated by fix effect method.
6: SRB extended model estimated by OLS method.
1 and 4: Includes country dummies, but not reported. Almost all of them are statistically significant at .01 level.

Robust standard errors in brackets.
**Significant at .01 percent level. * Significant at .05 percent level.

Figure Legends

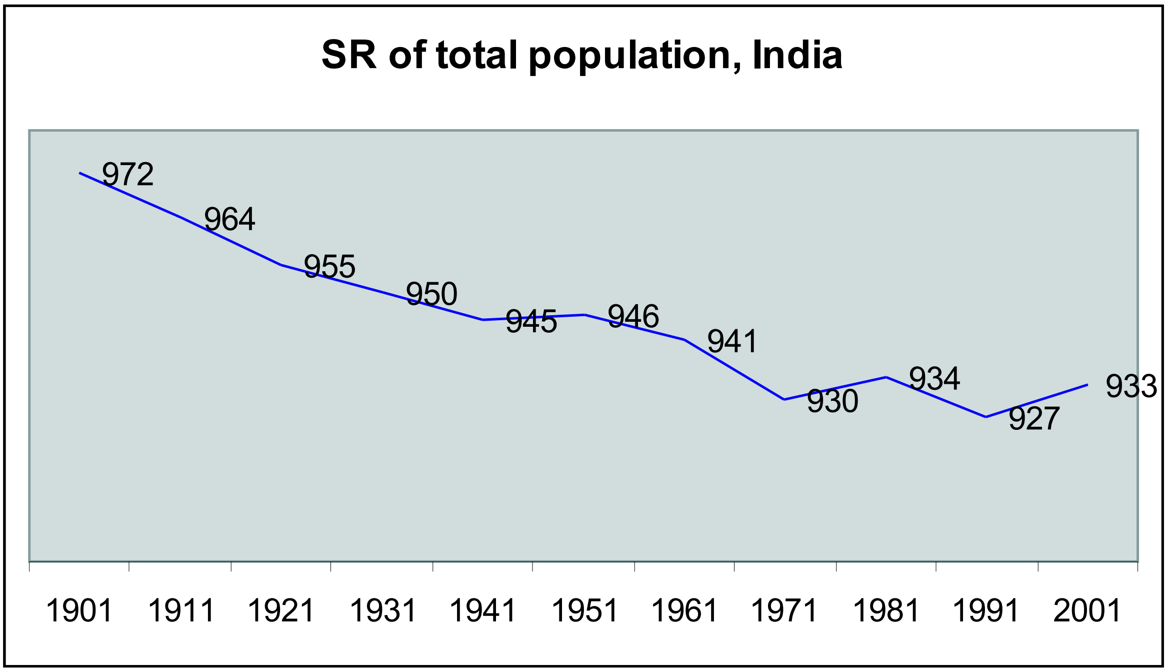
Figure 1.: Sex Ratio of total population is calculated as the ratio of female population to male population.

Figure 2.: Sex Ratio of total population is calculated as the ratio of female population to male population. Sex Ratio of child population is calculated as the ratio of female population in age group 0-6 to male population in age group 0-6.

Figure 3.: Values are labeled as follows: Female Advantage if values of estimated SRB are higher than 950 female born per 1,000 male born; and Female Disadvantage if values are lower than this. Beyond this, we consider Female Advantage to be high if this figure is above 970 and Female Disadvantage to be high if the figure is below 935. Values for the divisions come from Visaria (1971)'s study of the common values assumed in demographic studies.

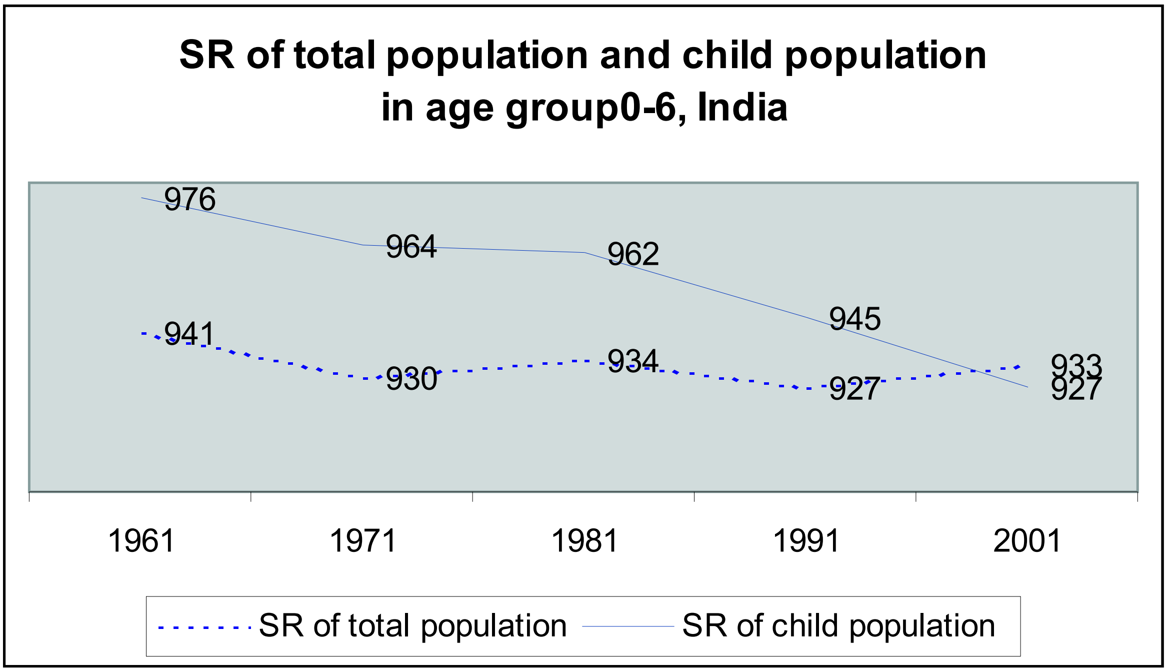
Figure 4.: Values are labelled as follows: Female Advantage if values of estimated SRB are higher than 950 female born per 1,000 male born; and Female Disadvantage if values are lower than this. Beyond this, we consider Female Advantage to be high if this figure is above 970 and Female Disadvantage to be high if the figure is below 935. Values for the divisions come from Visaria (1971)'s study of the common values assumed in demographic studies.

Figure 1.:



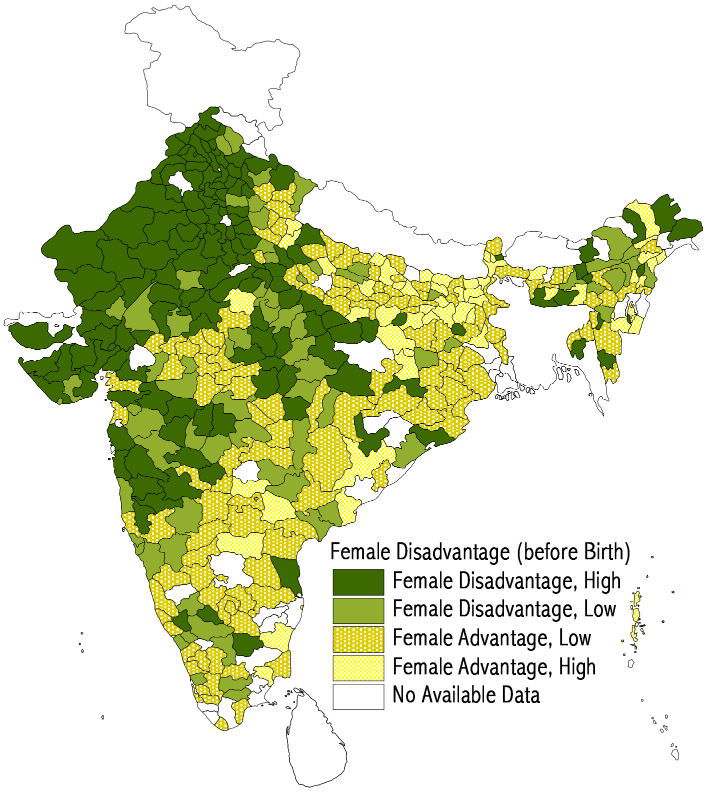
Source: Government of India (2001).

Figure 2.:



Source: Government of India (2001).

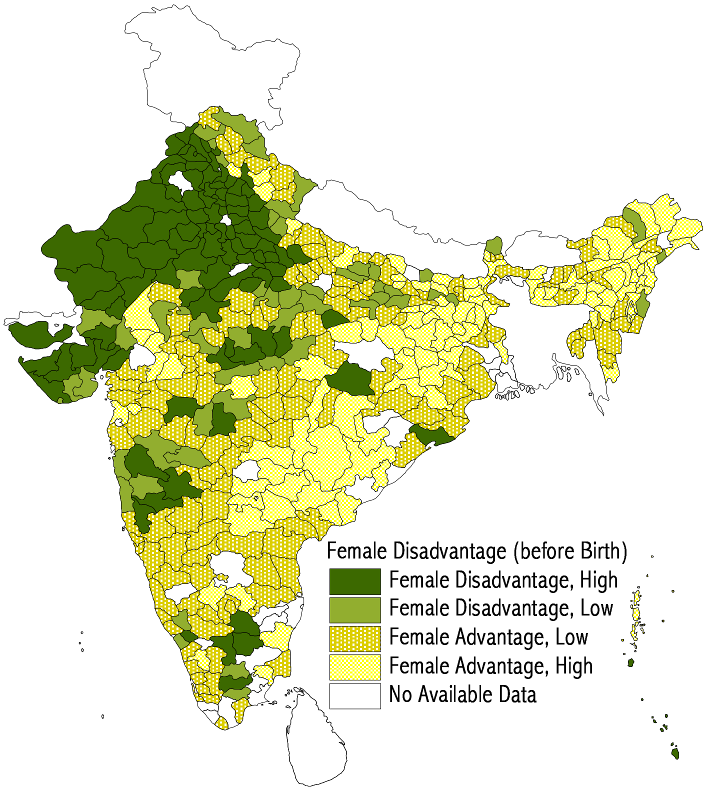
Figure 3.: Estimated Female Disadvantage at Birth, (Urban), 1991 [1]



Source: Own elaboration from the data given in the PCA of 1991 Census of India.

[1] Values are labelled as follows: Female Advantage if values of estimated SRB are higher than 950 female born per 1,000 male born; and Female Disadvantage if values are lower than this. Beyond this, we consider Female Advantage to be high if this figure is above 970 and Female Disadvantage to be high if the figure is below 935. Values for the divisions come from Visaria (1971)'s study of the common values assumed in demographic studies.

Figure 4.: Estimated Female Disadvantage at Birth, (Rural), 1991[2]



Source: Own elaboration from the data given in the PCA of 1991 Census of India.

[2]See figure 2 for an explanation of the value labels.

Calculations 1

First, consider the next notation and definitions,

F_i the total of female survivors to recorded female births i years ago,

M_i denotes total male survivors to recorded male births i years ago,

q_k^f the probability of dying from birth to the age k for females and, hence, q_{k+1}^f is the probability of dying from birth to the end of the considered period,

q_k^m this probability for males,

B^f the annual average of female births,

B^m the same average for males,

Definition 1:

The SR of child population in the age group (0-6), denoted SR(0-6), is given by,

$$SR(0-6) = \frac{F_0 + F_1 + F_2 + F_3 + F_4 + F_5 + F_6}{M_0 + M_1 + M_2 + M_3 + M_4 + M_5 + M_6} \quad (4)$$

The ratio is based on the fact that population in the 0-6 age-group are the survivors from the births recorded during the current and the last six years.

Definition 2:

The SR at birth, denoted SRB, is given by,

$$SRB = \frac{B^f}{B^m} \quad (5)$$

This is the number of recorded female births divided by the number of recorded male births.

Our calculations to estimate the SRB from data released by Government of India (1991) are derived as follows. The survivors of female births recorded i years ago are expressed as,

$$F_i = B^f - B^f q_{i+1}^f = B^f(1 - q_{i+1}^f) \quad (6)$$

In the same way, the survivors of male births recorded i years ago are given by,

$$M_i = B^m - B^m q_{i+1}^m = B^m(1 - q_{i+1}^m) \quad (7)$$

Then, the sex ratio of equation 1 can be expressed as a sum of the survivors of the births recorded during the current and the last six years. Formally,

$$SR(0-6) = \frac{B^f[(7 - \sum_{i=0}^{i=6} q_{i+1}^f)]}{B^m[(7 - \sum_{i=0}^{i=6} q_{i+1}^m)]} \tag{8}$$

From equations (2) and (5), we obtain the estimator of SRB as,

$$\widehat{SRB} = SR(0-6)\frac{7 - \sum_{i=0}^{i=6} q_{i+1}^m}{7 - \sum_{i=0}^{i=6} q_{i+1}^f} \tag{9}$$

For the calculations it is worth noting the next. The Government of India (1997) only releases q_1, q_2, q_3, q_5, separately for females and males. For simplicity, we assume that mortality ratios are the same at ages three and four and at ages five, six and seven. However, alternative interpolations offer similar results.