Oxford Review of Economic Policy, Volume 23, Number 2, 2007, pp.221–238

India's missing girls: biology, customs, and economic development

V. Bhaskar* and Bishnupriya Gupta**

Abstract We review the evidence on the sex ratio among children below the age of six. International evidence shows that the sex ratio at birth is slightly biased towards boys, but boys suffer greater mortality, a pattern consistent with Darwinian evolution. With economic development, the male bias in the child sex ratio increases. South and East India show levels and trends in the child sex ratio that are consistent with this evidence. However, unbalanced sex ratios in the northern and western states since the first censuses indicate discrimination against girls. Technological developments permitting sex-selective abortions have seriously aggravated the imbalances in these states. Economic modelling of parental choice regarding a child's gender suggests that gender imbalances may be consistent with individual maximization and marriage-market equilibrium. Nevertheless, these choices have adverse welfare consequences, which will be aggravated by the decline in population growth and consequent relaxation of the 'marriage squeeze'.

Key words: child sex ratio, gender discrimination, selective abortions, marriage markets

JEL classification: J12, J13, J16

> 'Eat gur, spin your thread,
> We don't want you, but a brother instead.'
> Chant accompanying the infanticide of a girl child in Punjab (quoted in the Census of 1881). Gur (raw sugar), placed in the mouth of the newborn girl, was an effective way of killing her.

I. Introduction

India's 'missing women' have long been a cause for concern, with discussion of the imbalance in the sex ratio in parts of North India and present day Pakistan dating back to the first censuses. More recently, Amartya Sen (1992) has highlighted the issue, with Coale (1991) and Klasen and Wink (2002) providing refined estimates of the precise numbers involved. Recent technological developments, such as amniocentesis and ultrasound, permit foetal-sex

*University College London, e-mail: v.bhaskar@ucl.ac.uk
**University of Warwick, e-mail: b.gupta@warwick.ac.uk
Thanks to Steve Broadberry, Wendy Carlin, Nick Crafts, and an anonymous referee for very useful comments and to Arpan Roy and Farshad Ardestani for research assistance.
doi: 10.1093/icb/grm016
© The Authors 2007. Published by Oxford University Press.
For permissions please e-mail: journals.permissions@oxfordjournals.org

determination and sex-selective abortions. This has caused much alarm—a recent paper in the *Lancet* (Jha *et al*., 2006), made newspaper headlines with an estimate that over 10m female foetuses have been aborted in India over a 20-year period. This raises important questions for economists, social scientists, and policy-makers. What is the precise nature and magnitude of the imbalance between the sexes? How can such an imbalance persist, given the importance of marriage and reproduction? Indian parents may often have a preference for sons, but surely they also desire grandchildren?

This paper attempts to shed some light on these issues, combining insights from demography, medicine, biology, and economics. Our concern is with the sex ratio in infancy and childhood, and we use this in order to examine the magnitude and implications of gender imbalance. More precisely, our focus in this paper is on the sex ratio (defined as the number of males per 100 females) from birth to 6 years of age—we shall refer to it simply as the child sex ratio (CSR). The narrowness of our focus has two advantages. First, whereas the overall population sex ratio is a complex aggregate that depends on many factors, the natural determinants of the child sex ratio are more limited, allowing us a cleaner analysis. Second, it is this ratio that is liable to be affected by selective abortions, whereas the population sex ratio moves only a little with these new developments.

Before we proceed to a detailed examination of the CSR, it may be useful to summarize some of its main properties, as can be gleaned from the large literature on comparative demography. We defer a detailed empirical justification of these claims to the body of the paper.

(i) The sex ratio at birth is somewhat biased towards boys, with about 103–106 boys per 100 girls being considered normal. However, boys generally have higher infant/child mortality, which leads to a decline in the sex ratio in the early years of childhood.
(ii) With economic development and improvements in health and nutrition, there is a reduction in infant mortality and in stillbirths. This disproportionately helps the weaker sex (boys), so that development is associated with a rise in the sex ratio. So more-affluent societies have a higher CSR, and the ratio also tends to rise with the process of development.

These facts pertain to normal variations in the CSR. The sex ratio also differs from what is normal owing to discrimination and the ill treatment of girls—and, in extreme cases, infanticide—resulting in their greater infant and child mortality. More recently, sex-selective abortions have become possible, allowing further manipulability of the sex ratio. However, in order to assess the magnitude of these discriminatory factors, one needs to have an idea of the sex ratio that would prevail in the absence of discrimination.

Table 1 presents state-wise figures on the CSR in India between the years 1961 and 2001. Let us disregard the figures for 1971, which appear to be somewhat of an outlier. The salient features of this table can be summarized as follows.

(i) There is considerable regional heterogeneity in behaviour of the CSR.
(ii) The states of the South (Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Goa) and the East (Assam, Bihar, Orissa, West Bengal) show ‘normal’ sex ratios, with some tendency to increase, which is consistent with development.
(iii) The states of the North (Punjab, Haryana, Himachal Pradesh, Delhi, Uttar Pradesh) and West (Gujarat, Rajasthan, Maharashtra) show ‘abnormally’ high sex ratios in 1961, as well as significant increases in the recent past. In particular, CSRs in the range 115–25 are clearly extreme and cannot be attributable to normal biological processes.

Table 1: Boys per 100 girls, years 0–6

	1961	1971	1981	1991	2001
South					
Andhra Pradesh	101.9	100.6	100.6	101.6	102.8
Karnataka	102.4	102.1	102.3	104.2	105.7
Kerala	103.9	102.5	102.8	104.4	104.1
Tamil Nadu	102.5	100.9	103.7	105.5	106.2
Goa	102.9	103.7	105.0	103.7	106.7
East					
Assam	103.3	99.5	100.2	102.6	103.6
Bihar	103.9	103.5	101.7	104.2	105.5
Orissa	102.5	97.5	100.3	103.2	105.0
W. Bengal	104.1	97.7	101.4	103.5	104.2
Central					
Madhya Pradesh	105.9	109.3	102.3	105.0	106.1
West					
Maharashtra	104.7	102.4	102.3	105.7	109.5
Gujarat	107.1	106.5	104.9	107.8	113.2
Rajasthan	107.8	107.0	105.0	109.1	110.0
North					
Haryana		111.2	111.2	113.8	122.1
Himachal Pradesh	106.3	101.7	102.7	105.1	111.7
Delhi			111.2	109.3	115.2
Punjab	109.2	111.3	109.9	114.3	125.3
Uttar Pradesh	108.7	108.4	125.9	107.8	109.3
India	105.2	99.8	103.0	105.8	107.8

Source: Indian Censuses, 1961–2001.

The remainder of this paper is organized as follows. Section II reviews the evidence on the sex ratio at birth, infancy, and early childhood from developed economies. The key lessons we draw from this evidence are that the sex ratio at birth and in infancy is slightly biased towards boys, and that with improvements in maternal health and reductions in infant mortality, this bias increases over time. Section III discusses the CSR across Indian states and over time, and possible explanations for gender bias. In section IV we draw on lessons from evolutionary biology in order to explore the implications of the equilibrium sex ratio. In particular, we examine Fisher's (1930) argument on the role of differential infant mortality, which shows that there are sound theoretical reasons why sex ratios are somewhat male biased at birth. Section V discusses economic models of gender bias and the sex ratio, and section VI examines possible reasons why gender bias may have intensified over time in India, including the 'marriage-squeeze' hypothesis. Section VII examines the controversial issue of sex-selective abortions, and critically evaluates estimates of the magnitudes involved. Section VIII concludes.

II. Evidence from developed countries

The sex ratio at birth varies between 105 and 106 boys per 100 girls in most developed economies. The sex ratio at birth depends upon the sex ratio at conception—the primary sex ratio—and sex-specific survival rates of the foetus during gestation (see Chahnazarian (1988), who provides an extensive review of the literature on the sex ratio at birth). There appears to be excess male mortality during the gestation period. With improvements in the nutritional and health status of the mother, there is a decline in excess male mortality, causing a rise in the sex ratio at birth. This suggests that societies with better maternal health/nutrition should have a more male-biased sex ratio at birth. The greater birth rate of boys is partly offset by their higher infant mortality, as compared to girls. These mortality differences appear to have been particularly pronounced before the advent of modern medicine and still prevail in poorer societies. With economic development and medical advances, the consequent decline in infant and child mortality has impinged more on the weaker sex (boys). Consequently, the sex ratio among under-5s has risen with economic development. For example, the sex ratio among under-5s in the year 1900 was 102, in the US population as a whole. At the beginning of the present millennium, this had risen to 105 in the USA (2000 census), and the ratio was the same in the UK (2001 census).

The greater antenatal and infant mortality of boys appears to be offset by greater mortality of girls in childhood. By the age of 5, the female advantage over boys disappears, and is replaced by a disadvantage. The mid-nineteenth-century evidence from England shows that female mortality was higher than male mortality in the age group 10–14 and also in the age group 15–39, the latter reflecting maternal mortality in child-bearing (see McNay *et al*., 2005). Although the excess female mortality disappeared in the age group 20–39 from 1871, it persisted in the age group 10–19 until 1891, and in the age group 5–9 until 1910. Using county-level data from England and Wales, McNay *et al*. find that male advantage was greater in areas where overall mortality was low. Such evidence is consistent with the idea that, with economic development, male mortality declines faster than female mortality.

The hypothesis that economic development raises the sex ratio at birth and in infancy is also supported by broader international evidence in the contemporary period. Klasen and Wink (2002) use a data set of non-African countries between 1984 and 1999 to show that a rise in life expectancy by 10 years causes an 0.9 percentage point higher sex ratio at birth. If the data are pooled for African and non-African countries, then the coefficient on life expectancy rises to 1.6. Klasen and Wink argue that males have higher mortality in infancy, so that the excess of males at birth disappears in the age group 10–20 in a high-mortality environment and by age 50 in a low-mortality environment.

The implications of this international evidence for India are as follows. First, one should expect the child sex ratio to increase over time with development, reflecting a higher sex ratio at birth and reduced male infant mortality. Second, one might expect higher sex ratios in regions or communities with lower infant mortality and higher life expectancy, as compared to poorer or more disadvantaged communities. In other words, one must be cautious in interpreting rises in the sex ratio (or cross-sectional differences) as reflecting son preference or discrimination against women.

III. The sex ratio over time and across regions

It has long been known that specific regions and communities in India have a strong preference for sons. The report of the census of 1881 contains a detailed discussion of son preference and possible infanticide among certain communities in North India, especially the Punjab and Rajasthan. The 1901 census shows a systematic regional divide in sex ratios, with the North and the West having ratios that are systematically more unfavourable to women than the East and the South.

In an influential paper, Dyson and Moore (1983) argued that cultural factors can explain why Northern India has more male bias than the South and the East. They argue that the greater female autonomy in the South reflects inheritance laws and marriage patterns. Women often marry within the same village (or one nearby) in the South, and property is passed on to daughters. The southern custom of cousin marriage keeps property within the family. This increases the value of women in these societies. However, Rahman and Rao (2004) find no significant difference in marriage outside the village between the North and the South, although cousin marriages are more common among certain communities in the South.

In this section we look at the trends in the sex ratio in India over the twentieth century and how it has varied across regions. We focus on the sex ratio in the age group under 5 or under 6, depending on the census. Our first reference point is the census of 1931 and we then compare the data with the censuses of 1971, 1981, 1991, and 2001.[1]

Table 2 reports evidence from the census of 1931. The picture reveals that in the age group 0–1, there were more females than males in all regions except in Punjab and Travancore/Cochin (princely states which are within the modern state of Kerala). The sex ratio favours girls right up to the age of 5 and then swings totally in favour of males. The female-biased sex ratio in early infancy is consistent with the picture of a high proportion of male stillbirths and pre-natal mortality in a poor economy. We would expect male ratios to rise with better nutrition and better living standards for mothers. Table 3 shows that life expectation at birth for males rose faster than that for females after the second decade of the twentieth century.

Table 2: Age-specific sex ratio across regions, 1931 (males per 100 females)

Region/state	Age group			
	0–1	**0–5**	**5–10**	**10–15**
South				
Cochin	100.6	100.8	92.4	102.2
Travancore	100.9	101.0	102.9	103.1
Hyderabad	89.9	91.3	108.5	110.6
Mysore	96.5	96.2	99.9	106.6
Madras	96.6	96.7	101.8	104.2
Bombay	99.8	99.1	111.5	116.3
North				
Rajputana	98.8	99.0	113.7	120.3
United Provinces	99.8	99.3	116.0	122.6
Central Provinces and Berar	98.1	96.1	103.9	106.0
Punjab	102.3	104.2	116.4	122.8
East				
Bihar and Orissa	98.2	95.3	108.7	112.6
Bengal	99.6	97.7	112.6	111.9
All India	98.8	97.9	109.9	113.6

Source: Census, 1931.

[1] Fragmentary evidence from the census of 1881 shows that the sex ratio in the age group 0–4 was about 94 and rose significantly after age 5.

Table 3: Expectation of life at birth for males and females

Year	Male	Female
1901–10	22.6	23.3
1911–20	19.4	20.9
1921–30	26.9	26.6
1931–40	32.1	31.4
1941–50	32.5	31.7
1951–60	41.9	40.6
1961–70	46.5	44.7
1971–80	50.9	50.0
1981–90	57.7	58.7

Source: Padmanabha (1981), Indian Census, Series 1.

It is interesting that the two regions that differ from this general picture appear to do so for completely different reasons. It is likely that the high sex ratio among children below the age of 1 in Punjab reflects strong son preference, and the possible infanticide or poor treatment of new-born girls. In this context, the census of 1881 mentions the possibility of female infanticide among high-caste Hindus and Sikhs in the Punjab. By contrast, in Travancore/Cochin the high sex ratio is likely to reflect the superior position of women within the household and, therefore, the better health, nutrition, and education of the mother, causing lower male mortality.

We now consider the under-6 sex ratio in recent Indian censuses, as reported in Table 1 in the introduction of the paper. In almost all the states, the sex ratio shows an increase over this period. The increase (and the level) is modest for the southern states (Andhra Pradesh, Karnataka, Kerala, Goa, and Tamil Nadu) and for the states in the East (Assam, Bihar, Orissa, and West Bengal), and could plausibly be due to the reduced infant mortality over this period. Madhya Pradesh, in central India, also fits this pattern. However, for the states in the North and West (Punjab, Haryana, Himachal Pradesh, Rajasthan, Gujarat, and Maharashtra), the increase is large and the overall level is also extreme in many cases.[2] Most striking are the extreme sex ratios in the northern states. By 2001, Punjab has a sex ratio of 125.3, Haryana 122.1, Delhi 115.1, while Gujarat has 113.2. These indicate serious gender imbalances in these states.

A comparison of sex ratio at birth and sex ratio in the age group 0–1 for 1981 and 1991 reveals an interesting picture. The sex ratio at birth was close to the normal range (106 boys per 100 girls) in all states, except Punjab and Gujarat in 1981. In these two states it was just above the normal, indicating the prevalence of gender bias. By 1991 the bias was stronger in these two states and also present in several others, indicating discrimination against girls. However, it is also true that in many southern states, such as Kerala, the sex ratio has also risen. As noted in section II, this is in line with developments in industrialized countries, where a greater fall in infant mortality among males is a feature of economic development. The rise in the all-India CSR reflects a combination of economic development and gender bias. Consequently, it is difficult to disentangle the effects of development from those of

[2] Uttar Pradesh in 1981 appears to be an anomaly, showing an implausibly high sex ratio, compared to other censuses and other states. Discounting this figure, one observes that Uttar Pradesh is close to the northern pattern, with a high sex ratio.

discrimination, and increases in the CSR cannot simply be ascribed to the latter.[3] As Sudha and Rajan (1999) note, infant mortality fell sharply between 1981 and 1991, from 152 per 1,000 to 96, and the effect has been larger for boys than girls. Small changes in relative infant mortality do have significant effects on the population sex ratio when population growth is over 2 per cent per year. Nevertheless, it is also clear that the 1990s witnessed a dramatic rise in the sex ratio in some regions, especially in North India, which could most plausibly be attributed to the availability of sex-selective technologies.

There is a large literature that attributes high female mortality among juveniles in India to discrimination against girls—see Muhuri and Preston (1991), Drèze and Sen (1996), and Klasen (1999). Das Gupta (1987) finds mortality to be even higher for a second-born girl. The intra-household allocation of food and clothing is biased against female children, with medical expenditure on boys being over twice that on girls. Oster (2006) has used the National Family Health Surveys (NFHSs) of 1992/3 and 1998/9 in order to examine the reasons for excess female mortality. She finds that excess mortality essentially occurs in years 1–5 of a child's life. The gender imbalance by age 5 is sufficient to explain almost all the gender imbalance in the population as a whole. Gender differences in vaccination explain 20–30 per cent of excess female mortality, while malnutrition explains 15 per cent.

A recent paper by Oster (2005) advances a new explanation for male-biased sex ratios. She argues that medical evidence suggests that the hepatitis-B status of the mother has an important effect on the sex ratio at birth, increasing it to the extent of 1.5 boys per girl. However, this factor has a relatively modest effect for the case of India, given the relatively low prevalence of hepatitis B as compared to other countries, such as China. Oster estimates that hepatitis B explains about 20 per cent of the figure of missing Indian women estimated by Coale (1991).

IV. Evolution and the sex ratio

We have established that mortality patterns differ across the sexes, with boys being more vulnerable early in life, while girls seem to suffer greater mortality after the age of 5. We now consider the implications of this differential mortality pattern for the sex ratio, taking the view of evolutionary biology. Indeed, the fact that more boys are born than girls has long been known—writing in 1741, Sussmilch noted that 'God the Creator' was wise in ensuring that

> 4 to 5 per cent more boys than girls are born, thus compensating for the higher male losses due to the recklessness of boys, to exhaustion and to dangerous tasks, to war, to sailing, to emigration, and Who thus maintains the balance between the two sexes so that everyone can find a spouse at the appropriate time for marriage. (Sussmilch, 1979, p. 505, cited in Chahnazarian (1988))

Darwinian evolution is less benevolent, since it argues that the sex ratio arises as an equilibrium when individual genes maximize fitness. The Darwinian theory of the sex ratio was set out in R. A. Fisher's great work (1930). Fisher provided an argument as to why the

[3] Das Gupta and Bhatt (1997) argue that the rising CSR in the South is due to declining fertility there rather than to falling infant mortality.

sex ratio in most species is approximately one. However, he also provided an explanation for the slight excess of boys at birth, arising not from their recklessness as adults, but from their greater mortality in infancy.

Fisher first provided an argument as to why the sex ratio would be balanced, in the absence of mortality differences. His argument applies to the evolutionary time scale, of hundreds of generations. Suppose that the individual parent could, in this time scale, choose the sex of their offspring, via a gene that controls the probability of having a boy. Then this parent would choose the sex for their child that is likely to result in the greater number of grandchildren. Now each child has one father and one mother, which implies that the total number of children fathered by men is equal to the total number of children borne by women. If the sex ratio at birth equals one, then the expected number of children per boy equals the expected number of children per girl. Thus parents are indifferent as to the sex of their child, and a gene which results in a sex ratio at birth of one is an equilibrium outcome.

This argument assumes that boys and girls are equally costly to bring up, and also that their survival probabilities do not differ. However, as we have argued, the infant and child mortality rate of boys exceeds that of girls, while girls may have greater mortality later in life. These mortality differences would have been particularly pronounced in hunter-gatherer societies, the societies in which humans have lived for the bulk of their history, and where evolutionary forces are likely to have played a role. Let λ_i, $i \in \{b, g\}$ be the infant mortality of boys and girls, respectively, with $\lambda_b > \lambda_g$. Our second stylized fact is that children require substantial amounts of investment by their parents before they reach adulthood. This implies that bringing up one child imposes a cost that may preclude the bringing up of another. Put differently, if the first child dies in infancy, this allows a part of the resources that would have been spent upon this child to be spent upon another child. We model this by assuming that there is a probability $\gamma_i \in (0,1)$, $i \in \{b, g\}$ that the mother who loses the one child can have another child. We assume that $\gamma_i < 1$, since the sunk parental investment in the first child is irrevocably lost, and $\gamma_i > 0$, since we are assuming that infant mortality takes place before the entire investment is incurred. Let us also suppose that any woman who has a marriage partner can have n opportunities to have children. At each such opportunity, the child may survive to adulthood; however, if the child dies, the opportunity is not lost but can be exercised again with probability γ. It will become apparent that n does not play any role in the analysis, and so for simplicity one may normalize it to 1.

We normalize the measure of boys at conception to 1, and let x be the measure of girls. So x is the sex ratio at conception, of girls relative to boys. The ratio of girls to boys at adulthood will be denoted by y, where

$$y = \frac{1 - \lambda_g}{1 - \lambda_b} x. \tag{1}$$

That is, y is the sex ratio in the marriage market. We may make several alternative assumptions regarding matching in the marriage market if y differs from unity. Let us start by assuming that every woman will be able to find a partner to father her children, regardless of whether y is less than or exceeds unity. This may be termed polygamous matching, and implies that the expected number of partners for a man is given by y. Let W^* denote the optimized value to an individual from future offspring, where these pay-offs are in terms of the expected number of grandchildren. Let $U(.)$ denote the value from having a boy. With probability $1 - \lambda_b$, the boy survives, and matches with y girls, where each match has value W^*. With probability λ_b, the boy dies, in which case with probability γ_b there is another opportunity to have a boy and earn $U(x)$. Thus the value from a boy is given by

$$U(x) = (1 - \lambda_b) y W^* + \lambda_b \gamma_b U(x). \tag{2}$$

Simplifying, one gets

$$U(x) = x \frac{1 - \lambda_g}{1 - \gamma_b \lambda_b} W^*. \tag{3}$$

Turning to the value of having a girl, one has a similar expression, except that a girl gets exactly W^* if she survives:

$$V(x) = (1 - \lambda_g) W^* + \gamma_g \lambda_g V(x). \tag{4}$$

$$V(x) = \frac{1 - \lambda_g}{1 - \gamma_g \lambda_g} W^*. \tag{5}$$

Now in an interior equilibrium, $U(x^*) = V(x^*)$, which yields:

$$x^* = \frac{1 - \gamma_b \lambda_b}{1 - \gamma_g \lambda_g} \tag{6}$$

$$y^* = \frac{1 - \gamma_b \lambda_b}{1 - \gamma_g \lambda_g} \frac{1 - \lambda_g}{1 - \lambda_b}. \tag{7}$$

Equation (6) provides an explicit expression for the sex ratio at conception. To interpret this, let us focus only on infant mortality, so that $\gamma_b = \gamma_g$ (i.e. since mortality occurs at the same time for both sexes, the cost involved is the same). Since empirical evidence suggests that infant mortality is greater for boys, so that $\lambda_b > \lambda_g$, this implies that the sex ratio at birth must be biased towards boys. However, one can also show that this implies that in the marriage market, the number of girls will exceed the number of boys, since $y^* < 1$. In other words, the excess births of boys will not be sufficient to offset their greater mortality. Intuitively, since boys are most costly to raise (owing to their higher mortality), their pay-off in the marriage market must be larger in order to compensate.

Now let us consider the implications of differential mortality patterns over time, with girls suffering mortality later in childhood as compared to boys. This implies that $\gamma_b < \gamma_g$, since the value of the investment lost will be the greater for the death of an older child (the girl). If we assume that overall mortality is the same for the two sexes (or lower for girls), this implies that $x^* > 1$. In other words, the differential temporal mortality pattern explains the excess number of boys at birth. In this case as well, the prediction is that in the marriage market there will be excessive numbers of girls. Finally, we may note that mortality at the end of the period of parental investment—i.e. either owing to the reckless behaviour of boys or owing to maternal mortality in child-bearing—has *no effect* on the equilibrium sex ratio. This may be verified from equation (6) by letting, say, $\gamma_g = 0$ and noting that, in this case, variations in λ_g have no effect on x^*.

To summarize, the evolutionarily stable sex ratio at conception is sensitive to infant or child mortality, but completely insensitive to mortality risks that arise once parental investment in the offspring is completed. The intuition for this is straightforward. Suppose, for instance, that 5 per cent of men die before they are able to marry, owing to recklessness, and the number of women is unaltered, the matching opportunities of surviving men increase by the exact amount, so that the *ex-ante* pay-offs to having a boy are unaltered. The evolutionary model tells us that there are good reasons for the sex ratio at birth to be biased in favour of boys, owing to their greater infant mortality, and, indeed, this bias is even greater at conception.

The Darwinian theory of the sex ratio also implies that parents who are motivated purely by considerations of genetic representation should be completely indifferent as to the sex of their child, given the equilibrium sex ratio. It therefore seems likely that credible models of gender bias have to incorporate non-biological considerations, such as the economic value of offspring or cultural values. Nevertheless, it seems worth considering solely biological models a little longer.

Trivers and Willard (1973) provide a biological explanation for distinct gender preferences for parents in different situations. They start from the fact that the variance in the number of offspring in typically larger in males than in females. While a female has a restricted number of reproductive opportunities, since she must physically give birth, a male faces no such constraint. So a male may mate with a large number of females and father many offspring, but may also be completely unsuccessful in doing so. In animals where females prefer to mate with large males, it is particularly advantageous to be a male if your size is going to be large, and disadvantageous if you are going to be small. So a mother who is in good physical condition and likely to produce a large offspring would prefer to give birth to a male child, while she would prefer a female child if her condition is poor.

The Trivers–Willard argument can be adapted to the human context. Even in monogamous societies, high mortality—especially of women in childbirth—implies that serial monogamy is possible, and gives rise to a greater expected number of offspring for those men who can practise it. Conversely, it also implies that some men will be unable to find marriage partners. Thus rich parents may be better off—from the point of view of having grandchildren—from having a son, while a poor parent is better off by having a daughter. This explains gender bias against women among the upper social classes, but by the same token, it implies that the poor should prefer girls to boys. This appears to be true in the North Indian context at the end of the nineteenth century or the beginning of the twentieth century. The upper castes traditionally followed the practice of requiring a bride to bring a dowry to the marriage and discriminated against women—for example, the high-caste Bedi Sikhs in the Punjab were known as *kuri-maar* or girl killers. Conversely, bride price was common among the lower castes, and discrimination against women appears less rife. Hypergamy—whereby a male from an upper caste was allowed to marry a woman from a lower caste—was permitted, but upper-caste women could not marry down.

V. Economic models of gender bias and the sex ratio

Biological models cannot generate systematic gender bias, since if it is advantageous for the rich to have boys, it becomes advantageous for the poor to prefer girls. So why is there widespread gender bias in societies such as India and China? One possibility is that technologies have changed rapidly relative to the hunter-gatherer societies, where evolutionary pressures operated. For example, people live longer and the economic value of children, for old age support, has become more important. Technology has also changed—compared to hunter-gatherer societies, where males specialized in hunting while women gathered, plough agriculture is arguably more male biased. Boserup (1970) argues that differences in agricultural technology explain the differences in relative position of women in Asia and sub-Saharan Africa. Whereas Asian agriculture was traditionally plough-based, that in sub-Saharan Africa has been hoe-based, allowing a greater role for women in agricultural production.[4] The argument has been extended to the Indian context. Bardhan (1974) suggested that in the wheat-growing regions of northern and western India there is little participation by women in agricultural work. In the rice-cultivating regions of the South and the East, women have an economic role and there is less discrimination against them.

There has been some work examining the validity of Bardhan's argument. Miller (1981) corroborates Bardhan on the differences in participation of women in agriculture across states. She also finds a negative correlation between female labour-force participation and the juvenile sex ratio, defined in terms of males per 100 females, using district-level data from the 1961 census. While Bardhan's argument is most persuasive as a long-term explanation for differences in son preference across regions, it has also been tested using time-series variation and panel data. Mayer (1999) finds a decline in women's labour-force participation between 1911 and 1981, which is correlated with a rise in the sex ratio. This is explained in terms of an increase in the ratio of land devoted to wheat as compared to rice. Mayer finds a strong negative correlation between the wheat–rice ratio and female labour-force participation. This argument provides a long-run explanation for the cross-sectional variation in gender bias in employment and the sex ratio. However, a state-level analysis of female labour-force participation and sex ratio using the 1971 census found that economic factors, such as cropping patterns and female literacy, cannot explain the rising sex ratio (Gulati, 1975).

There is also cross-sectional evidence suggesting that female labour-force participation and education reduces relative female mortality—see Rosensweig and Schultz (1982), and Murthi *et al*. (1995). Klasen and Wink (2002) find a positive effect of female labour-force participation and literacy (male literacy has no effect) on female mortality, using a panel data set of states from 1961 to 2001.

Let us consider the implications of boys and girls having different values for parents, either owing to economic considerations as set out above, or owing to cultural factors. Cultural factors are undoubtedly important—for example, Hindus traditionally consider it essential that a son light the parent's funeral pyre. We use a simplified version of the model set out in Bhaskar (2006). Let the pay-off to a parent from having a boy be given by

$$U(x) = \beta + x\rho. \tag{8}$$

β is the intrinsic value from having a boy, and ρ is the reproductive value from having grandchildren. Since x is the ratio of girls to boys, and the society is assumed to be monogamous, each boy gets a partner with probability x, as long as x is less than or equal to 1. This will turn out to be the case in equilibrium, but for this exposition let us take this to be an assumption. The pay-off from having a girl is given by

$$V(x) = \gamma + \rho. \tag{9}$$

[4] This view is also echoed in the context of new technology in English agriculture in the eighteenth century that reduced women's participation. Female mortality was higher in rural areas than in urban areas in England and Wales in the age groups 10–19 and 20–44 during the mid-nineteenth century (MacNay *et al*., 2005). Klasen (1998) finds support for this claim in the age group 20–45 using rural household data from Germany, even after controlling for maternal mortality. Scholars of European demography attribute higher female mortality to their low participation in economic activity, which resulted in unfavourable intra-household resource allocation.

Here, γ is the intrinsic pay-off from having a girl. Since we are assuming that there are at least as many boys as girls, a girl gets her reproductive value ρ for sure.

Let us assume, for simplicity, that the natural sex ratio is 1, i.e. a child is equally likely to be a boy or a girl. Let c denote the cost of sex selection. This should be interpreted as the cost of either mistreating a daughter so that she dies or, in more modern times, of a sex-selective abortion. That is, a mother who has an infant girl (or a girl foetus) can pay the cost c and try to have another child, in which case she will get the lottery where $U(x)$ and $V(x)$ are equally probable. Now if c is very large relative to the difference $\beta - \gamma$ (the difference in intrinsic pay-offs from a boy and a girl), then the sex ratio will be balanced. That is, if son preference is either not too strong or if parents do not like to ill treat their daughters, the presence of gender preferences will not affect the sex ratio. However, if either $\beta - \gamma$ is large or c is sufficiently small, then, at a balanced sex ratio, a parent who has a girl would prefer to incur the cost and try for a boy again. In this case, the equilibrium sex ratio x^* must be sufficiently different from 1 so that such a parent is indifferent between having a girl, and ill treating/aborting so that she can try again. More precisely, the indifference condition is

$$\frac{1}{2}[U(x^*) + V(x^*)] - c = V(x^*). \tag{10}$$

The left-hand side of the above equation shows the expected pay-off from trying again, and the right-hand side is the pay-off from accepting the girl. That is, the equilibrium sex ratio x^* is such that the pay-off to a boy is sufficiently reduced (via a reduced probability of marriage) so that this indifference condition is satisfied.

This simple model provides an explanation of how variations in economic values and technological factors (such as the availability of ultrasound scanning) affect the equilibrium sex ratio. An increase in the relative value of boys $(\beta - \gamma)$ reduces x^*. Suppose now that there is son preference, so that $\beta > \gamma$, and consider the impact of technological change that permits selective abortions, thereby reducing c. The effect of this reduces x^*. Notice that the equilibrium mechanism works by increasing the supply of boys and reducing their value to parents, by virtue of the fact that they may not be able to marry or reproduce.[5]

(i) Welfare implications

What are the implications of increased parental choice in a society with widespread gender bias? The standard response, from government agencies, international institutions, and non-governmental organizations, is to deplore sexual selection. In this view, gender bias reflects discriminatory preferences that are based on ignorance and backwardness. Rather than allowing choice based on discriminatory preferences, the state has a duty to educate away such preferences and, in the meantime, to constrain how they are exercised.

Let us consider the moral and welfare implications of selecting the sex of the child. This may be done in a variety of ways, depending upon technological possibilities. In the past, it would have been done via neglect or discriminatory treatment of the infant girl, resulting in greater mortality. More recently, it has become possible to do this via selective abortions. Even more recent technological developments, such as *in-vitro* fertilization, allow control

[5] Dharma Kumar (1983) presented an early argument that as girls become scarcer, their value will rise, and this will reduce gender bias and improve their position in society.

over the sex of the embryo itself, permitting sex selection without requiring abortions. Thus the overall trend has been towards a reduction in the psychological and financial costs of sex selection.

Let us focus on the question of sex-selective abortions. One can take two possible positions on abortions *per se*. First, that they are morally wrong, since the foetus is a person, in which case abortion constitutes a form of murder. This is essentially the position of 'pro-life' groups in the United States. If one takes this view, it is clear that sex-selective abortions are also wrong. Sex selection *per se* could be wrong, since it increases the likelihood of abortions. The alternative view is that the foetus does not constitute a person with a right to life, so that abortions are not necessarily wrong. If one takes this view, one cannot object to sex-selective abortions on the grounds that they violate the rights of the foetus. One must examine the implications of such abortions upon other persons in society, those who have rights and whose welfare is a constituent of society's welfare.

The simple economic model set out above allows one to examine the welfare implications of the equilibrium sex ratio. One can show (see Bhaskar, 2006) that the equilibrium outcome is not efficient—there are too many boys relative to the socially optimal outcome, which would require a balanced sex ratio. Allowing parental choice in a situation where the matches are random reduces welfare, by reducing the expected utility of the typical household or parent. The reason is that parents who choose to exercise choice do not take into account the congestion externality they exert in the marriage market. Furthermore, technological improvements that permit parental choice at lower cost have negative consequences for welfare, since they aggravate the congestion externality. The paper also argues that, with sex-selective abortions, one should witness a decline in dowry and the emergence of bride price, reflecting the relative scarcity of women. Nevertheless, even with a bride-price system, realistic modelling of marriage-market frictions suggests that we will not have efficiency since the sex ratio must still be unbalanced. In addition, there may be additional social problems that arise as a consequence of having so many men who are unable to find marriage partners.

What are the policy suggestions that one might make in this context? Sex-selective abortions are illegal, and have been so for over 30 years. Nevertheless, the law has proved to be no deterrent to this practice. Indeed, it is hard to see how a law that permits abortions but outlaws sex-selective ones can ever be enforced. It is not illegal to have an ultrasound, and there are genuine medical reasons for having one. So if the process of ascertaining the sex of the foetus is separated from that of getting an abortion, the practitioners can claim to be innocent.

This suggests that financial incentives or support for girl children may play a role in reducing gender imbalances. This will raise the value of girl children and thereby make it more attractive for parents to have girls. Several Indian states have introduced some financial support for girls (such as free education). Such policies may well have good consequences for boys, by reducing marriage-market imbalances in the future.

It is also plausible that many of the parents choosing actively to have boys and abort girls do not realize the long-term consequences of such decisions. They may not anticipate that the marriage market in 20 years' time is likely to be very different from that which has operated in the recent past, and that they may have to pay a bride price in order to marry off their son. This suggests that education may play in role in allowing them to make more informed choices. Finally, trends suggest that Indian society in 20 years' time may be quite different from its present incarnation, both in terms of gender relations and socially. This strengthens the case for liberalizing its laws and attitudes on the family and on sexual relations.

VI. Demographic factors: the marriage squeeze

It is argued by sociologists that the twentieth century has seen major changes in the position of women in India. While women have had relatively low social status in the North and West, their position in the East and in southern India was historically much better. Furthermore, it has been argued that discrimination was more prevalent in the upper castes. Although there is little systematic quantitative evidence, sociologists have argued that dowry has become widespread among the lower castes, and has spread to the South and to eastern parts of India. The position of women has also deteriorated. This phenomenon, of the spread to the lower castes of upper-caste practices, has been dubbed *Sanskritization* (Srinivas, 1962).

What explains the adoption by the lower castes of upper-caste *mores* that are not perhaps suitable to their situation? One possibility is that imitation has been successful in other contexts—such as technology adoption or sending children to school—and may, therefore, be practised in a domain where it is less appropriate. Coupled with this, underlying demographic factors have changed in the twentieth century. A key factor has been population growth and the consequent ‘marriage squeeze’, arising from the age difference at marriage. While this age difference is not immutable, and has, indeed, declined over time, it is nevertheless the case that the age difference is significant—women marry men who are between 5 and 10 years older. In a situation of population growth, this implies that the cohort of women is considerably larger than the corresponding cohort of men, born, say, 5 years earlier. Thus there is excess supply of women in the marriage market. The marriage squeeze has emerged as an important factor in the twentieth century, with population growth taking place since the beginning of the century (see Bhatt and Halli, 1999). It is a plausible explanation for the deteriorating position of women in the marriage market and the changes in social and marriage customs over the century, with many communities replacing the custom of bride price with dowry. While reliable data on dowry are scarce, Rao (1993) uses village-level data to argue that dowries have increased over time as a consequence of the marriage squeeze.

Some idea of the extent of the marriage squeeze as early as the 1930s can be gleaned from Table 4, which reports numbers of males and females in marriageable age groups. The third column reports the sex ratio in each cohort, while the fourth column reports the sex ratio assuming, conservatively, that the gap in marriage age is 5 years. We see that for females aged 10–15, there were only 84 males per 100 females. This implies a great excess supply of females in the marriage market, implying that 16 females per 100 could not get partners. On the other hand, when we consider the sex ratio for females in the age range 15–20, we find that there are 103 males per female, and a similar pattern obtains for females in the age group 20–25. This suggests that the marriage squeeze emerged as a serious phenomenon by the beginning of the 1930s. With the acceleration in population growth in the twentieth century, and the increases in sizes of successive cohorts, this is a plausible explanation for the spread of dowry and increased son preference in the twentieth century.

In recent years, fertility has declined and India’s population growth rate has also fallen. The age difference at marriage has also fallen as a consequence of increased education, especially of women. This suggests that the marriage squeeze is likely to be less important, and the marriage-market position of women is likely to improve. Paradoxically, this is happening in a situation where the relative numbers of women are also falling, thus aggravating the gender imbalance.

Table 4: Sex ratios in the marriage market, 1931 census

Age group	No. of males	No. of females	Sex ratio	Sex ratio (gap)
10–15	21.6	19.1	113	84
15–20	16.0	15.9	101	103
20–25	16.3	16.7	98	108
25–30	15.5	14.7	105	97

Note: Numbers in millions.
Source: 1931 Census.

VII. Sex-selective abortions

Recent developments in medical technology have increased parental choice and reduced the cost of choosing boys. The development of amniocentesis in the 1980s and ultrasound screening subsequently made foetal sex determination possible, thereby permitting selective abortion. Foetal sex determination for selective abortion has been illegal in India since 1994, but anecdotal evidence suggests that the practice flourishes, nevertheless. Comparing the censuses of 1981 and 1991, Sudha and Rajan (1999) argue that although the sex ratio at birth has become more biased towards males in some states, its magnitude does not suggest a widespread use of sex-selective abortions. The rural sex ratio at birth in 1991 was within the normal range, while the urban figure had increased from 104 to 108. The suggested number of missing girls would be about 74,600. Again it is concentrated in the North. Using the NFHS data of 1992/3, Mishra *et al*. (1998) put numbers much higher, at 207,000. Survey data from Punjab show that, in 1988, sex ratio at birth in a rural sample was 119, while that in hospital births was 122 (Das Gupta and Bhatt, 1997).

Evidence from the next decade is far more dramatic. A recent paper in the *Lancet* (Jha *et al*., 2006) analyses data from the Special Fertility and Mortality Survey (SFMS) of 1998. This is a survey of 1.1m households and the analysis is based upon fertility history of (ever married) women and upon children born to these women in the year 1997. Their main finding is that the sex ratio of the child born in 1997 depends upon the woman's fertility history. Specifically, the woman is substantially more likely to have a boy if she has a large number of girls. For example, the data they report show that, in the case of families who already have one child, the probability of the second child being a girl is 0.515 if the first child is a boy, but only 0.422 if the first child is a girl. Similarly, for families who already have two children, the probability of the third child being a girl varies from 0.531 (if both previous children are boys) to 0.466 (in the case of one previous boy and one girl) to 0.409 (if both previous children are girls). Jha *et al*. argue that these differences are only explicable as being due to selective abortions, with parents aborting girl foetuses if they already have girls in the household.

More controversially, Jha *et al*. go on to provide a quantitative estimate of the extent of selective abortions. They assume that the natural sex ratio at birth is between 102 and 105 boys per 100 girls. They assume that all the discrepancy between this assumed sex ratio and the actual sex ratio in the case of second births where the family has one girl, and of third births when the family has two girls, is due to selective abortions. This gives rise to a deficit of 0.31–0.34m girl births. They also assume that selective abortion explains half of the 'missing girls' among first-born or at higher orders, giving rise to a number of 0.14–0.20m. This results in a total of 0.45–0.54m selective abortions in the year 1997. Assuming that this pattern operated over two decades, this implies a headline figure of 10m missing female births in this entire period.

While it is uncontested that the selective abortions are occurring, the methodology underlying these quantitative estimates and the data sources that lie behind them, leave much to be desired. Let us consider the SFMS data first, and compare the sex ratios at birth reported there with those widely accepted as 'normal', in the absence of selective abortions. In her exhaustive survey of the sex ratio at birth, Chahnazarian (1988) notes that 'the figure of 106 males per 100 females is generally accepted as the usual sex ratio at birth for white populations'. One may test whether the sex ratios at birth reported in the SFMS data differ from this figure, which corresponds to a probability of a girl of 0.485. The reported sex ratios differ significantly (and substantially) from this ratio for every type of existing family size and composition. For example, the proportion of girls among the first-born is 0.456, which is clearly substantially different from 0.485. However, one also finds that the proportion of girls born in families with one boy is 0.515, which is significantly different from and *greater* than 0.485. Furthermore, in the case of families with two boys, the probability of having a girl rises to 0.531. Now, the evidence from other countries indicates that the probability of having a girl does not vary with the sex of the previous children (although there is some evidence that the probability of having a boy increases with the *total* number of existing children). In view of this, and since it is unlikely that families are selectively aborting boys, there is some doubt regarding the reliability of the data on which the entire analysis is based.

An alternative estimate, using the NFHSs of 1992/3 and 1998/9, is provided by Arnold *et al*. (2002). The latter NFHS shows a rise in the sex ratio in children born in the 5 years preceding the survey. The survey also has information on abortions and there has been a significant rise in reported induced abortions in the last few years preceding the second survey. In Group A states (i.e. the states which are known for their bias against girls) the probability of an abortion among women with one child is greater if the first child is female. Otherwise, induced abortions increase with the number of sons. There does not appear to be a simple correlation between the use of ultrasound and gender bias, since several states with high ultra-sound use (Goa (62 per cent of pregnancies), Kerala (44 per cent), and Tamil Nadu (31 per cent)) are also those where the sex ratio among under-5s is more favourable to girls. However, in Northern India, the group A states (Gujarat, Haryana, and Punjab) have a higher than average use (19–20 per cent). Arnold *et al*. estimate that approximately 0.1m sex-selective abortions occur in a year. This is based on their analysis of the use of ultrasound and upon reported terminations in the NFHS data for the year 1998.

Given the somewhat controversial evidence of the numbers of selective abortions based on sample survey data, let us now present our own estimates based on aggregate census data. This is rather crude, but it is at least based upon the census, rather than samples which appear somewhat unreliable. In the 2001 census, there were 20m births in the year. The sex ratio of these was 110 boys per 100 girls. This implies a sex ratio at birth of 0.4762, as compared to the benchmark of 0.4857, corresponding to the normal sex ratio at birth of 1.059 used by Coale (1991). Thus, there were approximately 10 missing girls in every 1,000 births. Based on this, we can estimate the number of sex-selective abortions as follows. Let N be the total number of births, and let A be the number of sex-selective abortions, assumed to be of girls. The number of girls is given by the observed proportion of girls in births multiplied by N, which must equal the expected proportion in $(N + A)$ minus A:

$$0.4762N = 0.4857(N + A) - A. \tag{11}$$

Solving this equation for A, we get

$$A = \frac{0.0095N}{1-0.4857}. \tag{12}$$

Substituting for $N = 20\text{m}$, one gets $A = 0.37\text{m}$.

This figure is subject to several caveats. First, it assumes that the sex ratio at birth is 0.4857. Second, it is possible that there may be under-enumeration of girl births. With regard to the first point, Oster (2005) argues that hepatitis B may result in excessive male births. Based on a hepatitis B prevalence rate of 4.33 per cent, she argues that the predicted sex ratio at birth in India should be 1.069 rather than 1.059. This gives rise to a lower estimate, of approximately 5 missing girls per 1,000 births. Re-doing the estimates, one gets the result that $A = 0.20\text{m}$.

These figures are admittedly crude and are merely a place to start from. Our main point is that one has to be careful in evaluating the quantitative evidence, and inconsistencies in the data need to be dealt with if one is to have reliable quantitative estimates.

VIII. Conclusions

This paper has provided a review of the evidence on the sex ratio in the infant and child population in India. We have drawn on a number of literatures, from biology, medicine, economics, and demography, in order to shed light on this difficult and important problem. There is considerable heterogeneity in the Indian experience, with serious evidence of gender imbalances in the North and the West of the country. These imbalances appear to be aggravated by recent technological developments permitting selective abortions, and will have important economic and social implications in the decades to come.

References

Arnold, F., Kishor, S., and Roy, T. K. (2002), 'Sex Selective Abortions in India', *Population and Development Review*, **28**, 759–85.

Bardhan, P. (1974), 'On Life and Death Issues', *Economic and Political Weekly*, **9**, 1293–304.

Bhaskar, V. (2006), 'Parental Choice and Gender Balance', University College London, mimeo.

Bhatt, P. M., and Halli, S. (1999), 'Demography of Brideprice and Dowry: Causes and Consequences of the Indian Marriage Squeeze', *Population Studies*, **53**, 129–48.

Boserup, E. (1970), *Woman's Role in Economic Development*, London, Earthscan.

Chahnazarian, A. (1988), 'Determinants of the Sex Ratio at Birth: A Review of Recent Literature', *Social Biology*, **35**, 214–35.

Coale, A. J. (1991), 'Excess Female Mortality and the Balance of the Sexes in the Population: An Estimate of the Number of "Missing Females"', *Population and Development Review*, **17**, 517–23.

Das Gupta, M. (1987), 'Selective Discrimination against Female Children in Rural Punjab', *Population and Development Review*, **13**, 77–100.

— Bhatt, P. M. (1997), 'Fertility Decline and Increased Manifestation of Sex-bias in India', *Population Studies*, **51**, 307–15.

Drèze, J., and Sen, A. (1996), *India: Economic Development and Social Opportunity*, Oxford, Clarendon Press.

Dyson, T., and Moore, M. (1983), 'On Kinship Structure, Female Autonomy and Demographic Behaviour in India', *Population and Development Review*, **9**, 35–60.

Fisher, R. A. (1930), *The Genetical Theory of Natural Selection*, Oxford, Oxford University Press.

Gulati, L. (1975), 'Female Work Participation: A Study of Interstate Differences', *Economic and Political Weekly*, **10**, 35–42.

Jha, P., Kumar, R., Vasa, P., Dhingra, N., Thiruchelvam, D., and Moineddin, R. (2006), 'Low Male to Female Sex Ratio of Children Born in India: National Survey of 1.1 million Households', *Lancet*, **367**, 211–18.

Klasen, S. (1998), 'Marriage, Bargaining and Intrahousehold Resource Allocation: Excess Female Mortality among Adults during Early German Development, 1740–1860', *Journal of Economic History*, **58**, 432–67.

— (1999), 'Gender Inequality in Mortality in Comparative Perspective', University of Munich, mimeo.

— Wink, C. (2002), 'A Turning Point in Gender Bias in Mortality? An Update on the Number of Missing Women', *Population and Development Review*, **28**, 285–312.

Kumar, D. (1983), 'Male Utopias or Nightmares', *Economic and Political Weekly*, 15 January, 61–4.

MacNay, K., Humphries, J., and Klasen, S. (2005), 'Excess Female Mortality in Nineteenth Century England and Wales: A Regional Analysis', *Social Science History*, **29**, 649–81.

Mayer, P. (1999), 'India's Falling Sex Ratios', *Population and Development Review*, **25**, 323–43.

Miller, B. (1981), *The Endangered Sex: Neglect of Female Children in Rural North India*, Ithaca, NY, Cornell University Press.

Mishra, U., Ramanathan, M., and Irudaya Rajan, S. (1998), 'Induced Abortion Potential among Indian Women', *Social Biology*, **45**, 278–88.

Muhuri, P. K., and Preston, S. H. (1991), 'Effects of Family Composition on Mortality Differentials by Sex Among Children in Matlab, Bangladesh', *Population and Development Review*, **17**, 415–34.

Murthi, M., Guio, A., and Drèze, J. (1995), 'Mortality, Fertility and Gender Bias in India: A District Level Analysis', *Population and Development Review*, **21**, 745–82.

Oster, E. (2005), 'Hepatitis B and the Case of the Missing Women', *Journal of Political Economy*, **113**, 1163–216.

— (2006), 'Proximate Causes of Population Gender Imbalance in India', University of Chicago, mimeo.

Rahman, L., and Rao, V. (2004), 'The Determinants of Gender Equity: Examining Dyson and Moore's Thesis with New Data', *Population and Development Review*, **30**, 239–68.

Rao, V. (1993), 'The Rising Price of Husbands: A Hedonic Analysis of Dowry Increases in Rural India', *Journal of Political Economy*, **101**, 666–77.

Rosenzweig, M., and Schulz, P. (1982), 'Market Opportunities and Genetic Endowments and Intra-family Resource Distribution: Child Survival in Rural India', *American Economic Review*, **72**, 803–15.

Sen, A. K. (1992), 'Missing Women', *British Medical Journal*, **304**, 587–88.

Srinivas, M. N. (1962), *Caste in Modern India and other Essays*, Bombay, Media Promoters and Publishers.

Sudha, S., and Rajan, S. I. (1999), 'Female Demographic Disadvantage in India 1981–1999: Sex Selective Abortions and Female Infanticide', *Development and Change*, **30**, 585–618.

Sussmilch, J. P. (1979), '"L'Ordre Divin" aux Origines de la Démographie', original translation with studies and comments collected by J. Hecht, Paris, Institut National d'Etudes Démographiques.

Trivers, R., and Willard, D. (1973), 'Natural Selection of Parental Ability to Vary the Sex Ratio of Offspring', *Science*, **179**, 90–1.