Working Paper No. 200

Exploring the Importance of Excess Female Mortality and Discrimination in 'Natality' in Explaining the 'Lowness' of the Sex Ratio in India

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July 2007

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Abstract

The beginning of the present century has been marked by a shift in attention from excess female mortality to discrimination in natality in explaining the 'lowness' of the sex ratio or weight of women in India's population. Such a shift in focus seemingly suggests that discrimination in intra-family allocation of resources has been reduced substantially in India. In this context, an attempt has been made to decompose the observed 'lowness' of the sex ratio in India into that attributable to (1) young age structure, (2) 'excess' female mortality, (3) abnormality in sex ratio at birth in India. Estimated contributions of each factor suggest that, as late as in 2001, 'excess' female mortality or 'lowness' of *relative survival advantage of females* accounts for as much as 65.63 per cent of the 'lowness' of the sex ratio in India. This result suggests that, despite substantial gains made in the recent past, 'excess' female mortality is still the single most important factor accounting for the 'lowness' of the sex ratio in India. The results also point to the importance of age structure, which accounts for around 43 per cent of the 'lowness' of the sex ratio in India in 2001, in determining the weight of women in a society.

Acknowledgements: The author is very grateful to S. Subramanian for the discussions with him, over a long period of time on the subject of the paper, and the comments on an earlier version of the paper were extremely useful.

1. Introduction

'Lowness' and the declining trend in the weight of women in India's population have received considerable attention of scholars (see, for example, Visaria (1971), Mitra (1979), Sen (1987, 1990, 1992 and 2003), Klasen and Wink (2002a and 2002b) and Mayer (1999). The consensus, until the early 1990s (see, Sen 1990 and 1992), was that the 'lowness' and the declining trend in the weight of women in India, respectively, were largely due to 'excess mortality' of women vis-à-vis men and its exacerbation over time. Excess female mortality, which in turn, was attributed to, '... the relative neglect of females, especially in healthcare and medical attention' (Sen 1990, in page 2). However, there seems to have been a shift in this line of reasoning since the beginning of the 21st century. Attention appears to have shifted from mortality differentials or 'low' relative survival advantage of women vis-à-vis men as an explanation for the observed lowness of the weight of women in India's population to discrimination in natality (particularly before birth).

This shift is reflected in the considerable growth of literature on the subject of sex-selective abortion in India [see, for example, Sudha and Rajan (1999), Clark (2000), Arnold, Kishor and Roy (2002), Retherford and Roy (2003), Bahagat (2004), Glenn (2004), Middle East Times (2005), Agnivesh, Mani and Koster-Lossack (2005), Boseley (2006), Schultz (2006), Gentleman (2006), Jha *et. al* (2006), Baldauff (2006), Patel, R (2007), Patel, T (2007), Unisa, Pujari, and Usha (2007)]. The works cited above include articles which bear titles such as: "10 Million Girl Foetuses Aborted in India", "7000 Unborn Girls Die From Sex-Selective Abortions Daily in India", "Millions of Abortions of Female Fetuses Reported in India", "Missing: 50 million Indian girls", and "India's Baby Girls Decimated Through Infanticide or Abortion". The growth of literature on sex selective foeticide, and the titles referred to above appear to suggest that the problem of 'lowness' of the weight of women in India's population is, largely, attributable to the 'lowness' of the female-to-male ratio at birth. There is a tendency to attribute the latter, largely, to sex-selective abortion or female foeticide[1].

The above-mentioned tendency seems to have emerged from conflating the causes for the 'lowness' and the declining trend of the female-to-male ratio in India. In this context, it seems important, as Sen (1987) had argued, to distinguish the trend from the 'lowness' of the female-to-male ratio. To quote Sen (1987: p.60), "...: the lowness of that ratio [female-to-male ratio] has to be distinguished from the declining *trend* [emphasis in original] of the ratio". The causes for the observed trend and the 'lowness' of the female-to-male ratio (FMR) in a population may differ. It is possible, while the observed 'lowness' of the FMR is explained by excess female mortality, the trend in FMR is accounted for by the trend in FMR at birth. Thus, there is a case for distinguishing the trend from the 'lowness' of the female-to-male ratio, and maintaining the two as distinct analytical categories. However, it needs to be stated that the attempt in this paper is restricted[2] to accounting for the 'lowness'

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[1] For example, in an article in *Humanist News*, titled "Female foeticide in India", Indu Grewal and J. Kishore (2004) state: "Female foetuses are selectively aborted after pre-natal sex determination, thus avoiding the birth of girls. As a result of selective abortion, between 35 and 40 million girls and women are missing from the Indian population". They also indicate that, "The United Nations has expressed serious concern about the situation".

[2] In this context, it may noted that Jayaraj and Subramanin (2007) have attempted to decompose the changes in the sex ratio in India between 1961 and 1971, and 1981 and 1991 into that attributable to trends in relative survival advantage of females and sex ratio at birth.

of the share of women in India's population at two points of time 1991 and 2001. To this end, first the constituent elements of the weight of women or sex ratio of a population are identified in Section 2. Section 3 details the accounting procedure adopted. The choice of the 'norm', and the rationale attending such choice of the 'norm' employed to assess the 'lowness' of the weight of women in India's population are provided in Section 4. Sources of data employed are discussed in Section 5. The results of the accounting exercise are provided and discussed in Section 6. Section 7, concludes.

2. Identifying the Constituent Elements of the Sex-ratio of a Population[3]

There are two widely employed measures of weight of women (or sex ratio) in a society. First is the female-to-male ratio (denoted as S), and the other is the female headcount ratio which is the proportion of women in the total population in a society (denoted as F). These measures are defined, respectively, as:

$$S=(P^f/P^m)*1000 \qquad \ldots(1);$$

where P^m and P^f , respectively, are the total male and female population in a society; and

$$F=P^f/P \qquad \ldots(2);$$

where P^f and P, respectively, are female and total population in a society. It may be added here that, in this note, unless stated explicitly, the female headcount ratio will be employed as the measure of the sex ratio of a population.

The sex ratio of a population at any particular point of time can also be written as a weighted — the weight is the proportion of the total population in each age — sum of age specific Fs. Accordingly, F can be written as:

$$F_t=\sum_{a=0}^{\bar{a}}\varphi_t(a)F_t(a) \qquad \ldots(3);$$

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[3] This Section relies heavily on, and is largely a reproduction of, Section 2, in Jayaraj and Subramanian (2007).

where t signifies time, a represents age, $\bar{a}$ is the age of the oldest person in the society, φ is the proportion of the population, and F is the female headcount ratio. From equation 3, it is clear that the sex ratio of a population at any point of time depends on the age specific sex ratios and the age-structure of the population at that point of time.

$F_t(a)$ is the ratio of females born t-a years ago who have survived to age a to total persons born t-a year ago who have survived to age a. Accordingly, $F_t(a)$ can also be written as: $[B^f_{t-a}\ (1-q^f_t(a))]/\ [B_{t-a}\ (1-q_t(a))]$; where B^f_{t-a} and B_{t-a}, respectively, are the total number of females and the total number of persons born t-a years ago; and $q^f_t(a)$ and $q_t(a)$, respectively, are the proportions of females and persons born t-a years ago who have died before reaching age a. Notice that $(1-q^f_t(a))$ and$(1-q_t(a))$, respectively, are the survival ratios of females and of all persons born t-a years ago to age a. The ratio defined as: $r_t(a)=(1-q^f_t(a))/\ (1-q_t(a))$ is called *the ratio of relative survival advantage of females* of age a at time t. It may also be noted that B^f_{t-a}/B_{t-a} is the female headcount ratio at birth t-a years ago, which will be denoted as F^0_{t-a}. For future reference, it may be noted that $r_t(a)$ could also be written as: $F_t(a)/F^0_{t-a}$. From the above discussion, it is clear that equation 3 can be written as follows:

$$F_t=\sum_{a=0}^{\bar{a}}\varphi_t(a)[r_t(a)F^0_{t-a}] \qquad ...(3').$$

From equation 3' it is clear that the sex ratio of a population at any particular point of time is determined by three factors: the age structure ($\varphi(a)$), the ratio of relative survival advantage of females (r(a)) or excess female mortality, and the trend in sex ratio at birth (F^0_{t-a}). It may be noted here that the observed age-structure at a particular point of time captures the impact of the past history of demographic development experienced by a population. Relative survival advantage ratio of females at age a accounts for mortality differentials experienced by females of a birth cohort at different points of time in their life between birth and reaching age a. For example, r(5) at time t captures the mortality differentials experienced by females born t-5 years ago at: (1) infancy t-5 years ago, (2) the age interval 0-1 t-4 years ago, (3) the age interval 1-2 t-3 years ago, (4) the age interval 2-3 t-2 years ago, (5) the age interval 3-4 t-1 year ago, and (6) the age interval 4-5 in year t. Similarly, the sex ratio of a population at a particular point of time is influenced by the trend in sex ratio at birth over a long period (the length of which depends on the age of the oldest birth cohort present in the population) of time. Thus, the sex ratio of a population at a particular point time encapsulates the prior histories — the history of demographic development, the cumulative history of discrimination in survival experienced by females (history of 'excess' female mortality), and the history of sex ratio at birth — in three variables.

3. Accounting for the 'Lowness' of the Sex Ratio of a Population

To account for the 'lowness' of the sex ratio of a population by its constituent elements, one needs to find answers to a series of counter factual questions. While posing the counterfactual questions it is important to take into account the levels of demographic and economic developments experienced by the population. The development experience is largely reflected in the age structure (see, Klasen and Wink (2002a and 2002b) of the population. Thus, given the levels of demographic and economic developments reached, to account for the 'lowness' of the sex ratio in India answers need to be found for the following counter factual questions. The basic question that needs to be answered is: what would be the sex ratio in India in the absence of discrimination against females? To answer this question one needs to find answers to the following queries. They are: (1) what would be the age structure of India's population if females have not been discriminated against?; (2) what would be the sex ratio in India corresponding to the age structure that would obtain in the absence of 'excess' female mortality?; and (3) what would be the sex ratio of India's population if there have been no abnormalities in the trend in the sex ratio at birth?

The questions posed above are easily answered if one could find a population that experiences comparable levels of economic and demographic developments but, unlike in India, does not discriminate against its females. In this connection, Klasen and Wink (2002a) has pointed out that in every known society women experience discriminations against them in one form or another. Thus, it is extremely difficult to identify a society where there exists no discrimination against females in all spheres of life. However, it appears to me that it is reasonable to assume that in the developed countries discrimination against women does not affect their survival chances in any age. Accordingly, to judge the performance of India at any particular age, the observed sex ratio of that age in any one of the developed countries could be employed as the 'norm'. However, the overall performance of India could not be judged employing the overall sex ratio of the population of any one of the developed countries. The developed countries have reached much higher levels of economic and demographic developments compared to India. Consequently, the age structures of the populations in the developed countries differ vastly from that of India's. For this reason, the overall sex ratios of the developed countries need to be corrected to correspond to the age structure[4] of India's population.

It is possible to derive the 'norm' for the overall sex ratio by combining the age structure of India and the sex ratios in each age a of a developed country. However, the observed age structure of India's population itself is a product of overall mortality pattern which is contaminated by 'excess' female mortality. For this reason, the age structure of India needs to be corrected for 'excess' female mortality. In what follows, the procedure employed to arrive at the corrected age structure of India's population is explained.

Employing the sex ratio in each age a of a developed country, indexed as j, the population share in each age, corrected for 'excess' female mortality in India, at time t, is obtained as follows. It is important to note here that the subscript t, which represents time, will be suppressed whenever the context presents no ambiguity. Notice, as indicated earlier, that F(a) is the product of two ratios: F^0_{t-a}, the sex ratio at birth t-a years ago; and r(a), *the ratio of relative survival advantage of females* at age a. Combining information on the sex ratio at birth in India and r(a) of the developed country j, the expected sex ratio at time t for each age a in India, could be obtained as:

$$ {}^{i}F^{*}(a) = [\, {}^{i}F^{0}_{t-a}\ {}^{j}r(a)] \qquad \ldots (4), $$

where ${}^{i}F^{*}(a)$ is the expected sex ratio at age a for India, and ${}^{j}r(a)$ is the relative survival advantage ratio at age a for the selected developed country. Notice here that the expected sex ratio in India in each age a is estimated employing the sex ratio at birth, ${}^{i}F^{0}_{t-a}$, for India. In other words, ${}^{i}F^{*}(a)$ is the sex ratio that would obtain in age a, given the sex ratio at birth in

[4] There appears to be a statistically significant positive relationship between age and relative survival advantage of females in the developed countries. The positive relationship between age and relative survival advantage of females suggest that as the share of the population in the upper end of the age spectrum increases, the sex ratio of the population is likely to increase. This impact could be termed as 'longevity' effect or demographic development effect.

India t-a years ago, in the absence of discrimination against females in survival. Employing the expected sex ratio and the number of males present in each age, the expected number of females to be present in each age a in India at time t is obtained as:

$$ {}^{i}P^{*f}(a) = [{}^{i}F^{*}(a)\,{}^{i}P^{m}(a)]/[1- {}^{i}F^{*}(a)] \qquad ....(5). $$

Where ${}^{i}P^{*f}(a)$ and ${}^{i}P^{m}(a)$ are, respectively, the female population expected to be present and male population observed to be present in age a in India, and ${}^{i}F^{*}(a)$ is as defined earlier. Now, the expected share of the population in each age, a, at time t could be estimated as:

$$ {}^{i}\varphi^{*}(a) = [({}^{i}P^{*f}(a)+ {}^{i}P^{m}(a))/({}^{i}P^{*f}+ {}^{i}P^{m}] \qquad ...(6), $$

where ${}^{i}\varphi^{*}(a)$ is the expected share of the total population in age a, and ${}^{i}P^{*f}$ is the total female population expected to be present in India. Notice here that $\sum_{a=0}^{\bar{a}} {}^{i}\varphi^{*}(a)$ is the age structure that would obtain in the absence of 'excess' female mortality in India.

Now it is easy to derive the overall sex ratio 'norm', denoted as $\hat{F}$, by combining ${}^{i}\varphi^{*}(a)$, and ${}^{j}F(a)$, as follows:

$$ \hat{F} = \sum_{a=0}^{\bar{a}} {}^{i}\varphi^{*}(a)\,{}^{j}F(a) \qquad ... (7). $$

Notice that ${}^{j}F(a)$, the sex ratio at age a for country j, could also be written as a product of two quantities as: ${}^{j}F(a) \equiv [{}^{j}F^{0}_{t-a}\ {}^{j}r(a)]$. Notice also that the sex ratio at birth in the developed country is not affected by pronounced son preference. Accordingly, $\hat{F}$ is the overall sex ratio of India's population that would obtain in the absences of abnormality in the sex ratio at birth and 'excess' female mortality. To put it differently, given the level of demographic development achieved, $\hat{F}$ is the sex ratio that would obtain in India in the absence of discrimination against females. Thus, the 'lowness' of $\hat{F}$ in relation to ${}^{j}F$ (the population sex ratio of country j) is attributable only to differences in age structures or differences in the levels of demographic developments of the two populations. Similarly, the female headcount ratios[5], that accommodates only for abnormality in sex ratio at birth and only for 'excess' female mortality or 'lowness' of the relative survival advantage in India, respectively, are derived as:

$$F^{sb} = \sum_{a=0}^{\bar{a}} {}^{i}\varphi^{*}(a)[{}^{j}r(a){}^{i}F^{0}_{t-a}] \qquad \dots (8),$$

and

$$F^{r} = \sum_{a=0}^{\bar{a}} {}^{i}\varphi^{*}(a)[{}^{i}r(a){}^{j}F^{0}_{t-a}] \qquad \dots (9),$$

where F^{sb} and F^{r} respectively are the overall sex ratios obtained allowing for, respectively, abnormality in sex ratio at birth and the 'lowness' of the relative survival advantage of females in India. Notice that the F^{sb} is arrived at combining corrected age structure and sex ratios at birth for India, and the relative survival advantage ratios of country j. As noted earlier, $\hat{F}$ is obtained by combining the corrected age structure of India, and the sex ratio at birth and the relative survival advantage ratio of country j. Accordingly, the difference between $\hat{F}$ and F^{sb} is attributable only to abnormalities in the observed trend in sex ratio at birth in India. Similarly, F^{r} is derived by combining the corrected age structure and relative survival advantage ratios of India with the sex ratios at birth for country j. Thus, the difference between $\hat{F}$ and F^{r} is attributable only to 'lowness' of the relative survival advantage ratios or 'excess' female mortality in India.

Now, it is possible, employing ${}^{i}F$, $\hat{F}$, F^{r}, F^{sb}, and ${}^{j}F$, to quantify the extent of the 'lowness' of the sex ratio in India attributable to young age structure or 'lowness' of demographic development, 'lowness' of the ratio of relative survival advantage or 'excess' female mortality and abnormality in sex ratio at birth. It needs to be noted that the extent of 'lowness' of the observed sex ratio in India is assessed by estimating the number of

[5] The construction of the female headcount ratios adjusted for age-structure, relative survival advantage of females and the sex ratio at birth is, somewhat, similar to the procedure adopted in Dereze and Sen (1995). They apply the age-structure of 1901 to the female-to-male ratio of 1981 to obtain the age-structure adjusted female-to-male ratio in 1981 in India. Here, the age-structure adjusted for 'excess' female mortality in India at time t is applied to the sex ratio in each age a of the population for country j at time t. This procedure helps to arrive at the age-structure adjusted headcount ratio of females which is employed to judge the contribution by young age structure of India to the observed 'lowness' of the sex ratio in India at a particular point of time.

'missing' women. 'Missing' women is the count of women required to make the sex ratio in India equal to that of country j. Thus the total number of 'missing' women is estimated as:

$$TMW = [({}^{j}F\ {}^{i}P^{m})/(1-{}^{j}F)]-{}^{i}P^{f} \qquad \text{... (10),}$$

where TMW is the total number of missing women in India; ${}^{i}P^{m}$ and ${}^{i}P^{f}$, respectively, are observed total male and female populations in India; and ${}^{j}F$ is the population sex ratio of country j. The total number of 'missing' women (TMW) could be decomposed into four components. They are missing due to (1) young age structure or 'lowness' of demographic development, (2) 'lowness' of the ratio of relative survival advantage of females or 'excess' female mortality, (3) abnormality in sex ratio at birth in India vis-à-vis country j, and (4) 'missing' due to the interaction effect of age structure, 'excess' female mortality and sex ratio at birth differences. The last term is hard to interpret. However, since this term usually accounts for a very small proportion of TMW, its contribution may be neglected.

The estimation of the numbers of 'missing' women attributable to young age structure, abnormality in sex ratio at birth, 'excess' female mortality and the interaction effect at a point of time in India is detailed in what follows. 'Missing' women accounted for by longevity or age structure impact, denoted as MW^{a}, is obtained as:

$$MW^{a} = [({}^{j}F\ {}^{i}P^{m})/(1-{}^{j}F)] - [(\hat{F}\ {}^{i}P^{m})/(1-\hat{F})] \qquad \text{... (11),}$$

The numbers of 'missing' women attributable to (1) the 'lowness' of the relative survival advantage ratio in India, MW^{r}, and (2) abnormality in the sex ratio at birth in India, MW^{sb}, respectively, are obtained as follows:

$$MW^{r} = [(\hat{F}\ {}^{i}P^{m})/(1-\hat{F})] - [(F^{r}\ {}^{i}P^{m})/(1-F^{r})] \qquad \text{... (12);}$$

and

$$MW^{sb} = [(\hat{F}\ {}^{i}P^{m})/(1-\hat{F})] - [(F^{sb}\ {}^{i}P^{m})/(1-F^{sb})] \qquad \text{...(13).}$$

Given, TMW, MW^a, MW^r, and MW^{sb}, the 'missing' women attributable to the complex interaction of age structure, relative survival advantage, and sex ratio at birth, denoted as IMW, is obtained as a residual as follows: $IMW= [TMW-(MW^a + MW^r + MW^{sb})]$. Given, the decomposition procedure, in what follows, the selection of the 'norm' or the country employed to assess the 'lowness' of the sex ratio in India is discussed.

4. On the Choice of the 'Norm'

As indicated earlier, I believe that in none of the developed countries discrimination against females results in excess female mortality. Accordingly, one could employ the sex ratio of any one of the developed countries as the 'norm'. However, in order to decompose the extent of 'lowness' of the sex ratio in India into the 4 components, listed above, data on: (1) annual time series on the sex ratio at birth of all the age cohorts that constitute the population, and (2) age-specific sex ratios of the population present at a point of time are required. Data on both the variables could be easily accessed only for the two countries Japan and Finland. An examination of the age distributions of sex ratios of the populations of both the countries indicates the presence of abnormalities at the upper end of the age spectrum. Such abnormalities[6] are probably attributable to the impact of the First and the Second World Wars (See, in this connection, Klasen and Wink (2002a)). For this reason, age specific sex ratios of these two countries, for which requisite data are available, could *not* be employed as 'norms'. Sweden, a country known for its neutrality[7] during the First and Second World Wars, appears to be a better candidate. However, for Sweden, while age-wise data on sex ratios are available on the Internet, time series data on sex ratio at birth are not easily accessible.

To overcome the problems of non-accessibility of data and hence the choice of the country, the following procedure has been employed. The female-to-male ratio (FMR)

[6] An examination of the age-sex-ratio curves (not provided here, but will be made available on request) for Japan, for the year 1990, and Finland, for the year 1991, show that there exist some abnormalities in the distributions of sex ratios across age in these countries. In the age-sex-ratio curve for Japan there exists a hump in the age range 65-75. In the case of Finland one observes that the age-sex-ratio curve displays very steep increases after age 65.

[7] It appears that Swedish men took part in the Second World War, but since the country itself had maintained neutrality, the impact of World Wars on the overall sex ratio and the age structure of Swedish population appears to be relatively small. Accordingly, the age-sex-ratio curve, examined for the year 1991, for Sweden does not display the presence significant abnormality.

employed — employed to estimate the number of 'missing' women in China, South Asia, West Asia and North Africa — by Sen (1990) at 1.05 (or 1050[8] females per one thousand males) has been adopted as the 'norm' to judge the 'lowness' of the overall sex ratio of India's population. This adoption solves the problem with respect to the overall sex ratio 'norm'. However, to effect the decomposition suggested earlier, data on age-specific sex ratios, the age structure, and the sex ratio at birth are required. As mentioned earlier, the age distribution of the sex ratio in Sweden does not display any abnormality. However, the overall sex ratio of Sweden's population is observed to be lower than the 'norm' adopted here. For this reason, the distribution of the sex ratio across age in Sweden needs to be adjusted in such a way that the overall sex ratio at 0.5122 (corresponding to an FMR of 1050) $= \sum_{a=0}^{\bar{a}} {}^{s}\varphi^{*}(a){}^{s}F^{*}(a)$. Notice here that a represents age, $\bar{a}$ indicates the age of the oldest person, superscript s represents Sweden, superscript * indicates that the variable is adjusted to make the overall sex ratio equal to 0.5122, φ is the proportion of the population, and F is the female headcount ratio. Notice that the adjusted age distribution rather than the observed one for Sweden is employed. This change in the use of the variable is necessitated by the correction made to the distribution of females in each age a for Sweden to make the overall sex ratio to correspond to the 'norm' adopted. Notice also that, as in the previous section, subscript t has been suppressed.

To arrive at the adjusted age-specific sex ratios and the adjusted age structure, first, the total number of women expected to be present at time t to make the population sex ratio of Sweden equal to 0.5122 has been estimated as: ${}^{s}W^{*} = [(0.5122\,{}^{s}P^{m})/(1-0.5122)]$. Where ${}^{s}W^{*}$ and ${}^{s}P^{m}$, respectively, are the total number of women expected to be present, and the total number of males reported to be present in Sweden. Employing ${}^{s}W^{*}$, the number of females expected to be present in each age a in Sweden has been estimated as: ${}^{s}P^{*f}(a) = ({}^{s}\varphi^{f}(a)\,{}^{s}W^{*})$, where ${}^{s}\varphi^{f}(a)$ is the share of total females in each age a in Sweden. Now, it is easy to estimate the corrected sex ratio in each age a at time t in Sweden as: ${}^{s}F^{*}(a) = ({}^{s}P^{*f}(a)/($

[8] I do not believe that the overall sex ratio of Sweden is affected by gender discrimination in survival. Accordingly, the overall sex ratio of that country could be employed as the 'norm'. However, since Sen (1990) suggests that the female-to-male ratio in populations where men and women receive similar care is observed to be around 1.05, while this is questionable, has been adopted here as the 'norm'. It may also be noted that the objective in this paper is to identify the contributions of the constituent elements of the sex ratio to the 'lowness' of the sex ratio in India, and not obtaining an accurate estimate of 'missing' women in India.

${}^{s}P^{*f}(a)+{}^{s}P^{m}(a))$. Employing the estimated number of females expected to be present in each age in Sweden, the corrected population share in each age a is obtained as: ${}^{s}\varphi^{*}(a) = [{}^{s}P^{*f}(a)+{}^{s}P^{m}(a)]/[{}^{s}P^{m}+{}^{s}W^{*}]$. Thus the corrected population share and corrected sex ratio in each age a for Sweden at time t have been obtained. It may also be noted, as mentioned earlier, that data on the sex ratio at birth are not easily accessible for Sweden. To overcome this difficulty, the data on sex ratio at birth for Finland are employed as a proxy for sex ratio at birth in Sweden. Accordingly, the ratio of relative survival advantage of females in each age a in Sweden has been obtained as: ${}^{s}r^{*}(a) = {}^{s}F^{*}(a)/{}^{f}F^{0}_{t-a}$, where ${}^{f}F^{0}_{t-a}$ is the sex ratio at birth for Finland. Notice here that in accordance with the fact that age-specific sex ratios of Sweden have been corrected, ${}^{s}F^{*}(a)$ instead of ${}^{s}F(a)$ has been employed in computing ${}^{s}r^{*}(a)$.

Finally it needs to noted that the variables ${}^{j}F(a)$, ${}^{j}r(a)$ and ${}^{j}F^{0}_{t-a}$ have been replaced, respectively, by ${}^{s}F^{*}(a)$, ${}^{s}r^{*}(a)$ and ${}^{f}F^{0}_{t-a}$ in all the relevant equations in section 3. Similarly the variable ${}^{j}F$ has been replaced by the overall sex ratio 'norm' at 0.5122, that corresponds to an FMR of 1.05 employed by Sen (1990), in the equation used for estimating TMW.

5. Sources of Data and the Method Employed to Generate the Time Series on Sex Ratio at Birth in India[9]

It may be recalled that the decomposition exercise requires: (1) time series data on sex ratio at birth for Sweden and India, and (2) sex ratio in each age for the years 1991 and 2001 for the two countries. As noted earlier, time series data on the sex ratio at birth for Sweden are not easily accessible. Hence the time series data available at http://www.joensu.fi/statistic/lin/alho/7_3_Sex_ratio.html, based on Statistics Finland, for Finland is employed as a proxy for the time series on sex ratio at birth for Sweden. Data on sex ratio at birth in India are not available. For this reason, Subramanian and Jayaraj (2007) had resorted to estimating the sex ratio at birth for the years 1901 to 1991 employing an indirect method. The procedure employed by them is described below.

In order to construct an annual time series on sex ratios at birth for India Jayaraj and Subramanian (2007) had resorted to the 'reverse survival method'. To employ the reverse survival method, an annual time series on the male and female populations less than a year

[9] This section too relies heavily on Jayaraj and Subramanian (2007).

old and the annual time series on male and female infant mortality rates are required. A brief account of the data sources and assumptions employed by them to construct the annual time series data on sex ratio at birth for India is provided here.

It is important to note, in this context, that the construction of the time series on male and female populations less than a year old had been complicated by over-time changes in the territorial boundaries of India. Independence obtained in 1947 occasioned a change in the boundary of India. Changes were effected to the territories of states in 1956 as a result of reorganisation of states within the country. The coverage of census operations, which differed over time, affected the geographical unit of India for which the time series could be constructed. To be more precise, census was not conducted in 1981 and 1991, respectively, in the states of Assam and Jammu and Kashmir. For these reasons, to make the inter-temporal comparisons consistent Jayaraj and Subramanian (2007) had left out of reckoning the states of Assam and Jammu and Kashmir from India as constituted at the time of independence. They had employed data available in Census of India (1961a), which permit the reconstruction of over-time State-wise estimates of male and female populations for the geographical unit of 'India' as defined excluding the states of Assam and Jammu and Kashmir from post-1947 India.

Jayaraj and Subramanian (2007) had constructed the annual time series data on male and female populations less than a year old along the following lines. They had employed data on the proportions of males and females less than a year old available for each of the Census years 1901, 1911, 1921 and 1931 in Census of India 1931. For the years 1941 and 1951 these proportions were computed making use of the data from Census of India 1951a and b. Absolute number of males and females less than a year old had been obtained by application of the proportions to the total populations as recorded in the relevant Censuses. For the years 1961, 1971, 1981 and 1991, the male and female populations less than a year old had been obtained from the corresponding Censuses for these years by aggregating the relevant population totals across the States of the Indian Union. These data had been employed to compute the annual compound growth rates of females less than a year old and males less than a year old for each decade between one Census year and the next. Computed annual compound growth rates had been used to estimate the less-than-one-year female population and the less-than-one-year male population in each of the nine years between a pair of successive Census years. In this manner, they had constructed an annual time-series of the female and male populations of age less than one year from 1901 and 1991. Employing the same procedure, I extend the coverage to include the decade between 1991 and 2001. For the year 2001, the single year age returns are available for all-India (including the states of Assam and Jammu and Kashmir) in Census of India (2001). However, for the two states Assam and Jammu and Kashmir, single year age returns of male and female populations are not available. Hence, the total female and male populations of Assam and Jammu and Kashmir have been subtracted, respectively, from the all-India total female and male populations. Thus, the total female and male populations of India excluding Assam and Jammu and Kashmir have been obtained. The age distributions of females and males, respectively, for all-India have been employed to obtain, respectively, the age distributions of female and male populations for India excluding Assam and Jammu and Kashmir. It needs to be noted here that the Indian census data suffer from considerable age misreporting and age less than one year (frequently referred to as age zero) is unlikely to be an exception to the rule.

The time series on male and female infant mortality rates had been constructed largely from data generated by the Civil Registration System, published in different sources for different periods. The Civil Registration System (CRS), as noted by Visaria (1971), suffers from incomplete registration of births and deaths. Visaria also notes that the extent of such under-registration varies across both regions and the sexes. Since there is no other alternative, as Jayaraj and Subramanian observe, one is constrained to use the data provided based on the CRS. Further, for the years 1901-1947, and for want of an alternative, they had employed figures of infant mortality valid for British India as valid for 'India'. They also note that, despite their best efforts at accessing direct statistical sources or compilations made by other researchers, they were unable to obtain infant mortality figures for eleven specific years in the 91-year time series from 1901 to 1991: the gaps for these eleven years were filled in by resort to simple linear intrapolation. The time series on female and male infant mortality rates generated by them have been extended to cover the period 1991 to 2001. For the first five years in the decade 1991-2001, data on female and male infant mortality rates have been obtained from the annual publication titled Vital Statistics of India, based on CRS. For the years 1996-2001, required data on infant mortality rates based on CRS could not be obtained. For this reason, the data gaps in infant mortality rates have been filled by resorting to linear extrapolation. Specifically, the estimated trend lines, respectively, of female and male infant mortality rates for the period 1976 to 1995 have been extrapolated to obtain data on, respectively, male and female infant mortality rates for the years 1996 to 2001. The specific assumption made in this context needs to be noted. It is assumed that the trends in infant mortality rates of only the recent past (i.e. the trend in the two decades that precede the year 1996) determine the levels of infant mortality rates in the years 1996 to 2001. The sources of data employed by Jayaraj and Subramanian (2007) and the additional sources employed in this paper are provided in Appendix 1.

6. Results and Discussion

The attempt in this paper has been to explore the importance of 'excess' female mortality and abnormality in the sex ratio at birth in explaining the 'lowness' of the sex ratio of India's population in 1991 and 2001. In this context, it has been identified that demographic development that gets reflected in longevity and fertility are important factors affecting the level of the sex ratio of a population. Age structure captures the impact of demographic development. Accordingly, attempt has been made to identify the contributions by the young age structure, abnormality in sex ratio at birth and 'lowness' of relative survival advantage of females to total number of 'missing' women in India. To this end, data on the age distributions of the populations of Sweden and India in 1991 and 2001, and the time series data on the sex ratio at birth for Finland and India for the period 1901 and 2001 have been employed. It may be noted here that data on these variables are not provided here, but will be made available on request. Notice also that the population distributions are truncated at age 90. A truncation necessitated by the fact that it is possible to construct the sex ratio at birth series for India only since 1901. The birth cohort of 1901, the first birth cohort in the time series, constitutes the age cohort of 90 in 1991. To make the comparison of the results between 1991 and 2001 consistent, the age distribution in 2001 is also truncated at age 90. This truncation is likely to be off little consequence. For the attempt here is to get a quick fix on the broad orders of magnitude of the contributions of the constituent elements of the sex ratio of a population to the observed 'lowness' of the overall sex ratio in India. Moreover, the age interval [0, 90] accounts for as much as 99.37 and 99.63 per cent of the total populations in India, respectively, in 1991 and 2001. The share of the relevant age interval in the estimated (estimated adjusting the female population in such a way that the overall sex ratio corresponds to the 'norm' at 0.5122) total population of Sweden in the years 1991 and 2001, respectively, are at 99.63 and 99.43 per cent. The overall sex ratio 'norm' at 0.5122 becomes 0.5113 and 0.5108, respectively, for the years 1991 and 2001 because of the truncation of the age distribution of the populations at 90 years of age.

Data on: $\hat{F}$, F^r, F^{sb}, ${}^sW^*$, and male and female populations of India and Sweden in the age range [0, 90] are provided in Table 1 for the years 1991 and 2001. Table 2 presents the estimates on TMW, MW^a, MW^r, MW^{sb}, and IMW, for the years 1991 and 2001. It may be recalled that: (1) $\hat{F}$, given the levels of demographic and economic developments achieved, is the population sex ratio that would obtain in India in the absence of discrimination against females; (2) F^r is the sex ratio that would obtain in India if only the impact of 'excess' female mortality is present; and (3) F^{sb} is the sex ratio that would obtain in India if only the abnormality in sex ratio at birth is present. ${}^sW^*$, is the total number women expected to be present in Sweden to make the female-to-male ratio equal to 1050. TMW is the total number of missing women in India. MW^a, MW^r, and MW^{sb}, respectively, are the estimated number of missing women accounted for, respectively, by young age structure or 'lowness' of the demographic development; 'excess' female mortality or 'lowness' of the relative survival advantage of females; and abnormality in sex ratio at birth in India. IMW is the estimated number of 'missing' women accounted for by the complex interaction of variations in the three factors: age structure, sex ratio at birth and relative survival advantage of females, and it is hard to interpret this term.

Table 1: *Data Population and Sex Ratios*

Year	Population of Sweden (in the age range 0 and 90)		Population of 'India' (in the age range 0 and 90)		${}^sW^*$	Population Sex Ratio 'Norm'	$\hat{F}$	F^r	F^{sb}
	Females	Males	Females	Males					
1991	4,349,823	4,262,564	390,381,220	420,599,135	4,484,154	0.5113	0.4984	0.4757	0.5036
2001	4,462,763	4,396,154	477,088,079	511,113,669	4,628,867	0.5108	0.4992	0.4803	0.5008

Note: 1). ${}^sW^*$ is estimated in relation to the total population and not the population in the age range [0, 90].
2) The population sex ratio 'norm' differs from 0.5122 because of the truncation of the distribution of population at age 90.
Source: Provided in Appendix 1.

The number presented in Tables 1 and 2 are, largely, self-explanatory. Hence, only the important points that emerge are highlighted here. Notice that $^{s}W^{*}$ for the years 1991 and 2001, respectively, are estimated to be at 4,484,154 and 4,628,867. But the actual number of women reported to be there in Sweden in 1991 and 2001, respectively, are at 4,373,496 and 4,500,683. Simple calculations, based on the numbers presented above, suggest that there were 110,658 (4484154-4373496) and 128,184 (4628867-4500683) women 'missing' in Sweden, respectively, in the years 1991 and 2001. These numbers suggest that between 1991 and 2001 the count of 'missing' women had increased in Sweden!

Table 2: *Estimates on 'Missing' Women*

Year	Total 'Missing' Women: **TMW**	'Missing' Women Attributable to Age Structure Difference: MM^{a}	'Missing' Women Attributable to 'Excess' Female Mortality: MW^{f}	'Missing' Women Attributable to Abnormality in Sex Ratio at Birth: **MW^{sb}**	'Missing' Women Attributable to Interaction Effect: **IMW**
1991	49,687,852 (100.00)	22,219,863 (44.72)	36,242,793 (72.94)	-8,874,270 (-17.86)	99,466 (0.20)
2001	56,547,433 (100.00)	24,112,648 (42.64)	37,110,156 (65.63)	-3,136,331 (-5.55)	-1,539,040 (-2.72)

Note: Figures in parentheses are the per cent contribution by the relevant factor to TMW.
Source: As in Table 1.

The figures provided in parentheses in Table 2 indicate the contribution of each factor to total estimated number of 'missing' women in India in the age range [0, 90]. The numbers in column 1 suggest that the absolute number of missing women has increased from around 50 million in 1991 to 56.5 million in 2001. Notice here that the population sex ratio 'norm' employed at 0.5113 and 5108, respectively, for the years 1991 and 2001 are substantially higher than the $\hat{F}$ values, at 0.4984 and 0.4992 for the respective years. If $\hat{F}$ is employed to estimate (estimated as the difference between TMW and MM^{a}) the number of 'missing' women, the count turns out to be around 27.5 and 32.4 million, respectively, in 1991 and 2001. These figures are much lower than TMW for the respective years. Since the difference between TMW and (TMW-MM^{a}) is attributable to young age-structure of India's population, the latter estimates are preferable. Even the preferred estimates suggest that the problem of 'missing' women is vast in India.

While the absolute number of 'missing' women has increased between 1991 and 2001, the ratio of 'missing' women (TMW) to total enumerated women in the appropriate age range has registered a marginal decline[10] from 12.73 to 11.85 per cent. This decline is in accordance with the marginal increase (female to male ratio increased from 929 to 933) observed in the sex ratio of India's population between 1991 and 2001. Accordingly, the results suggest that *the observed increase* between 1991 and 2001 in TMW, as Sen (2003) has observed, is attributable to population growth effect and, probably, to the declining trend in sex ratio at birth.

In this connection, digressing a little bit from the results presented in this paper, attention is drawn to the results presented in Jayaraj and Subramanian (2007). Their results indicate that while the decline in the sex ratio of India's population between 1961 and 1971 is, almost exclusively, attributable to deterioration in relative survival advantage of females, the decline between 1981 and 1991 is, largely, explained by the declining trend in the sex ratio at birth. The questions that arise, in this context, are: (1) is the declining trend in the sex ratio at birth unique to India? and (2) how much of the declining trend in the sex ratio at birth could be attributed to foeticide? It appears that the declining trend is not unique to India. Declining trends in sex ratio at birth had occurred in countries such as England and Wales (Moore (1958)) Sweden (Johansson and Nygren (1991)). Data[11] available (not reported here, but will be made available on request) for Finland suggest that the female-to-male ratio at birth: (1) was in the region of 980-990 (very close to the range observed for India at the beginning of the 20th century) in the early 1750s; (2) declined to a low figure of 931 in 1911 (close to the figure estimated for India in 1991); and (3) experienced a marginal recovery since 1911, and at present is observed to hover around 950. Time series data[12], available for Japan from 1872 to 2002, interrupted for three years 1944, 1945, and 1946, too display a significant[13] declining trend. Thus, it appears that the declining trend in the sex ratio at birth is not unique to India and it had occurred in other countries, which are not

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[10] The decline is from 7.04 per cent to 6.80 per cent when 'missing' women are estimated employing $\hat{F}$ as the appropriate 'norm'.

[11] Available at: http://www.joensu.fi/statistic/lin/alho/7_3_Sex_ratio.html, are based on Statistics Finland are employed here.

[12] Available at: www.stat.go.jp/data/chouki/zuhyou/02-21.xls, which is based on: Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labour and Welfare, Japan are used describe the trend.

[13] The estimated linear trend co-efficient of female-to-male ratio at -0.1159 is statistically significant at 1 per cent level.

known to have pronounced son preference, too. It is possible that such declining trends have been mediated by 'benign' factors related to development: both economic and demographic. More specifically, improvements in maternal healthcare and nutritional status of women could have contributed to the declining trend in sex ratio at birth both in India and elsewhere (see, on this line of reasoning, Schultz (1918) and Jayaraj and Subramanian (2004)). In the absence of reliable data on sex ratio at birth and on sex-selective abortion, it is hard to quantify the extent of the influence of discrimination in natality on sex ratio at birth in India. Often the sex ratio of the age-group 0-4 or 0-6 is employed as a proxy for sex ratio at birth. Sex ratio of the age-group 0-6 observed to be around 927 is considered to be low (see, Sen (2003) compared to the norm employed at 950. In this connection, it needs to be noted that the data on sex ratio at the lower end of the age-spectrum (of age group 0-4 or 0-6) appear to suffer from progressive deterioration in the count of the population. The progressive deterioration could be understood by comparing the population in the age-group 0-4 in a census with the enumerated population in the age-group 10-14 in the next census (notice that population censuses are conducted in India at the start of each decade since 1901). Such comparisons over successive pairs of censuses starting from 1961 indicate the following. In India, as constituted excluding the states of Assam and Jammu and Kashmir, the population of males enumerated in 10-14 in successive censuses of the pairs: 1961, 1971; 1971,1981; 1981,1991; and 1991, 2001; respectively, exceeded that of the population in the age-group 0-4 in the previous census by a factor of, respectively, 8.7, 16.13, 20.45, 24.40 per cent. These figures for girls are observed to be at 0.00, 7.63, 11.05, and 17.11. These numbers clearly suggest that the undercount of both boys and girls increase over time in the age-group 0-4. The implications of such progressive undercount to the declining trend and 'lowness' of the sex ratio of the age-group 0-4 or 0-6 at a particular point of time is difficult to assess. However, the evidence provided above on the progressive undercount of the population, particularly at the lower end of the age spectrum, indicates the need for validating the population census data for internal consistency. It needs to be emphasised here that these issues are brought to attention *not* to discredit the notion that female foeticide is prevalent in India, but to indicate that it is hard to quantify its significance. It is probable that the influence of this phenomenon on the trend and the 'lowness' of the sex ratio at birth is limited (see, for example, Bhat 2002)).

Getting back to the numbers presented in Table 2, the results indicate that, despite the fact that the sex ratio at birth appears to be declining in India almost since the early 1930s (see, in this context, Jayaraj and Subramanian (2004)), the sex ratio at birth effect on TMW in India is negative. In other words, the history of sex ratio at birth holds up the population sex ratio in India. Accordingly, even as late as in 2001, discrimination in natality (attributed largely to foeticide) has not contributed to 'missing' women in India. However, the negative contribution which was around 18 per cent in 1991 has declined to 5.55 per cent in 2001. This decline suggest that the sex ratio at birth, if the declining trend in it is not halted, will emerge as an important candidate explaining the 'lowness' of the overall sex ratio in India in the near future.

The numbers presented in Table 2 suggest that, even in the latest census year 2001, the effect of the history of 'excess' female mortality accounts for around 66 per cent of the total 'missing' women or 'lowness' of the sex ratio of India's population. Also, it is important to note that the contribution of 'excess' female mortality to TMW has declined from around 73 in 1991 to around 66 per cent in 2001. This result indicates that the impact of subtle forms of discrimination, throughout the life span of women, on the sex ratio has registered only a marginal decline. Thus, the results indicate that there is a case for not neglecting or diverting attention from subtle forms of discrimination that affect the relative survival chances of women in India.

The results also suggest that the contribution of young age structure or 'low' demographic development to TMW in India in 2001 was around 43 per cent. The importance of age structure in accounting for the 'lowness' of the weight of women in India's population suggests that the wellbeing of both the overall population and, probably, that of the population at the upper end of the age spectrum needs to be considerably improved.

7. Concluding Observations

The objective in this paper has been to identify the relative importance of discrimination in natality and excess female mortality in accounting for the 'lowness' of the sex ratio in India. 'Lowness' of the sex ratio was sought to be quantified by estimating the number of 'missing' women in India. The contributions of young age structure or 'lowness' of demographic development, abnormality in sex ratio at birth and 'excess' female mortality to the count of missing women in India in 1991 and 2001 have been estimated. The results indicate that the contribution of 'excess' female mortality to the count of 'missing' women is observed to be around 66 per cent in 2001. It is important to note here that expectation of life at birth differential in India has switched in favour females since the mid-1980s. Despite such a switch, 'lowness' of the relative survival advantage of females emerge as the single most important determinant of the deficit of women in India in 2001. This suggest that while there might have been improvements in relative survival chances of females in India, the levels of mortality advantage experienced by Indian females' fall short of their counterparts in the developed countries.

The results also suggest that the contribution of abnormality in sex ratio at birth to the count of 'missing' women is negative. However, as pointed out earlier, the trend in the sex ratio in the recent period is explained largely by the trend in sex ratio at birth. Thus, as Sen (1987) had argued, it is important to draw a distinction between level (stock) and trend (flow) in the female-to-male ratio. Distinguishing the trend from the level not only has intrinsic merit but also has practical utility. In the present case, policy formulations based on an analysis of the trend or changes over time will result in focussing, somewhat, exclusive attention on the declining trend in sex ratio at birth, which may lead to the neglect of "...social practices that lead to excess female mortality [which] are far more subtle and widespread ..." (Dreze and Sen (1995: p.144)) that still persist.

The results also suggest that a little more than two-fifths of the 'lowness' of the sex ratio in India is attributable to the age structure which is relatively dense in young age-groups in India. This result points to the importance of demographic development in determining the sex ratio of a population. To put it differently, elimination of discrimination against females while is a necessary condition to arrive at the level of the sex ratio employed as the 'norm', that in itself may not be sufficient. In India, expectation of life at birth must increase and fertility must fall to levels achieved in the developed countries. Thus, the results suggest that there is a case for attending to improving the wellbeing of the population in general, and that of women in particular. To put it differently, there is a case for exerting pressure on the state to improve the availability of infrastructural facilities (or basic amenities) such as: roads, hospitals, schools, protected drinking water, clean fuel, and public transport. More importantly, there is a case for maintaining pressure on the state to provide for social security measure such as widow pension, and free healthcare for women.

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Appendix 1: Sources of Data

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