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Mortality, Fertility, and Gender Bias in India: A District-Level Analysis

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INDIA IS A COUNTRY of striking demographic diversity. Even broad comparisons between its states bring out enormous variations in basic demographic indicators. At one end of the scale, Kerala has demographic features that are more typical of a middle-income country than of a poor developing economy, including a life expectancy at birth of 72 years, an infant mortality rate of 17 per thousand live births, a total fertility rate (1.8 births per woman) below the replacement level, and a ratio of females to males in the population well above unity (1.04). At the other end, the large North Indian states find themselves in the same league as the world's least developed countries in terms of the same indicators. In Uttar Pradesh, for instance, the infant mortality rate is six times as high as in Kerala, the total fertility rate is 5.1, and the female–male ratio (0.88) is lower than that of any country in the world.[1]

India is also, increasingly, a country of rapid demographic change. As in many other developing countries, mortality rates in India have declined significantly in recent decades; the infant mortality rate, for example, has decreased by about 50 percent between 1961 and 1991. The same period has seen a sustained decline in fertility, particularly in the South Indian states (in Tamil Nadu, the total fertility rate declined from 3.5 to 2.2 during the 1980s). There have also been significant changes in the relative survival chances of men and women.[2]

Apart from being of intrinsic interest, these interregional and intertemporal variations provide useful opportunities to study the determinants of demographic outcomes in India. This article examines some of the relevant relationships based on a cross-section analysis of district-level data from the 1981 Census of India.[3]

Our sample consists of 296 districts for which detailed information is available. The demographic outcomes under study are the child mortality rate, the total fertility rate, and the relative survival chances of male and female children. The choice of explanatory variables is partly guided by recent analyses of the determinants of demographic behavior, but also reflects the limitations of available statistical sources. Particular attention is paid to the influence of per capita income, male and female literacy, female labor force participation rates, levels of urbanization, availability of health care facilities, and related socioeconomic variables. We begin with a brief discussion of the relevance of different explanatory variables, before turning to the presentation and interpretation of our results.

Issues and hypotheses

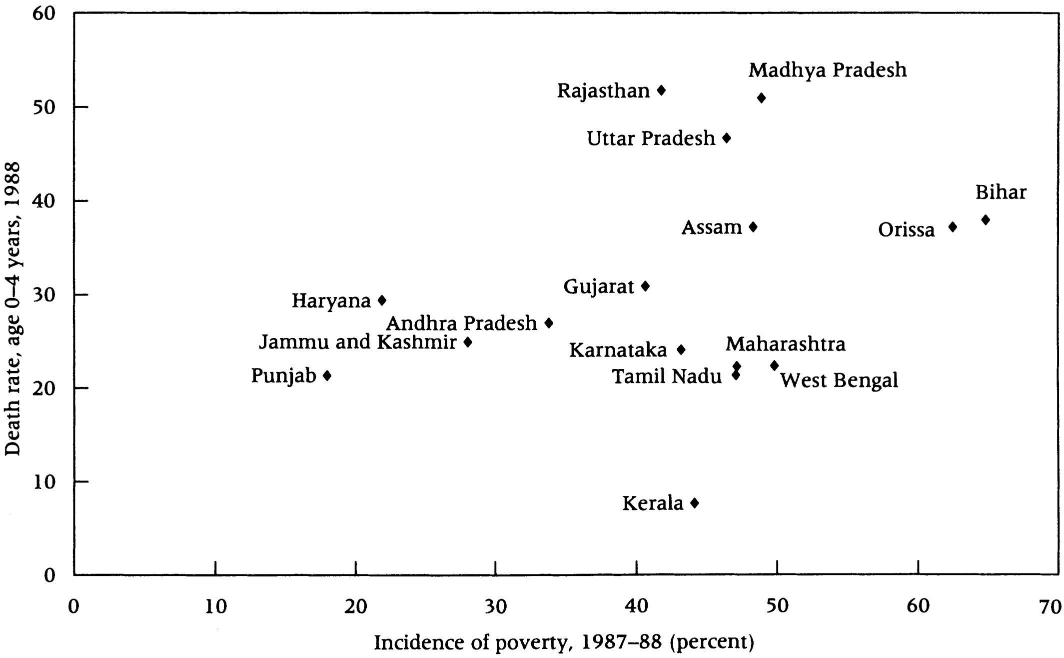
In this section we discuss some plausible relationships between demographic outcomes and basic personal and social characteristics. We start with mortality and fertility and then take up the issue of gender bias.

Economic development and the demographic transition

Demographic change (in particular, the "demographic transition" from high to low levels of mortality and fertility) is sometimes thought of as a byproduct of economic growth and rising incomes. Certainly a broad inverse association can be observed, at the international level, between per capita gross national product, on the one hand, and mortality and fertility levels, on the other. Evidence of a causal relationship abounds, with rising incomes typically leading to some reduction of mortality and fertility. But recent research suggests that the "income effect" can be quite slow and weak, and that other personal characteristics such as female literacy often have a more powerful influence on demographic outcomes.

The limited explanatory power of per capita income and related variables can be illustrated by considering the relationship between child mortality and the incidence of poverty (as measured by the "head-count ratio") in different states of India. The relevant information is presented in Figure 1.[4] The association between the two variables is clearly weak. Some aspects of this weakness of association are striking; for instance, rates of child mortality are more than six times higher in Uttar Pradesh than in Kerala, even though the head-count ratios are similar—and close to the all-India average—in the two states. This need not mean that income and expenditure have no effect on child mortality and related demographic outcomes. There is plenty of evidence, for India as for many other countries, that mortality declines with higher income (this elementary relationship also emerges in the empirical analysis presented below). The point is that

FIGURE 1 Relationship between poverty and child mortality in 16 Indian states



NOTE: The measure of poverty is the head-count ratio, which indicates the proportion of the population living in households with per capita expenditure below a specified poverty line.
SOURCES: Minhas, Jain, and Tendulkar 1991; Government of India 1990: Statement 39, p. 48.

many other factors, not all of which are themselves strongly correlated with income, also have a strong influence on demographic outcomes.

The role of literacy

Among the factors other than private income that have a strong influence on fertility and mortality, basic education—especially female education—is now widely considered one of the most powerful. The close relationship between education and demographic change has clearly emerged in recent empirical studies.[5] A wide range of theoretical analyses from different disciplines points in the same direction.[6]

Considering fertility first, economic, demographic, and anthropological studies suggest specific ways in which female education contributes to fertility reduction. At a general level, it is useful to distinguish between the influences of female education on (1) desired family size, (2) the relationship between desired family size and planned number of births, and (3) ability to achieve the planned number of births.

Female education can be expected to reduce desired family size for several reasons. First, educated women are more likely to voice resentment at the burden of repeated pregnancies and to take action to lighten that burden. This may occur because educated women have other sources of prestige and fulfillment besides reproductive performance, more control over household resources and personal behavior, and greater involvement in reproductive decisions (Dyson and Moore 1983; Cain 1984). Second, educated women are likely to be less dependent on their sons as a source of social status and old-age security, and this too may lead to a reduction in desired family size. Third, educated women often have higher aspirations for their children, combined with lower expectations from them in terms of labor services provided (United Nations 1993). This may reduce desired family size if there is a perceived tradeoff between the number of children and their personal achievements. Fourth, the opportunity cost of time tends to be comparatively high for educated women, and this creates an incentive to minimize such time-intensive activities as childbearing and childrearing.[7] Further links of this kind have been found to have empirical relevance, usually implying a negative association between female education and desired family size.

Female education also affects the relationship between desired family size and the planned number of births. Specifically, since better maternal education reduces infant and child mortality (as discussed below), educated mothers are able to plan fewer births in order to achieve a particular family size. Maternal education also helps in achieving the planned number of births, by facilitating knowledge and command of modern contraceptive methods. This reduction of unplanned pregnancies is another basis of the negative relationship between female education and fertility.[8]

Some of the effects described in the preceding paragraphs, for example the reduction of fertility through lower child mortality, also suggest a negative link between paternal education and fertility. But it is clear that many of the links between education and fertility are likely to be much weaker for male than for female education.[9] In the statistical analysis below, we attempt to identify the separate contributions of male and female education to fertility reduction.

The relationship between maternal education and child mortality requires comparatively little elaboration. At the most obvious level, educated women are likely to be more knowledgeable about nutrition, hygiene, and health care. This aspect of maternal education may be particularly significant given the remarkably uninformed and deficient nature of child care practices in large parts of rural India. In villages of Uttar Pradesh, for instance, it is still common for cooked food to be left uncovered for long hours, for umbilical cords to be cut with unsterilized sickles, for children to be left unimmunized, and for extraordinary beliefs to be entertained about the causes of simple childhood diseases such as tetanus and diarrhea.[10] In addition, basic education can be important in helping mothers to demand adequate attention to children's needs by other members of the household, to take advantage of public health care services, and generally to pursue their aspirations (including the wellbeing of children) in the family and society in a more informed and effective way.

In assessing the relationship between education, mortality, and fertility, it is important to remember that mortality and fertility tend to be positively related, in the sense that, other things being equal, mortality is likely to have a positive effect on fertility and vice versa. High fertility rates, for instance, are typically associated with short birth spacing, which is often detrimental to child health. Similarly, high child mortality rates raise the number of births required to achieve a given desired family size (in terms of surviving children), and this has the effect of elevating fertility. These interaction effects are also relevant in assessing the influence of other explanatory variables on mortality and fertility. We return below to their implications for estimation procedures and interpretation.

Other influences

Aside from the demographic impact of income and education, the influences of several other variables on mortality and fertility can be usefully investigated on the basis of district-level data for India.

One relationship of interest is that between female labor force participation and child mortality. It is difficult to determine a priori whether the effect of higher female labor force participation on child survival is likely to be positive or negative.[11] In the case of boys, two important effects work in opposite directions. First, involvement in gainful employment often enhances the effectiveness of women's agency roles in society and family, including those connected with child care. Second, the "double burden" of household work and outside employment can impair women's ability to ensure the good health of their children, if only by reducing the time available for child care activities (since men are typically reluctant to share the domestic chores).[12] In the case of girls, a third consideration is that higher levels of female labor force participation may enhance the importance attached to the survival of a female child. The net result of these different effects remains a matter of empirical investigation.

The effect of female labor force participation on fertility is more predictable. Generally, we expect greater female labor force participation to have a negative impact on fertility, since the double burden of household work and gainful employment makes repeated childbearing particularly stressful. It is, of course, also possible that fertility affects female labor force participation, since having many children makes it more difficult for women to take up gainful employment. This effect may not be important in India, where other social and economic factors are likely to be far more crucial determinants of female labor force participation. If the effect is important, however, some bias will be involved in using female labor force participation as an exogenous explanatory variable in analyzing the determinants of fertility (and also of mortality, given the interaction effects mentioned earlier). We therefore also present results based on treating female labor force participation as an endogenous variable (this essentially involves dropping female labor force participation from the set of explanatory variables in the "reduced form" equations).

The availability of health care services can reasonably be expected to have a negative impact (if any) on child mortality. However, the functioning of health services can be as important as their availability. Many studies have demonstrated the poor functioning of health services in large parts of India, especially the big North Indian states.[13] Many empirical studies have noted the widespread diversion of rural health care services to family planning campaigns.[14] In the absence of statistical information on these and other qualitative aspects of health care provision, quantitative indicators of available health facilities are likely to provide imprecise measures of the services actually supplied, and the relationship between health care provision and child mortality may be hard to identify. Similar caveats apply in the case of fertility. The fact that rural health services have given overwhelming priority to family planning in many Indian states may suggest a strong negative relationship between the availability of health services and fertility levels. But the validity of this inference is far from obvious, given the ineffective and even counterproductive nature of the top-heavy tactics that have often been used in rural India to promote family planning.

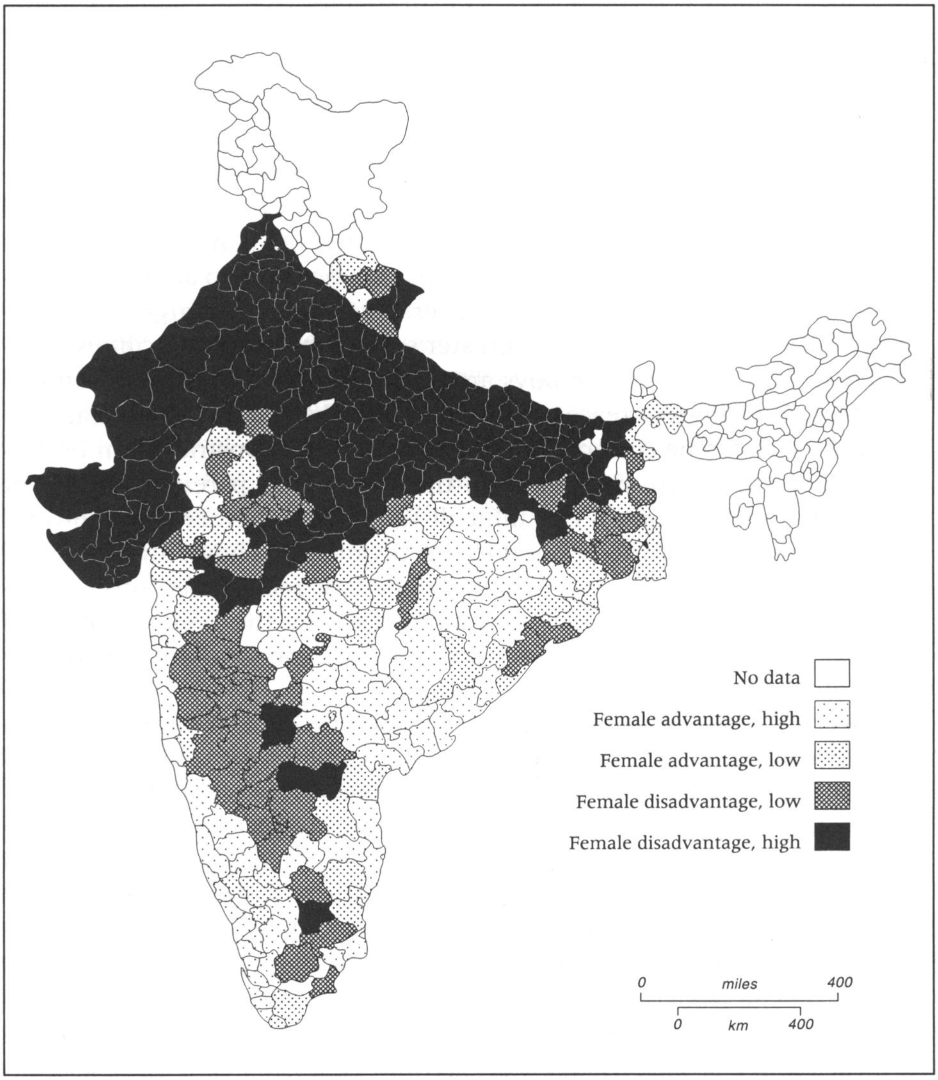
Another issue of interest is whether the identified relationships between demographic and socioeconomic variables are roughly the same in urban and rural areas. It is quite possible for urbanization to influence fertility and mortality independently of the other variables included in the analysis, through, for example, better access to various types of relevant information in urban areas.[15] Similarly, it is worth investigating whether the identified relationships vary significantly between social groups. In India, the contrast between "scheduled castes," "scheduled tribes," and other sections of the population is of particular interest.

Finally, the relationship between poverty, on the one hand, and mortality and fertility, on the other, deserves careful examination. We have already noted that the bivariate association between poverty and child mortality appears to be weak in India, judging from broad interstate comparisons (Figure 1). The question remains whether poverty has a strong effect on mortality or fertility after controlling for other explanatory variables. Also, quantitative estimates of that effect are of interest, especially in comparison with the effects of other variables. These estimates give us an idea of the relative effectiveness of different means of intervention aimed at more rapid reductions of mortality and fertility.

Gender bias

Relatively little is known about the antecedents of gender bias in child survival in India. The existence of a female disadvantage in large parts of the country has been clearly identified, and the regional patterns (see Figure 2) are well known.[16] But the social, economic, and cultural factors under-

FIGURE 2 Gender bias in under-five mortality rates, by district: India 1981



NOTES: Female disadvantage, high FD>5; female disadvantage, low 0<FD<5; female advantage, low –5<FD<0; female advantage, high FD<–5. For the definition of FD, see Table 1, p. 759.

lying these sharp regional contrasts remain a matter of speculation. In fact, the literature contains a number of contradictory claims and findings on this subject.[17] It has been suggested, for instance, that gender bias tends to diminish with higher female literacy (Bourne and Walker 1991) as well as with lower female literacy (Basu 1992); with higher levels of poverty (Krishnaji 1987; Dasgupta 1993; Miller 1993) as well as lower levels of poverty (Agarwal 1986); with higher levels of fertility (Das Gupta 1993, 1994) as well as lower levels of fertility (Basu 1992).

There are at least two reasons for this confusion. First, with respect to theoretical analysis, it is often difficult to predict whether the effect of a particular variable on gender bias in child survival is likely to be positive or negative, and plausible arguments can often be presented in both directions. Consider, for instance, what happens to the relative survival chances of boys and girls as a household's access to medical facilities improves. It has often been argued that, in a situation of widespread son preference, this improved access to medical facilities is likely to enhance the survival chances of boys more than those of girls (because of an anti-female bias in the use of additional health care facilities), and therefore to accentuate gender inequality in child survival. However, it has also been argued—sometimes by the same authors—that greater scarcity of medical facilities exacerbates gender bias, because boys are given priority in the use of limited resources. Both lines of reasoning are plausible, but, in any particular context, only one can be correct. Similarly, when other constraints on household opportunities are relaxed (e.g., through higher parental literacy or higher per capita income), it is difficult to predict whether the improved opportunities are likely to be used to the advantage of boys, and therefore to accentuate gender bias, or whether they will reduce the force of discriminatory practices that were initially caused by the limited nature of available opportunities. Different authors have tended to emphasize one or the other of these two plausible effects.

Second, when it comes to empirical investigation, the findings often depend on which variables are included in the analysis. It has been observed, for instance, that gender bias in child survival tends to be relatively low among poor households, among disadvantaged castes, and among households with high levels of female labor force participation.[18] But we also know that there is a good deal of colinearity between these three variables; only multivariate analysis can tell us whether, say, poverty has a positive or negative effect on gender bias independently of the influence of caste or female labor force participation. Similarly, an examination of the relationship between parental literacy and gender bias in child survival can be misleading if it fails to take into account other relevant variables. Indeed, if gender bias is lower among poorer households, it would be quite possible, in principle, to find a positive *bivariate* assocation between parental literacy and gender bias (given the positive correlation between poverty and illiteracy), even if literacy reduces gender bias at any given level of poverty.

Clearly, then, empirical investigation in a multivariate framework has much to contribute to the identification and quantification of relevant relationships. Two earlier studies illustrate the point. In a pioneering study, Rosenzweig and Schultz (1982) examined the relationship between differential adult employment opportunities and intrafamily resource allocation between girls and boys. Based on a multivariate statistical analysis of district-level census data for India in 1961 (supplemented with a similar analysis of household survey data collected by the National Council of Applied Economic Research), they found that improved employment opportunities for adult women tended to raise the relative survival chances of girls. This is in line with the predictions of the human capital approach adopted in that study. Most of the other variables included in the analysis did not have a statistically significant effect on relative survival chances.

More recent work by Kishor (1993, 1995) investigates the determinants of gender bias in child survival using district-level data from the 1981 Census of India. The author examines the relevance of two hypotheses, respectively stressing the influence of daughters' "economic worth" and "cultural worth" on their relative survival chances vis-à-vis male children. Economic worth is measured by female labor force participation. The incidence of patrilocal exogamy (measured, roughly speaking, as the proportion of women not born in their village of enumeration) is taken as an inverse indicator of cultural worth, which essentially refers to the influence of kinship systems on the valuation of female survival. Kishor finds that the relative survival chances of girls strongly depend on both economic and cultural worth (i.e., survival chances tend to be higher in districts where female labor force participation is higher, and where the incidence of patrilocal exogamy is lower).

The soundness of this dichotomy between economic worth and cultural worth (and of the identification of these notions with female labor force participation and patrilocal exogamy, respectively) is not entirely clear. It can be argued that both female labor force participation and patrilocal exogamy (or, more generally, kinship systems) have an economic as well as a cultural basis.[19] Similarly, both variables may influence the relative survival chances of girls through economic as well as cultural links.[20] Be that as it may, Kishor's study represents a major achievement in clarifying the respective influences of female labor force participation and kinship systems on relative female survival chances. It also yields insights into the relationship between gender bias in child survival and a range of other variables such as mortality and fertility levels, development indicators, and geographical location.

Many of these relationships also emerge in the analysis presented here. Although Kishor's analysis of gender bias and our own differ in approach, the results are broadly consistent, and the two studies can usefully be treated as complementary. Some of the important similarities and differences will be mentioned as we go along.

Claims and counterclaims

Before presenting our own results, it may be worth commenting further on the issues that have emerged from earlier studies of the relationship between gender bias in child survival and particular economic and social variables. The following discussion concentrates on the possible influence of four variables: female labor force participation, female literacy, poverty, and fertility.

Perhaps the only uncontroversial finding of earlier studies is that *female labor force participation* tends to be associated with lower levels of female disadvantage in child survival. The empirical studies of Rosenzweig and Schultz (1982) and Kishor (1993) both confirm this hypothesis. What remains unclear, however, is the precise mechanism underlying that relationship. There are a number of possibilities, including that female labor force participation: (1) raises the returns to "investment" in girls; (2) raises the status of women in society, and therefore the value attached to young girls; (3) lowers dowry levels, and therefore reduces the costs of rearing daughters; (4) makes women less dependent on adult sons for security in old age, and therefore reduces son preference; and (5) raises the bargaining power of adult women and their ability to resist male pressure to discriminate in favor of boys. As things stand, there is little evidence to distinguish between these alternative hypotheses.

The link between adult *female literacy* and gender bias in child survival is far from clear. In her analysis of data from the Khanna study in Punjab, Das Gupta (1987) found a positive bivariate association between anti-female bias and maternal education, and she suggested that educated women are in a better position to "keep the mortality of undesired children high by withholding the requisite care" (p. 84). It is a hard to believe, however, that it takes good education to discriminate between boys and girls. A different line of explanation, pursued in greater depth by Das Gupta and Mari Bhat (1995), is that educated mothers have lower fertility, which tends to be accompanied by higher gender bias.

Other studies have yielded a wide range of results. Empirical investigations have suggested that the relationship between maternal education and gender bias in child survival may be: (1) positive, as originally argued by Das Gupta (Bhuiya and Streatfield 1991); (2) positive in North India, but negative in South India (Basu 1992); (3) generally negative, but possibly positive in South India (Bourne and Walker 1991); (4) negative in the case of first daughters but positive for higher-parity daughters (Amin 1990); (5) negative (Simmons et al. 1982).[21] Other studies find, or suggest, that no simple relationship between the two can be established (Chen et al. 1981; Sen and Sengupta 1983; Caldwell, Reddy, and Caldwell 1989). The debate continues.

As to the influence of *poverty*, there is a widespread hunch that discrimination against female children is less intense among poorer households. Arguments along those lines have been advanced by Miller (1981, 1993), Krishnaji (1987), and Dasgupta (1993), among others. Some authors have distanced themselves from this hypothesis (Agarwal 1986), or have suggested that poverty may not be a major determinant of gender bias in child survival (Chen, Huq, and D'Souza 1981; Harris 1990; Das Gupta 1987). Unfortunately, detailed empirical investigations of this issue are few.[22]

One noteworthy exception is Krishnaji's (1987) discussion of the relationship between the female–male ratio and per capita expenditure, based on National Sample Survey data. Krishnaji observed that the female-male ratio is higher at lower levels of per capita expenditure, suggesting that anti-female discrimination is less intense in poorer households. But the author qualified this conclusion, pointing out that households with a high female–male ratio may be concentrated at the lower end of the per capita expenditure scale simply because females have more-restricted earning opportunities than males.

In short, there is some evidence that gender bias in child survival is lower among poorer households, and no sound evidence of the opposite pattern. But the empirical basis for these observations remains limited. We concur with Kishor's (1995) judgment that "we do not as yet have any conclusive evidence that poorer households are necessarily less discriminatory."

The relationship between *fertility* and gender bias in child survival is complex. One major insight comes from Das Gupta's (1987) finding that, in rural Punjab, the female disadvantage in child survival is particularly pronounced among children of higher birth parity.[23] From this "parity effect," it is tempting to conclude that fertility decline would generally contribute to reducing gender bias in child survival.

This conclusion receives further support from the argument that high fertility and excess female mortality in childhood derive from a common root, namely the economic and other advantages of having male children (Basu 1991, 1992). A similar argument is advanced by Dyson and Moore (1983), who see the low status of women in society as a common cause of high fertility and gender bias in child survival. Here again, one might expect fertility and gender bias to move in the same direction.

In a recent study, however, Das Gupta and Mari Bhat (1995) argue that the intensification of gender bias in India (specifically, the decline in juvenile female–male ratios between 1981 and 1991) is "a consequence of fertility decline." They argue that the "parity effect" is outweighed by an "intensification effect," which renders parity-specific gender bias more pronounced at lower levels of fertility. That pattern, according to the authors, can be observed in the Khanna study. Their explanation for the intensification effect is that, in many situations, the desired number of sons declines less rapidly than the desired number of children.

The general validity of this argument, however, calls for further empirical investigation. There is, for instance, some indication from cross-section data that one force in the direction of fertility decline in India may be the gradual displacement of "two sons, one daughter" by "one son, one daughter" as the most widely preferred family pattern.[24] In this case the desired number of sons declines more rapidly than the desired number of children, contrary to the suggested basis of the intensification effect.

Das Gupta and Mari Bhat refer to the recent spread of sex-selective abortion in China, South Korea, and India as further evidence of the strength of the intensification effect. Selective abortion of female fetuses, however, has a direct and obvious effect on the female–male ratio in the population, whether or not it also contributes to the reduction of fertility, and there is no great advantage in seeing that direct effect through the prism of fertility decline. One difficulty in this discussion is that fertility decline can have many causes, not all of which would have the same influence on gender bias. While it is easy to see that sex-selective abortion would often lead simultaneously to fertility decline and lower female–male ratios, the same pattern need not apply to a reduction of fertility due, say, to more widespread literacy or a more equal valuation of boys and girls (fertility decline, for instance, has not "caused" an intensification of gender bias in Kerala—on the contrary). To put it another way, there is some danger in treating "fertility" as an exogenous variable in any analysis of gender bias in child survival.

Interpretation of the estimates

As we discussed earlier, mortality and fertility influence each other. This complicates the analysis if, for example, we are interested in estimating the effect of fertility on mortality, or the effect of female education on mortality other than through reduced fertility. Thinking in terms of a simple linear framework, if we include fertility as an explanatory variable when estimating the equation for mortality, the estimated coefficient is not easily interpretable (does it measure the effect of fertility on mortality or that of mortality on fertility?). Moreover, the use of an endogenous variable as a regressor induces a correlation between the error term and the explanatory variables. Under these circumstances, the ordinary least squares estimates will be inconsistent, and the estimated coefficients will not approach their true values even in very large samples. In principle, if we can find suitable instruments (variables that are correlated with the endogenous variable but uncorrelated with the error term), we can estimate the relevant coefficients consistently. In practice, finding suitable instruments may not be an easy task for reasons of both theory and data availability.

We therefore concentrate on the reduced forms that relate the dependent variables of interest (child mortality, fertility, and gender bias in child survival) to exogenous variables alone.[25] The estimated coefficients thus measure the total effect of each explanatory variable on each endogenous variable, without determining the relative importance of the endogenous mechanisms through which this effect operates.[26] For instance, the estimated coefficient on female education in the equation for mortality measures the total effect of female education, including its effect on child mortality through fertility reduction.

Data and estimation

The analysis that follows is based on a sample of 296 districts for which adequately detailed information is available. These districts are located in 14 of India's 15 most populous states. These states contained 326 districts in 1981 and accounted for 94 percent of India's total population. The missing state is Assam, where the 1981 census was not conducted.

Fertility is measured by the total fertility rate (TFR), which represents the number of children that would be born to a woman if she lived to the end of her childbearing years and bore children at each age in accordance with the prevailing age-specific fertility rates. The age-specific fertility rates are derived from responses to the census question on births during the last year.[27] For our purposes, the total fertility rate is a more useful measure of the fertility level than, say, the crude birth rate, since it is independent of the age structure of the population. The child mortality variable (Q5) is the probability that a child will die before attaining the age of five years. It is based on census questions on the number of children ever born and the number of children surviving.[28] Gender bias in child mortality is measured as FD = 100 (Q5F – Q5M)/Q5F, where Q5F is mortality among female children and Q5M is mortality among male children. For convenience, we refer to this measure of gender bias as "female disadvantage" (or FD for short). Negative values of this measure indicate female advantage. TFR, Q5, and FD are the three endogenous variables of interest.

Turning to the exogenous variables, our indicator of female literacy is the crude female literacy rate, defined as the proportion of literate females in the total population, and similarly with male literacy.[29] Female labor force participation, where included, is the proportion of female "main workers" in the total female population (on the definition of "main workers" see note 11). Urbanization is measured by the proportion of the total population living in urban areas.[30] We use the distributionally sensitive Sen index as an indicator of poverty.[31] The availability of health care services is measured by the proportion of villages with medical facilities. In addition to these, we include two variables relating to the composition of the population: the proportion of "scheduled castes" and the proportion of "scheduled tribes" in the population. Finally, three dummy variables are used to identify regional patterns: South, for Andhra Pradesh, Karnataka, Kerala, and Tamil Nadu; East, for districts in Bihar, Orissa, and West Bengal; and West, for Gujarat and Maharashtra.[32] A list of the variables, their definitions, and sources is given in Table 1, which also presents summary statistics for our sample. Table 2 gives the mean values of these variables in the 14 Indian states and for all of India.

Most of the information used in this analysis is derived from the 1981 census and is available in published census reports (see Table 1 for sources). The main exception concerns the Sen index, which requires further comment.

District-specific indicators of income or expenditure are not available in India. The standard source of information on per capita expenditure, the National Sample Survey (hereafter NSS), does not generate district-specific estimates, because the sample size is too small for many districts. Instead, the NSS divides the country into a number of "regions," based on agro-climatic and socioeconomic criteria, and permits reasonably reliable region-specific estimates of average per capita expenditure and related indicators. The NSS region is essentially an intermediate unit between the district and the state, with each region consisting of several districts within a particular state, and each of the major states being divided into several regions. The 14 states included in this study contain 51 regions. For these regions, estimates of average per capita expenditure, the head-count ratio, and the Sen index are available for 1972–73 (rural areas only) from Jain, Sundaram, and Tendulkar (1988), based on the 27th round of the NSS. The poverty indicator used here for each district is the Sen index of rural poverty for the region in which the district is situated. For want of information on the level of poverty in rural and urban areas combined, we have included a separate variable indicating the level of urbanization.

Two caveats are in order. First, the reference year for the poverty variable is 1972–73, rather than 1981 (as with the other variables). The justification for using 1972–73 for the poverty variable is that the 1981 mortality estimates are based on birth and death information pertaining to the late 1970s, and poverty levels during that period must have been quite close to those observed in 1972–73. Fortunately, the relative position of different regions in terms of poverty levels seems to be fairly stable over time. In fact, replacing the Sen index for 1972–73 with the Sen index for 1987–88 (also available for NSS regions) has little effect on the results presented here.[33]

TABLE 1 Variable definitions and sample summary statistics

Variable	Definition	Mean	Standard deviation
TFR	Total fertility rate, 1981	5.0	1.0
Q5	Under-five mortality rate, 1981: probability that a child will die before the fifth birthday (x 1,000)	156.9	42.8
FD	Female disadvantage in child survival, 1981, defined as FD = 100 (Q5F – Q5M)/Q5F (percent)	5.4	10.7
Female literacy	Crude female literacy rate, 1981 (percent)	22.0	13.7
Male literacy	Crude male literacy rate, 1981 (percent)	44.8	12.2
Female labor force participation	Proportion of "main workers" in the female population, 1981 (percent)	14.5	10.5
Urbanization	Proportion of the population living in urban areas, 1981 (percent)	19.8	12.0
Poverty	Sen index of rural poverty, 1972–73, for the "region" in which the district is situated (x 100)	17.6	8.5
Medical facilities	Proportion of villages with some medical facilities (percent)	21.4	20.5
Scheduled caste	Proportion of scheduled-caste persons in the population, 1981 (percent)	16.0	6.9
Scheduled tribe	Proportion of scheduled-tribe persons in the population, 1981 (percent)	8.0	13.5
South	Dummy variable, with value 1 for districts in Andhra Pradesh, Karnataka, Kerala, and Tamil Nadu	0.23	0.42
East	Dummy variable, with value 1 for districts in Bihar, Orissa, and West Bengal	0.16	0.37
West	Dummy variable, with value 1 for districts in Gujarat and Maharashtra	0.14	0.35

SOURCES: TFR: Sharma and Retherford (1990); Q5, Q5F, and Q5M (FD is calculated from the last two): Government of India (1988); Female literacy, Male literacy, Female labor force participation: Government of India (1981); Urbanization: Government of India (1982); Poverty: Jain, Sundaram, and Tendulkar (1988); Medical facilities: Government of India (1986); Scheduled caste and Scheduled tribe: Government of India (1984).

Second, the use of the regional poverty estimate for each district within a region involves the implicit assumption that intraregional variations in poverty are small. This is plausible, since the NSS regions are meant to be relatively homogeneous in terms of agro-climatic and socioeconomic fea-

TABLE 2 State-level averages of the regression variables

	TFR	Q5	FD	Female literacy	Male literacy	Female labor force participation	Urbanization	Poverty	Medical facilities	Scheduled caste	Scheduled tribe
Andhra Pradesh	4.35	138.6	–6.2	19.4	38.4	27.5	22.8	15.8	25.9	15.0	6.4
Bihar	5.24	141.1	14.4	13.4	37.6	8.6	11.6	24.8	18.1	14.9	1.8
Gujarat	4.80	126.1	6.2	30.9	53.1	10.7	28.2	15.5	28.2	7.4	11.0
Haryana	5.40	139.0	17.5	21.5	48.0	4.5	21.4	3.7	58.2	18.9	0.0
Karnataka	4.68	142.3	–3.4	27.1	48.0	19.9	24.5	14.5	13.4	14.2	5.1
Kerala	3.40	81.2	–10.5	66.0	75.4	13.1	17.9	20.9	95.8	10.4	0.9
Madhya Pradesh	5.57	202.9	4.4	14.5	38.5	20.3	19.6	19.3	5.8	14.9	21.1
Maharashtra	4.34	155.7	–2.0	31.8	56.4	26.2	26.2	25.1	18.3	7.3	10.1
Orissa	4.81	175.7	–4.2	18.9	44.9	11.8	11.6	37.8	10.8	14.2	24.9
Punjab	3.26	110.6	10.6	33.4	47.4	2.4	26.7	3.8	26.8	26.7	0.0
Rajasthan	6.05	174.6	9.8	10.5	34.4	9.6	19.2	13.2	16.7	16.7	14.2
Tamil Nadu	3.92	126.8	–2.8	35.7	58.5	22.7	32.3	17.6	32.6	17.6	1.1
Uttar Pradesh	5.89	185.6	15.3	14.7	50.2	8.0	17.3	13.0	11.8	20.8	0.5
West Bengal	4.57	123.0	1.0	28.2	46.6	7.1	23.3	28.4	15.2	22.9	7.2
All India	5.02	156.5	5.3	22.1	44.7	14.3	20.7	17.9	21.4	15.9	8.0

NOTE: For definition of variables see Table 1.
SOURCES: See Table 1. The state-level averages presented here are calculated by aggregating the relevant district-level figures.

tures. However, some loss of information is certainly involved here, and the results presented below have to be interpreted bearing in mind the imprecise nature of the district poverty indicators.

One way of dealing with this second limitation of the poverty variable is to carry out the entire analysis at the level of "regions" rather than of districts. Although this approach has the advantage of generating a more accurate poverty indicator for each observation, reducing the number of observations from 296 to 51 also entails a major loss of information. As it turns out, the broad conclusions of this alternative approach are similar to those obtained on the basis of district-level analysis. In the following, we focus primarily on the district-level results, but the region-level results are also presented.

Cross-section analysis is standardly based on the assumption that the error terms are independently and identically distributed. In this case, there is a possibility of spatial correlation in the error terms. Spatial correlation refers to the positive or negative correlation of a variable between neighboring regions of a surface, such as contiguous districts of a map.[34] Spatial correlation in the errors may arise because of unobserved (or unobservable) variables that may themselves be spatially correlated. In our context, for instance, spatial correlation may result from the influence of unobserved cultural factors on mortality or fertility.[35] If the regression errors are spatially correlated, then the standard assumption of a diagonal error covariance matrix fails to hold. We therefore adopt a standard technique of spatial econometrics, which consists of modeling the spatial structure of the errors by parametrizing the error covariance matrix as a function of a spatial dependence parameter, λ, and estimating the model using maximum likelihood estimation. We test whether $\lambda = 0$, that is, whether spatial correlation in the errors is negligible (in which case the properties of the ordinary least squares estimator are restored). The test fails in all cases, confirming the need to take spatial correlation into account. For further details of the estimation procedure, and diagnostics, see Murthi, Drèze, and Guio (1995).

Basic results

Table 3 presents the main results. Apart from indicating the signs of the coefficients and whether they are statistically significant, Table 3 makes it possible to assess the quantitative effects of different variables on fertility, child mortality, and gender bias by combining the given information with the mean values presented in Table 1.

In arriving at the estimates in Table 3, we began with general specifications that included quadratic terms (for nonlinearities) and cross-products. We found no evidence of nonlinearities, except in the equation for

TABLE 3 Determinants of fertility, child mortality, and female disadvantage: Maximum likelihood estimates of reduced forms

	Dependent variable		
Independent variable	**TFR**	**Q5**	**FD[a]**
Constant	6.60 (23.10)*	205.82 (14.37)*	0.86 (3.00)*
Female literacy	–0.03 (–4.28)*	–0.87 (–2.45)*	–0.04 (–4.46)*
Male literacy	–0.005 (–0.70)	–0.49 (–1.40)	0.01 (1.97)*
Female labor force participation	–0.02 (–3.57)*	0.44 (1.82)**	–0.02 (–3.85)*
Poverty	0.007 (1.14)	0.53 (1.76)**	–0.02 (–3.13)*
Urbanization	–3.9E–04 (–0.15)	–0.31 (–2.40)*	0.005 (1.73)**
Medical facilities	–0.002 (–1.04)	–0.25 (–2.23)*	0.005 (1.84)**
Scheduled tribe	–0.01 (–3.40)*	–0.60 (–3.57)*	–0.01 (–3.96)*
Scheduled caste	–0.007 (–1.23)	0.55 (1.89)**	–0.007 (–1.13)
South	–0.55 (2.60)*	–41.50 (–3.85)*	–0.82 (–4.91)*
East	–0.25 (–0.99)	–38.08 (–2.91)*	0.15 (0.81)
West	–0.38 (–2.06)*	–12.24 (–1.32)	–0.15 (–0.87)
λ	0.82 (25.95)*	0.84 (28.07)*	0.61 (11.00)*
Mean squared error	0.31	15.15	0:39
Adjusted R^2	0.89	0.87	0.81
Log likelihood	–155.95	–1310.26	–190.80
Sample size	296	296	296

[a] The dependent variable is a logistic transform of FD.
NOTES: Asymptotic *t*-ratios in parentheses. * significant at 5 percent; ** significant at 10 percent. For definition of variables see Table 1.

female disadvantage. Visual inspection and nonparametric estimation suggested that the relationship between this variable and the individual explanatory variables follows a logistic pattern, so we used a logistic transform of this variable as our dependent variable in Table 3. We present no cross-product terms at this stage, in order to keep the discussion relatively straightforward, but we later discuss some results relating to cross-product terms.

The estimates in Table 3 treat female labor force participation as an exogenous variable, but, as discussed earlier, that variable may both influence and be influenced by the fertility rate and is therefore potentially endogenous. In Table 4, we exclude female labor force participation as an explanatory variable in recognition of its endogeneity. In general, the conclusions that follow from Table 3 are upheld by Table 4.

TABLE 4 Determinants of fertility, child mortality, and female disadvantage, excluding female labor force participation: Maximum likelihood estimates of reduced forms

	Dependent variable		
Independent variable	**TFR**	**Q5**	**FD**[a]
Constant	6.38 (21.90)*	210.72 (14.09)*	0.66 (2.21)*
Female literacy	–0.02 (–3.52)*	–1.01 (–2.88)*	–0.03 (–3.46)*
Male literacy	–0.01 (–1.49)	–0.35 (–1.03)	0.01 (1.01)
Female labor force participation	—	—	—
Urbanization	1.7E–04 (–0.06)	–0.32 (–2.46)*	0.01 (1.88)**
Medical facilities	–0.002 (–1.07)	–0.24 (–2.21)*	0.005 (1.92)**
Poverty	0.007 (1.14)	0.53 (1.73)**	–0.02 (–3.05)*
Scheduled tribe	–0.01 (–3.68)*	–0.56 (–3.37)*	–0.01 (–4.11)*
Scheduled caste	–0.005 (–0.82)	0.50 (1.72)**	–0.004 (–0.54)
South	–0.66 (–3.01)*	–37.91 (–3.58)*	–1.02 (–5.77)*
East	–0.11 (–0.42)	–40.42 (–3.10)*	0.26 (1.21)
West	–0.41 (–2.17)*	–11.09 (–1.19)	–0.23 (–1.26)
λ	0.84 (28.43)*	0.83 (27.66)*	0.68 (14.05)*
Mean squared error	0.31	15.26	0.39
Adjusted R^2	0.89	0.87	0.81
Log likelihood	–162.05	–1311.91	–197.24
Sample size	296	296	296

[a] The dependent variable is a logistic transform of FD.
NOTE: Asymptotic *t*-ratios in parentheses. * significant at 5 percent; ** significant at 10 percent. For definition of variables see Table 1.

We first comment on the influence of different explanatory variables on child mortality and female disadvantage, before turning to fertility.

Child mortality and female disadvantage

With respect to child mortality and female disadvantage, the following observations are particularly noteworthy:

Female literacy has a negative and statistically significant effect on child mortality. It has a negative effect on both male and female child mortality, but the effect on female child mortality is larger. This is why female literacy also has a negative (and statistically significant) effect on FD, the extent of female disadvantage in child survival. The last result contrasts with the hypothesis, advanced by several other researchers, that higher female literacy is often a tool of intensified discrimination against female children.

Higher female literacy reduces child mortality and anti-female bias in child survival independently of male literacy. Male literacy also has a negative effect on child mortality (independently of female literacy), but its effect is much smaller than that of female literacy, and is not statistically significant. Male literacy has a significant effect on the extent of gender bias in child survival, in the direction of enhancing female disadvantage (because male literacy reduces male child mortality more than female child mortality). Interestingly, the last statement remains true even if female literacy is dropped from the regression.

We tested the hypothesis that the effect of female literacy on gender bias varies between regions by introducing additional interaction terms involving the female literacy variables and regional dummies. None of the coefficients of these interaction terms is statistically significant. In particular, we find no support for the notion that the effect of female literacy on gender bias is positive in the North but negative in the South, or vice versa.

Higher *female labor force participation* reduces the extent of gender bias in child survival, and this effect is statistically significant. This result is in keeping with the findings of earlier studies. Although higher levels of female labor force participation are clearly associated with reduced anti-female bias in child survival, the relationship between female labor force participation and absolute levels of male and female child mortality is more complex. The results presented in Table 3 suggest that higher female labor force participation is associated with higher levels of male and female child mortality. When examining the effects of female labor force participation on child mortality, however, it is important to control carefully for the economic and social disadvantages that motivate many women to seek gainful employment. In particular, it is important to control for the level of poverty; given the aforementioned limitations of our measure of poverty, the effect of female labor force participation on absolute levels of child mortality requires further scrutiny. We return to this issue below.

Urbanization has a negative and statistically significant effect on child mortality. The effect on male mortality is larger than that on female mortality; therefore, urbanization is associated with higher levels of female disadvantage in child survival. The last effect is statistically significant at the 10 percent level, but not at the 5 percent level.

Medical facilities have essentially the same effects as urbanization: they reduce child mortality, but amplify the female disadvantage in child survival. Here again, the last effect is statistically significant at the 10 percent level.

As expected, higher levels of *poverty* are associated with higher levels of child mortality. This variable is not significant at the 5 percent level, although it is significant at 10 percent.[36] Less evidently, there is a negative and statistically significant relationship between poverty and FD: higher levels of poverty are associated with lower levels of female disadvantage in child survival. This is consistent with the hypothesis, discussed earlier, that anti-female discrimination is particularly strong among privileged classes.[37]

A higher proportion of *scheduled tribes* in the population reduces the extent of anti-female bias in child survival, and this effect is statistically significant. It is interesting that this variable has a significant effect even after controlling for female labor force participation, which is generally higher among scheduled tribes than in the population as a whole. This suggests that tribal groups have other features that enhance the relative survival chances of female children, for example kinship systems and property rights.[38]

It is also noteworthy that the absolute levels of child mortality are relatively low in districts with a high proportion of scheduled tribes, after controlling for poverty and literacy. This is consistent with the common notion that tribal lifestyles have some healthy aspects, for example relatively low levels of crowding and pollution. But the precise basis of this statistical association requires further investigation.

There is no significant association between the proportion of *scheduled castes* in the population and the extent of female disadvantage in child survival. This is consistent with recent research on gender inequality among scheduled castes, particularly relating to trends in sex ratios. Until recently, the female–male ratio in the population was considerably higher than average among disadvantaged castes, including those now classified as "scheduled." Many observers have attributed this contrast to the relatively egalitarian character of gender relations within these castes. In recent decades, however, there has been a striking decline of the female–male ratio within scheduled castes, so that by 1991 this ratio (0.922) was very close to the ratio in the population as a whole (0.927).[39] In other words, differences in gender relations between the scheduled castes and the rest of the population appear to have narrowed, and have disappeared altogether as measured by the female–male ratio, a basic indicator of gender inequality.[40]

Finally, with regard to *regional dummies*, even after controlling for the other variables, the southern region has considerably lower levels of child mortality. This is particularly the case for girls; indeed, female children have a survival advantage over boys in that region (see Table 2). With respect to both child mortality and gender bias, the contrast between the southern region and the rest of the country is statistically significant.

The demographic features of South India, including the relatively favorable survival chances of female children, have been much discussed in the literature.[41] The findings presented in Table 3 suggest that the demographic contrast between South India and the rest of the country cannot be explained entirely in terms of female literacy, female labor force participation, and other variables included in the regression.[42] This is consistent with the view that differences in kinship systems, property rights, and related features of the economy and society not captured in this analysis (for lack of adequate statistical information) play an important role in the North–South contrast.[43]

Fertility

Tables 3 and 4 include further results related to the determinants of the total fertility rate. Female literacy and female labor force participation have a negative and statistically significant effect on TFR. Fertility is also significantly lower in the southern and western regions and in districts with a high proportion of scheduled tribes. None of the other variables is statistically significant.

Further results and extensions

Poverty and female labor force participation

Earlier we commented on some limitations of our variable for measuring poverty. We noted, in particular, that the reference year for this variable is 1972–73, rather than 1981 (as with the other variables), and also that the available poverty indicators relate to NSS regions rather than to individual districts.

These limitations may lead to inaccurate estimates of the effect of poverty on demographic outcomes. They may also lead to bias in the estimated coefficients of variables that are strongly correlated with poverty. One important example concerns female labor force participation, in particular the relationship between that variable and child mortality. As we discussed earlier, in estimating the effect of female labor force participation on child mortality and other demographic outcomes, it is important to control for the incidence of poverty. Indeed, female labor force participation in India is often a reflection of economic hardship, and failure to control for this factor may lead, for instance, to a spurious positive relationship between female labor force participation and child mortality (implicitly reflecting, in fact, the positive association between poverty and child mortality).[44]

In view of these considerations, we have explored alternative ways of dealing with the poverty variable. As for the reference year, we have examined the effects of replacing the 1972–73 poverty estimates with the corresponding 1987–88 estimates. The basic results presented above continue to hold; hence the choice of reference year for the poverty variable does not seem to be a major issue.

Regarding the use of region-level (as opposed to district-level) poverty estimates in the regressions, one way of investigating whether this procedure leads to serious bias is to re-estimate the regression equations using region-level estimates for all variables listed in Table 1. Region-level estimates can easily be obtained by aggregation, as weighted averages of the district-level values. While this method leads to a sharp reduction in the number of observations (from 296 to 51), it eliminates any bias arising from the fact that the poverty variable and other variables relate to different levels of territorial aggregation. The corresponding results are presented in Table 5.

The results of the region-level analysis (Table 5) are similar to those of the district-level analysis (Table 3). One difference is that the *t*-ratios tend to be lower in the region-level regressions than in the district-level regressions, and, accordingly, some variables that were statistically significant in the latter are not significant in the former (this applies, for instance, to the South "dummy" in the mortality and fertility regressions). This is not surprising, since the region-level regressions are based on a smaller number of observations and reflect a considerable loss of information.

Aside from this, the main difference between the two sets of regressions is that, in the region-level regressions, higher female labor force participation is associated with lower child mortality (both sexes combined). Although this association is not statistically significant, it suggests that the positive association between these two variables obtained in the district-level regressions may reflect a failure to adequately control for poverty.[45]

Fertility and gender bias in child mortality

As we discussed earlier, the links between fertility and gender bias in child survival are unclear. To shed light on this issue, we have included the total fertility rate as an additional regressor in the equation for female disadvan-

TABLE 5 Determinants of fertility, child mortality, and female disadvantage, NSS regions: Maximum likelihood estimates of reduced forms

	Dependent variable		
Independent variable	**TFR**	**Q5**	**FD**
Constant	6.67 (9.62)*	136.99 (4.32)*	13.08 (1.95)**
Female literacy	–0.04 (–2.47)*	–1.84 (–2.41)*	–0.69 (–4.57)*
Male literacy	0.020 (1.09)	1.17 (1.41)	0.38 (2.24)*
Female labor force participation	–0.03 (–2.82)*	–0.34 (–0.65)	–0.31 (–3.56)*
Urbanization	–0.005 (–0.080)	–0.39 (–1.27)	0.03 (0.47)
Medical facilities	0.002 (0.46)	–0.29 (–1.29)	0.08 (1.84)**
Poverty	5.6E–04 (0.06)	0.74 (1.73)**	–0.16 (–1.61)
Scheduled tribe	–0.01 (–1.54)	0.09 (0.24)	–0.29 (–3.95)*
Scheduled caste	–0.02 (–1.78)**	1.04 (1.63)	–0.01 (–0.41)
South	–0.25 (–0.77)	–12.29 (–0.72)	–8.34 (–4.19)*
East	–0.29 (–0.92)	–30.04 (–1.82)**	–2.96 (–1.44)
West	–0.44 (–1.65)**	2.94 (0.22)	0.50 (0.24)
λ	0.59 (4.45)*	0.66 (5.42)*	–0.41 (–1.98)*
Mean squared error	0.36	18.14	3.71
Adjusted R^2	0.74	0.68	0.79
Log likelihood	–23.45	–223.23	–140.17
Sample size	51	51	51

NOTES: Asymptotic *t*-ratios in parentheses. * significant at 5 percent; ** significant at 10 percent. For definition of variables see Table 1.

tage.[46] We find that higher fertility is associated with *higher* female disadvantage in child survival, and the association is statistically significant.[47] Thus, it appears that, after controlling for other pertinent factors, the relative survival chances of girls are lower in areas of high fertility. These results contribute to dispelling any fear that rapid fertility decline in India might entail some intensification of gender bias in child survival.

Interaction between female literacy and medical facilities

One way in which female literacy may help reduce child mortality is by enabling women to take better advantage of available medical facilities. If that hypothesis is correct, then we might expect female literacy and medical facilities to have synergistic effects on child mortality, in the sense that the influence of one of these two variables is stronger when the other is also at work. We test this hypothesis by including an interaction term in the regression for child mortality, as an additional righthand variable. This interaction term (the product of "female literacy" and "medical facilities") allows the effect of medical facilities to vary with the level of female literacy, and vice versa. We find the coefficient of this interaction term to be negative and statistically significant, suggesting that medical facilities and female literacy do have synergistic effects in reducing child mortality.[48]

Structural change

Another issue of interest is the stability of the estimated relationships over time. When detailed results of the 1991 census are available, it will be possible to carry out regression exercises similar to those presented here and to compare them with the 1981 results. Meanwhile, we attempt a tentative assessment of structural change as follows.

We estimated an additional regression equation, with "crude birth rate" (CBR) as the dependent variable, using 1981 district-level data. We retained all explanatory variables in Table 3 except "medical facilities."[49] This equation was used to "predict" the crude birth rate in 1991, using the 1991 values of the independent variables. In the absence of district-level information for 1991, this could only be done at the state level. These predicted CBRs were then compared with the actual figures derived from the 1991 census.[50]

This comparison indicates that our regressions under-predict the decline of the crude birth rate between 1981 and 1991 in each of the 14 states considered. The difference between predicted and actual CBR (expressed as a proportion of actual CBR) is very small for Madhya Pradesh (1.1 percent) and also relatively small (less than 10 percent) for Haryana, Rajasthan, and Uttar Pradesh, but particularly large for West Bengal (21 percent), Punjab (24 percent), Andhra Pradesh (25 percent), Kerala (41 percent), and Tamil Nadu (46 percent). The under-prediction of CBR decline in all states suggests that structural change during 1981–91 has reinforced cross-sectional effects identified in this study. Further, the state-specific patterns are consistent with recent evidence of an accelerated demographic transition in South India, contrasted with much greater inertia in the large North Indian states.[51]

Sex ratio and child mortality

Finally, we examined the hypothesis that, even for given values of the explanatory variables included in this analysis, child mortality is higher in areas of higher gender inequality. The idea is that high levels of gender inequality tend to suppress the agency of women in society, one consequence of which may be higher levels of child mortality (insofar as the health of children in India depends greatly on women's initiative).

To test this hypothesis, we used the juvenile sex ratio (number of females per thousand males in the 0–10-year age group) as an additional righthand variable in the equation for child mortality.[52] The juvenile sex ratio is interpreted here as a rough indicator of gender inequality.[53] Holding other factors constant, we find that child mortality is higher in districts with a lower juvenile sex ratio, and this effect is statistically significant.[54] This lends some support to the proposed hypothesis.

Discussion

Women's agency and demographic outcomes

The findings of this study clearly demonstrate the role of women's agency and empowerment in reducing mortality, fertility, and gender inequality.

Consider, for instance, the determinants of gender bias in child mortality. It is striking that, while the variables directly related to women's agency (specifically, the female literacy rate and female labor force participation) have a strong and statistically significant negative impact on female disadvantage, those relating to the society's general level of economic development and modernization (e.g., poverty, urbanization, male literacy, and medical facilities) do nothing to improve the relative survival chances of girls vis-à-vis boys. In fact, to the extent that these variables have a statistically significant influence on female disadvantage in child survival, this influence operates in the "wrong" direction in each case: higher levels of male literacy and urbanization, lower levels of poverty, and improved access to medical facilities are all associated with a larger female disadvantage (see Tables 3, 4, and 5 for details). The reason is that these variables reduce male child mortality more than female child mortality. Insofar as a positive connection exists in India between the level of development and reduced gender bias in survival, it seems to work through variables that are directly related to women's agency, such as female literacy and female labor force participation.

Similarly, while indicators of development such as male literacy, reduced poverty, greater urbanization, and the spread of medical facilities do have positive effects on absolute levels of child survival, these effects are relatively small compared with the powerful effect of female literacy. This point is illustrated in Table 6, which indicates how the predicted values of Q5 and FD respond to changes in female literacy when the other variables are kept at their mean value (responses to male literacy and poverty are also shown in the table).[55] The influence of female literacy on child mortality and gender bias is quite large, especially in comparison with the influence of male literacy or poverty.

The same point emerges in connection with the determinants of fertility. In this case, in fact, none of the variables related to the general level of development and modernization is statistically significant. By contrast, female literacy and labor force participation appear to be crucial determinants of the total fertility rate. As shown in Table 6, for instance, female literacy alone exerts considerable force in reducing fertility. Here again, the message seems to be that some variables related to women's agency (in this case, female literacy) play a much more important role in demographic outcomes than do variables related to the general level of development.

Cross-section and time-series analysis

As we discussed in the preceding section, our results lend little support to the notion that gender bias in India automatically declines with economic development (except insofar as the latter enhances female literacy and fe-

TABLE 6 Effects of selected independent variables (female literacy, male literacy, and poverty) on child mortality (Q5), female disadvantage (FD), and fertility (TFR)

Assumed level of independent variable (percent)	Predicted values of Q5, FD, and TFR when the *female literacy rate* takes the value indicated in the first column			Predicted values of Q5, FD, and TFR when the *male literacy rate* takes the value indicated in the first column			Predicted values of Q5, FD, and TFR when the *proportion of the population below the poverty line* takes the value indicated in the first column[a]		
	Q5	FD	TFR	Q5	FD	TFR	Q5	FD	TFR
10	166.4	10.7	5.38	172.9	–2.0	5.18	151.5	9.8	4.79
20	157.7	5.9	5.07	168.0	–0.1	5.13	152.7	8.5	4.85
30	149.0	1.1	4.76	163.1	1.8	5.08	153.8	7.1	4.91
40	140.2	–3.3	4.45	158.2	3.9	5.03	154.9	5.8	4.97
50	131.5	–7.1	4.15	153.3	5.9	4.98	156.0	4.4	5.03
60	122.8	–10.3	3.84	148.4	8.0	4.93	157.2	3.1	5.09
70	114.0	–12.8	3.53	143.5	10.1	4.88	158.3	1.8	5.15
80	105.3	–14.8	3.22	138.7	12.2	4.83	159.5	0.5	5.21

[a] For convenience of interpretation, the "Sen index" has been replaced here by the "head-count ratio" (i.e., the proportion of the population below the poverty line). The figures presented in these three columns are based on the same regressions as in Table 3, with the Sen index replaced by the head-count ratio.

NOTE: For definition of variables see Table 1.

male labor force participation). This may seem surprising, but it is worth noting that our finding is consistent with the widely discussed phenomenon of sustained decline in India's ratio of females to males since the beginning of this century.[56]

In 1901, the ratio of females to males in the Indian population was 0.972. From then, the female–male ratio declined almost monotonically until 1991 (the last year for which census estimates are available), when it reached the lowest-ever recorded value of 0.927.[57] The causes of this decline are a matter of debate, and the results we presented here are of some relevance in this context. The regressions presented in Table 3 suggest that the only important force that may have worked to reduce gender bias over this period is the expansion of female literacy. Most other developments, including the expansion of per capita income, medical facilities, and male literacy, would have worked in the other direction, if our cross-section results are any guide to the corresponding effects over time.[58]

These observations should not be taken to imply that economic development in India is comprehensively detrimental to the position of women in society. Such a conclusion, if drawn, would require at least three qualifications. First, our results suggest that gender bias is reduced by an expansion of female literacy, and that expansion is part of economic development. Even female labor force participation can be expected to increase in the future, and that too is likely to reduce gender bias.

Second, the relationship between gender bias and level of economic development may well be nonlinear, with the relative position of women first declining and later improving as, say, per capita income increases. Some authors have indeed stressed the plausibility of such a nonlinear relationship (see particularly Kishor 1995). In our own work, we have found no evidence of this type of nonlinearity, but this may reflect the fact that India is still at an early stage of development. The relationship between gender bias and economic variables may well change.

Third, our investigation has been confined to one aspect of gender bias—differences in mortality rates between boys and girls. Obviously, all aspects of gender inequality need not move in the same direction, and it would be difficult to deny that some aspects of the condition of Indian women have improved considerably in the recent years. [59]

Demographic change

Since population growth in India is often of intense concern, it is worth reiterating that the only variables we found to have a significant effect on fertility are female literacy and female labor force participation. In addition, of course, there is likely to be a significant causal link between mortality and fertility, with the latter going down as mortality declines. The direct promotion of child health, female literacy, and female labor force participation is likely to be more conducive to lowering fertility than are indirect interventions based on promoting economic development.

It would, of course, be helpful to know more about the precise links between fertility and child mortality. The problem is that there are simultaneous causal links in both directions, links that are difficult to estimate. We made one attempt at such estimation, based on two-stage least squares estimation of the fertility equation (with child mortality as an additional righthand variable in the fertility regression). Identifying the effect of child mortality requires the inclusion in the model of at least one exogenous variable that influences child mortality but not fertility. "Availability of drinking water" seemed like a plausible candidate, but tentative estimates based on using it as an instrument for child mortality gave no useful results. This is an important area for further research.

Notes

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1 The figures cited in this paragraph (with 1991 as the reference year in each case) are taken from Drèze and Sen (1995): Statistical Appendix, and are based on data from the census and the Sample Registration System. A few countries of West Asia (e.g. Kuwait and the United Arab Emirates) actually have a lower female–male ratio than Uttar Pradesh, but this is due to exceptionally high levels of male inmigration.

2 On this point, see e.g. I. Sen (1986), Karkal (1987), Dyson (1988), Miller (1989), Kundu and Sahu (1991), Srinivas (1991), Nanda (1992), Rajan et al. (1991, 1992), and Raju and Premi (1992).

3 Earlier investigations of this type, for India, have often been based on state-level data, involving a much smaller number of observations; see e.g. Jain (1985), Bourne and Walker (1991), Reddy and Selvaraju (1993), and Tulasidhar and Sarma (1993). Analyses based on district-level data include Rosenzweig and Schultz (1982), Gulati (1992), Kishor (1993), Guio (1994), and Khemani (1994).

4 1987–88 is the latest year for which state-specific estimates of the head-count ratio are available.

5 On the international evidence, see Caldwell (1979, 1986), Behrman and Wolfe (1984, 1987), Ware (1984), Cleland and van Ginneken (1987, 1988), United Nations (1987), Cleland (1990), Bhuiya and Streatfield (1991), Thomas et al. (1991), Barro and Lee (1993a, 1993b), and Subbarao and Raney (1994). For studies related to India, see Vlassoff (1980), Jain (1985), Jain and Nag (1985, 1986), Nag (1989), Beenstock and Sturdy (1990), Bourne and Walker (1991), Satia and Jejeebhoy (1991), United Nations (1993), International Institute for Population Sciences (1994), and Basu and Jeffery (forthcoming).

6 See e.g. Dasgupta (1993) and the literature cited therein.

7 Some formal economic models in the neoclassical tradition have analyzed the relationship between education and fertility in terms of standard income and substitution effects (see e.g. Becker 1960 and Olsen 1994 for a review). If children are "normal goods" intensive in the use of the mother's time, then the income effect of a rise in female education (implying a rise in the mother's

"shadow wage") raises the demand for children while the substitution effect lowers it. If the analysis is extended so that parents derive utility from both the number of children and child "quality" (also likely to be intensive in the use of time), the income effect on the demand for children is attenuated and the substitution effect strengthened.

8 There are some effects in the other direction, too. For instance, the duration of breastfeeding often declines with maternal education, lowering the duration of postpartum amenorrhea, and postpartum abstinence taboos tend to be less influential among educated women. But these effects are unlikely to be strong enough to dominate the negative links between maternal education and fertility.

9 In the neoclassical framework mentioned in note 7, male education has an income effect only (assuming that fathers have little involvement in child care). The direction of the income effect is ambiguous, as it depends on the relative strengths of the demands for child "quantity" and "quality."

10 Personal observations. For a telling study of maternal perceptions of marasmus in Pakistan, see Mull (1991).

11 The variable we use to measure female labor force participation is the ratio of female "main workers" (women engaged in "economically productive work" for at least 183 days in the year) to the total female population. The instructions to census investigators state that unpaid "household duties" are not to be counted as economically productive work. The census definition of "economically productive work," while questionable, serves our purpose since we are interested in the relationship between child survival and women's independent income-earning opportunities (rather than their economic contribution generally, whether or not rewarded).

12 For useful empirical analyses of this "maternal dilemma" in the Indian context, see Basu (1992) and Gillespie and McNeill (1992). On the international evidence, see Leslie (1988), Leslie and Paolisso (1989), and the literature cited therein.

13 See particularly the evaluations carried out by the Operations Research Group (including Khan and Prasad 1983; and Khan et al. 1980, 1983, 1986, 1988, 1989) and by the Public Systems Group (Indian Institute of Management 1985; Shah 1989). For some fairly damning case studies see Budakoti (1988), Prakasamma (1989), and Indian Council of Medical Research (1989).

14 See e.g. Iyengar and Bhargava (1987), Jeffery et al. (1989), Prakasamma (1989), Priya (1990), Jesani (1990), Gupta et al. (1992), and the studies cited in note 13.

15 Analyses of fertility in the neoclassical tradition also point to the lower costs of children in rural compared with urban areas, given the opportunities for rural children to contribute to household production and to acquire training and skills cheaply within the household. See Schultz (1981, 1994).

16 In 1991, the death rate in the 0–4-year age group (per thousand population) was 25.6 for males and 27.5 for females at the all-India level. The female mortality rate in this age group was lower than the male rate in the southern states of Andhra Pradesh, Kerala, and Tamil Nadu, but higher in all other major states except Assam and Himachal Pradesh. The female mortality disadvantage was most pronounced in the northcentral and northwestern states of Bihar, Madhya Pradesh, Punjab, Rajasthan, and Uttar Pradesh. See Government of India (1993): Table 7.

17 For recent reviews of this literature, see Guio (1994) and Kishor (1995).

18 See e.g. Miller (1981) on the caste factor, Krishnaji (1987) on the poverty factor, and Bardhan (1974) on the female labor force participation factor.

19 It has been suggested, for instance, that patrilocal exogamy in rural India can be usefully interpreted as an insurance mechanism, which facilitates risk sharing between households living in diverse agro-climatic zones (Rosenzweig 1988, 1993; Rosenzweig and Stark 1989). On the other side, female labor force participation is closely linked with the practice of female seclusion, which may be as much a cultural phenomenon as an economic one.

20 To illustrate: patrilocal exogamy can reduce the returns to parental investment in

female child survival (an economic link), and female labor force participation can raise the general perception of women's role and value in society (which is part of the local culture).

21 Unfortunately, Kishor (1993) does not include female education in her analysis. Rosenzweig and Schultz (1982) find no statistically significant relationship between female education and the relative survival chances of female children.

22 Poverty is not among the explanatory variables included in the multivariate statistical analyses of Rosenzweig and Schultz (1982) and Kishor (1993). Rosenzweig and Schultz (1982) found a positive association between landlessness and the relative survival chances of female children based on district data, but found the reverse relationship based on household data. In Kishor's (1993) study, the variable most closely related to poverty is the proportion of agricultural laborers in the population, but this variable is not statistically significant.

23 This finding is based on data from the Khanna study. For similar findings in rural Uttar Pradesh, see Khan et al. (1989).

24 For some relevant evidence, see the studies cited in Basu (1991) and the more recent information from the National Family Health Survey (International Institute for Population Sciences 1994).

25 Given the possibility that female labor force participation is endogenous, we also treat it as a fourth endogenous variable in some of the regressions presented later.

26 Formally, the model can be written as $Y = AY + BX$, where Y_{ij} is the value of the ith endogenous variable in the jth district and X_{kj} is the value of the kth exogenous variable in the jth district (A is a square matrix with as many rows and columns as there are endogenous variables). Provided that the matrix $[I - A]$ is invertible, Y can be written as $Y = [I - A]^{-1}BX$, which is the "reduced form."

27 Estimates of birth rates obtained in this way are normally adjusted upward to compensate for potential underestimation (see Government of India 1989). In this analysis we use the adjusted series given in Sharma and Retherford (1990).

28 Estimates of Q5 are "graduated" to remove inconsistencies between the estimated probabilities of death at different ages. We use graduated estimates from Government of India (1988).

29 Literacy is defined in the Census of India as the ability to read and write with understanding in any language.

30 Settlements counted as urban areas in the 1981 census were those with a population exceeding 5,000; those with a municipality, corporation, or cantonment board; those with a population density greater than 1,000 per square mile; and those with at least 75 percent of the male labor force in the nonagricultural sector.

31 On the definition and properties of the Sen index, see Sen (1976). Another measure of economic status is average per capita expenditure. The Sen index has the advantage of being more sensitive to what happens at the lower end of the per capita expenditure scale (where child mortality tends to be heavily concentrated). In any case, the results obtained by replacing the Sen index with average per capita expenditure are very similar to those we present here.

32 The control region thus consists of Haryana, Punjab, Madhya Pradesh, Rajasthan, and Uttar Pradesh. The regional partition used here is essentially the same as that used in the Sample Registration System (see e.g. Government of India 1993: 39), except that we have merged the SRS's "Central" and "North" regions and have taken this merged unit as the control region.

33 To our knowledge, 1972–73 and 1987–88 are the only two years for which poverty indicators have been calculated for the NSS regions. The 1987–88 estimates are available from unpublished tabulations of the National Sample Survey performed by P. V. Srinivasan (Indira Gandhi Institute of Development Research, Bombay).

34 The analogy with time-series data is that of serial correlation. The main difference is that time provides an ordering to the data so that earlier disturbances can affect later disturbances, but not vice versa; space provides no such ordering, so that a disturbance at one point affects neighbors in all directions.

35 On cultural influences on demographic behavior in India, see Sopher (1980a, 1980b), Dyson and Moore (1983), and Basu (1992).

36 The absence of statistical significance at the 5 percent level may reflect the lack of precision of the poverty variable, as discussed above.

37 On this, see our earlier discussion, as well as Drèze and Sen (1995): ch. 7.

38 Kishor (1993) finds that the statistically significant association between gender bias in child survival and the proportion of tribal groups in the population disappears after her "patrilocal exogamy" variable is included in the regression.

39 On this, see Agnihotri (1994) and Drèze and Sen (1995): ch. 7.

40 The "Sanskritization" process, involving the emulation of high-caste practices by members of the lower castes as a means of improving their social status, suggests an explanation for the recent convergence of female–male ratios in the two groups. Indeed, restrictions on the lifestyle and freedom of women have often played a prominent part in this process. However, there are other lines of explanation. For instance, the sharp decline of female–male ratios among scheduled castes may simply reflect the combination of (1) upward economic mobility among the scheduled castes, and (2) a positive link between economic affluence and gender inequality (due to economic or other factors that may have little to do with caste as such). This alternative line of explanation need not invoke "Sanskritization" as an important influence.

41 See e.g. Karve (1965), Bardhan (1974, 1984, 1988), Sopher (1980a, 1980b), Miller (1981), Dyson and Moore (1983), Mandelbaum (1988), Basu (1992), Gupta et al. (1993), and Kishor (1993).

42 For a similar finding (even after including "patrilocal exogamy" as an additional explanatory variable and further discussion, see Kishor (1993).

43 On these and related influences, see Basu (1992), Kishor (1993), and Agarwal (1994), and the studies cited in Drèze and Sen (1989, 1995), Gupta et al. (1993), and Dasgupta (1993).

44 This argument holds whether or not female labor force participation is exogenous.

45 Kishor (1993) found that female labor force participation had a positive and statistically significant effect on both female and male child mortality. In that study, too, the positive association between female labor force participation and child mortality may reflect the lack of adequate control for poverty (the regressions presented there included only rough proxies for "level of development"). An additional reason may be the omission of female literacy from the analysis (bearing in mind that there is likely to be a negative correlation between female literacy and female labor force participation).

46 This procedure assumes, in line with the literature on the subject, that level of fertility affects the relative survival chances of girls but is not affected by it.

47 The coefficient on the total fertility rate is 0.13, and its *t*-ratio is 2.04. None of the other coefficients changes very much, nor are there important changes in levels of statistical significance.

48 The coefficient on the interaction term is –0.011, with a *t*-ratio of –2.55. The statistical significance of the other variables remains unchanged.

49 The reason for dropping this variable is that 1991 information on medical facilities was not available at the time of writing.

50 The 1991 CBR estimates were calculated by P. N. Mari Bhat (Population Research Centre, Dharwad). We are grateful to him for making these unpublished estimates available to us.

51 On this, see particularly Visaria and Visaria (1994).

52 As with similar exercises presented in this section, the validity of this procedure requires that the added variable (in this case, the juvenile sex ratio) is not affected by the lefthand variable (in this case, the child mortality rate).

53 The reason for using the juvenile sex ratio, rather than the sex ratio in the population as a whole, is that the latter can be sensitive to migration patterns at the district level (see Miller 1981).

54 The coefficient on the juvenile sex ratio, measured as the ratio of girls to boys in the 0–10-year age group, is –0.166, with a *t*-ratio of –3.23.

55 The simulations in Table 6 concerning the effect of changes in the level of pov-

erty are based on equations in which the head-count ratio of poverty is used as an explanatory variable in place of the Sen index. The substitution was made because percentage changes in the head-count ratio are more straightforward to interpret. The use of the head-count ratio in place of the Sen index makes little overall difference to the estimates.

56 On this issue, see Drèze and Sen (1995): ch. 7, and the literature cited therein.

57 For the latest figures on female–male ratios in India and Indian states since 1901, see Nanda (1992): 102–103.

58 One qualification concerns time trends in female labor force participation. Given the frequent changes in definition and treatment of women's work in Indian censuses, it is difficult to state with confidence whether female labor force participation rates in India have increased or decreased since the beginning of this century (see e.g. Duvvury 1989 for further discussion). It is unlikely, however, that a major *increase* in female labor force participation has taken place over that period.

59 The gender gap in literacy, for instance, has narrowed somewhat between the 1981 and 1991 censuses. Similarly, the survival advantage of women in the older age groups has noticeably increased since 1971, and the age at which that advantage begins has also declined; as a result, female life expectancy has recently overtaken male life expectancy (see Karkal 1987; Dyson 1988; and Rajan et al. 1992).

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