MORTALITY, FERTILITY AND GENDER BIAS IN INDIA:

A District Level Analysis *

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ABSTRACT

This paper examines the determinants of fertility, child mortality and gender-bias in child mortality in India using district-level data from the 1981 Census of India. A common set of explanatory variables is used including male and female literacy, the level of poverty, female labour force participation, urbanization, health-care facilities and other socio-economic variables. The equations may be interpreted as the reduced form of a system that jointly determines fertility, mortality and gender differences in child mortality.

The analysis brings out the powerful demographic influence of variables that relate directly to women's agency, such as female literacy and female labour force participation. Female literacy, in particular, significantly reduces child mortality, fertility levels, and the female disadvantage in child survival. Female labour force participation has no statistically significant effect on the level of child mortality, but reduces gender bias in child survival as well as fertility levels.

Variables reflecting the general level of development and modernization (e.g. per-capita expenditure, male literacy, urbanization, and the availability of medical facilities) have a negative but comparatively weak impact on mortality and fertility levels, and, if anything, amplify rather than reduce the gender bias in child survival. In particular, we find that the female disadvantage in child survival is significantly lower in districts with higher poverty levels.

The paper concludes with a discussion of various extensions of the basic model, and of some practical implications of these findings.

JEL Classification: J11, J13, I12

Keywords: mortality, fertility, gender inequality, female literacy and demographic change.
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1. Introduction

India is a country of striking demographic diversity. Even broad comparisons between different states within the country 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 only 17 per 1,000 live births, a total fertility rate below the replacement level (1.8 births per woman), and a female-male ratio well above unity (1.04). At the other end, the large north Indian states find themselves in the same league as the least developed countries of the world 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 as high as 5.1, and the female-male ratio (0.88) is lower than that of any country in the world.25

India is also, increasingly, a country of rapid demographic change. As in many other developing countries, mortality rates in India have significantly declined in recent decades, e.g. the infant mortality rate has decreased by about 50 per cent since 1961. The same period has seen a sustained decline in fertility, particularly in the South Indian states (in Tamil Nadu, for instance, 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.26

Apart from being of much interest in themselves, these interregional and intertemporal variations provide useful opportunities to study the determinants of demographic outcomes in

25 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 Census and Sample Registration System data. 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 in-migration.

India. This paper is an attempt to examine some of the relevant relationships based on a cross-section analysis of district-level data for 1981.  

Our sample consists of 296 districts for which detailed information is available. The demographic outcomes under study are (1) the child mortality rate, (2) the total fertility rate, and (3) 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 behaviour, but also reflects the limitations of available statistical sources. Particular attention will be paid to the influence of per-capita income, male and female literacy, female labour force participation rates, urbanization, health-care facilities, and related socio-economic variables. The intention of this analysis is not to discriminate between different theories of demographic outcomes (it would, indeed, be difficult to use the results in that way), but rather to identify the basic empirical relationships, including the demographic influence of different personal and social characteristics.

The paper is organised as follows. In section 2, we discuss the possible relevance of different explanatory variables, in the light of recent research on demographic change. Section 3 comments on data sources and estimation techniques (the latter are discussed in more detail in the Appendix). Sections 4 and 5 present the main findings, and some extensions, respectively. Section 6 concludes.

2. Issues and Hypotheses

This section discusses some possible relationships between demographic outcomes and basic personal and social characteristics. We focus, to start with, on mortality and fertility, before taking up the issue of gender bias.

2.1. Economic Development and the Demographic Transition

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27 Earlier investigations of this type, for India, have tended to be 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), Khemani (1994).
Demographic change (in particular, the "demographic transition" from high to low levels of mortality and fertility) is sometimes thought of as a by-product of economic growth and rising incomes. It is certainly the case that a broad inverse association can be observed, at the international level, between per-capita GNP, on the one hand, and mortality and fertility levels, on the other. There is also much evidence of a causal relationship being involved, with rising incomes typically leading to some reduction of mortality and fertility. But recent research has brought out that the "income effect" can be quite slow and weak, and that other personal and social 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. The association between the two variables is rather weak, to say the least. Some aspects of this weakness of association are indeed rather striking; for instance, child mortality is more than six times as high in Uttar Pradesh as in Kerala, even though the head-count ratios are very similar - and close to the all-India average - in both states. This need not be taken to entail that income or 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 does decline with higher incomes (this elementary relationship also emerges in the empirical analysis presented in this paper). The point is that many other factors, not all of which are themselves strongly correlated with income, also have a strong influence on demographic outcomes.

2.2. 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 as one of the most powerful. The close relationship between education and demographic change has

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28 The head-count ratio on which Figure 1 is based measures the proportion of the population living in households with per-capita expenditure below a pre-specified poverty line. The reference year is 1987-88 - the latest year for which state-specific estimates of the head-count ratio are available.
indeed clearly emerged in a number of recent empirical studies.\textsuperscript{29} A wide range of theoretical analyses from different disciplines also point in the same direction.\textsuperscript{30}

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 against the burden of repeated pregnancies, and to take action to avoid that burden. This may be because they have other sources of prestige and fulfilment than reproductive performance, more control over household resources and personal behaviour, 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 some reduction in desired family size. Third, educated women often have higher aspirations for their children, combined with lower expectations from them in terms of labour services (United Nations [1993]). This, again, may reduce desired family size, e.g. if there is a trade-off 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 against time-intensive activities such as child-bearing and child-rearing.\textsuperscript{31} Further links of this kind have


\textsuperscript{30} See e.g. Dasgupta (1993), and the literature cited there.

\textsuperscript{31} Some formal economic models in the neoclassical tradition have analysed 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
been found to have empirical relevance, usually implying a negative association between female education and desired family size.

Aside from this, 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 need 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.\(^{32}\)

Some of the effects described in the preceding paragraphs, e.g. 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.\(^{33}\) In the statistical analysis presented further in this paper, an attempt will be made 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 very common for cooked food to be left uncovered around the house for long hours, for umbilical cords to be cut with unsterilised sickles, for children to be left unimmunized, and for

\(^{32}\) There are some effects in the other direction, too. For instance, the duration of breast-feeding often declines with maternal education, lowering the duration of post-partum amenorrhea, and post-partum 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.

\(^{33}\) In the neoclassical framework mentioned in footnote 7, male education only has an income effect, if 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".
extraordinary beliefs to be entertained about the causes of simple child diseases such as tetanus or diarrhoea. In addition, basic education can be important in helping mothers to demand adequate attention to children's needs within the household, to take advantage of public health care services, and generally to achieve a more informed and effective pursuit of their aspirations (including the well-being of children) in the family and society.

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 quite 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 will return, at the end of this section, to their implications for estimation procedures and interpretation.

2.3. Other Influences

Aside from the demographic impact of income and education, discussed earlier, 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 labour force participation and child mortality. It is difficult to determine a priori whether the effect of higher female labour force participation on child survival is likely to be positive or negative. In the case of boys, there are two important effects to consider, working in opposite directions. First, involvement in gainful

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

35 The variable used in this paper to measure female labour 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 make it clear that unpaid "household duties" are not to be counted as economically productive work. The census definition of "economically productive work" is questionable, but it 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).
employment often has positive effects on a woman's agency roles, which, in India, typically include 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 typically show great reluctance to share the domestic chores).  

In the case of girls, a third consideration is that higher levels of female labour force participation may enhance the importance attached to the survival of a female child (see section 2.4). The net result of these different effects is a matter of empirical investigation.

The effect of female labour force participation on fertility is somewhat more predictable. Generally, we expect higher female labour force participation to have a negative impact on fertility, since the double burden of household work and gainful employment makes repeated child-bearing particularly stressful. There is, of course, also a possibility that fertility affects female labour force participation (since having a large number of 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 labour force participation. If it is important, however, some bias will be involved in using female labour force participation as an exogenous explanatory variable in analysing the determinants of fertility (and also of mortality, given the interaction effects mentioned earlier). We will therefore also present results based on treating female labour force participation as an endogenous variable (this will essentially involve dropping female labour 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, it should be remembered that the functioning of health services can be as important as their availability. Many studies have brought out the poor functioning of health services in large parts of India, especially the large north Indian states.  

One particular aspect of this problem, noted in a large number of empirical studies, is the

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36 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 there.

massive diversion of rural health care services to family planning campaigns. \textsuperscript{38} In the absence of statistical information on these and other qualitative aspects of health care, quantitative indicators of the availability of health services are likely to be quite "noisy", and the precise relationship between the provision of health care and child mortality may be hard to identify. Similar remarks apply in the case of fertility. The fact that rural health care services have given overwhelming priority to family planning in many Indian states may be taken to 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 counter-productive nature of the top-heavy methods that have often been used in rural India to promote family planning.

Another issue of interest is whether the identified relationships between demographic and socio-economic 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, e.g. due to better access to different types of relevant information in urban areas. \textsuperscript{39} Similarly, it is worth investigating whether the identified relationships vary significantly between different 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 rather weak in India, judging from broad inter-state comparisons (Figure 1). The question remains whether poverty has a strong effect on mortality or fertility after controlling for the other explanatory variables mentioned so far. Also, quantitative estimates of that effect are of some 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 a more rapid demographic transition. Some tentative


\textsuperscript{39} Analyses of fertility in the neoclassical tradition also point to the lower costs of children in rural compared to urban areas, given the opportunities that rural children have to contribute to household production, and to acquire training and skills quite cheaply within the household. See Schultz (1981, 1994).
results of this type will be presented in section 4.

2.4. Gender Bias

Basic Issues

Relatively little is known about the determinants 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 are also well-known. But the factors underlying these strong regional contrasts remain a matter of some speculation, and much also remains to be learnt about the social, economic and cultural factors that influence gender bias in one direction or another.

In fact, a good number of contradictory claims and findings can be found in the literature on this subject. It has been suggested, for instance, that the extent of gender bias tends to go down with higher female literacy (Bourne and Walker [1991]) but also with lower female literacy (Das Gupta [1987]); with higher levels of poverty (Krishnaji [1987], Dasgupta [1993], Miller [1993]) but also with lower levels of poverty (Sen and Sengupta [1983], Agarwal [1986]); with lower levels of fertility (Basu [1992]) and also with higher levels of fertility (Das Gupta and Mari Bhat [1995]).

There are at least two reasons for this confusion. First, as far as theoretical analysis is concerned, it is often difficult to predict whether the effect of a particular variable on the extent of 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 boy preference, this improved access to

40 In 1991, the death rate in the 0-4 age group (per thousand) was 25.6 for males and 27.5 for females at the all-India level. The female mortality rate in that age group was lower than the male mortality 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 disadvantage was most pronounced in the north-central and north-western states of Bihar, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh. See Government of India (1993), Table 7.

41 For recent reviews of this literature, see Guio (1994) and Kishor (1995).
medical facilities is likely to enhance the survival chances of boys more than those of girls (because of an anti-female bias in the utilization 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 utilization of the limited resources that are available. Both lines of reasoning are plausible, but, in any particular context, only one of the two 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 due to the limited nature of available opportunities. Different authors have tended to emphasise 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 labour force participation. But we also know that there is a good deal of "collinearity" between these three variables; only multivariate analysis can tell whether, say, poverty has a positive or negative effect on gender bias independently of the influence of caste or female labour force participation. Similarly, an examination of the relationship between parental literacy and gender bias in child survival can be quite 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 association 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 have taken that route. In a pioneering study, Rosenzweig and Schultz (1982) examined the relationship

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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.

A more recent study by Sunita Kishor (1993, 1995) investigates the determinants of gender bias in child survival using district-level data from the 1981 Census of India. The author attempts to examine the relevance of two different 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 labour 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. The author finds that the relative survival chances of girls strongly depend on both economic and cultural worth (i.e. they tend to be higher in districts where female labour 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 labour force participation and patrilocal exogamy, respectively) is not entirely clear. It can be argued that both female labour force participation and patrilocal exogamy (or, more generally, kinship systems) have an economic as well as a cultural basis.\footnote{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 labour force participation is closely linked with the practice of female seclusion, which may be a cultural phenomenon as much as an economic one.} Similarly, both variables may influence the relative survival chances of girls through economic as well as cultural links.\footnote{To illustrate: patrilocal exogamy can reduce the returns to parental investment in female child survival (an economic link), and female labour force participation can raise the general perception of women's role and...
achievement in terms of bringing out the respective influences of female labour force participation and kinship systems on relative female survival chances. It also yields a wealth of insights into the relationship between gender bias in child survival and a whole 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 further in this paper. Although there are important differences of approach between Kishor's analysis of gender bias and our own, 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 Counter-claims

Before presenting our own results, it may be worth commenting a little more on the tensions 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: (1) female labour force participation, (2) female literacy, (3) poverty, and (4) fertility.

(1) Perhaps the only uncontroversial finding of earlier studies is that the participation of adult women in gainful employment tends to go 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 somewhat unclear, however, is the precise mechanism underlying that relationship. There are a number of possibilities, including that female labour force participation: (i) raises the returns to "investment" in girls; (ii) raises the status of women in society, and therefore the value attached to young girls; (iii) lowers dowry levels, and therefore reduces the costs of bringing up daughters; (iv) makes women less dependent on adult sons for security in old age, and therefore reduces boy preference; (v) raises the bargaining power of adult women, and their ability to resist male pressure to discriminate in favour of boys. There is, as things stand, little evidence to discriminate between these alternative hypotheses.
(2) 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 little hard to believe, however, that it takes good education to discriminate between boys and girls. A different line of explanation, pursued in greater depth in Das Gupta and Mari Bhat (1995), is that educated mothers have lower fertility, and that low fertility tends to go with higher gender bias (more on the last point further in this section).

Other studies have yielded a wide range of results. Different empirical investigations have suggested that the relationship between maternal education and gender bias in child survival may be: (1) positive, as initially 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]).

Another group of studies find, or suggest, that no simple relationship between the two can be firmly established (Chen et al [1981], Sen and Sengupta [1983], Caldwell et al [1989]). The debate continues.

(3) As far as the influence of poverty is concerned, 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), Dasgupta (1993), among others. Some authors have distanced themselves from this hypothesis (Agarwal [1986]), or suggested that poverty may not be a major determinant of gender bias in child survival (Chen et al [1981], Harriss [1990], Das Gupta [1987]). Unfortunately, detailed empirical investigations of this issue are few and far between.


46 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 the reverse relationship based on household data. In Kishor's (1993) study, the variable most closely related to
One noteworthy exception is Krishnaji's (1987) discussion of the relationship between 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 the per-capita expenditure scale, suggesting that anti-female discrimination is less intense in poorer households. But the author qualified this possible 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 of gender bias in child survival being lower among poorer households, and no sound evidence of the opposite pattern. But the empirical basis of these observations remains quite limited as things stand. On the whole, we concur with Kishor's (1995) judgement that "we do not as yet have any conclusive evidence that poorer households are necessarily less discriminatory".

(4) The relationship between fertility and gender bias in child survival is a complex issue. One major insight on this subject 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. From this "parity effect", it is tempting to conclude that fertility decline would generally be a factor in reducing gender bias in child survival.

This conclusion receives further support from another argument, namely that high fertility and excess female mortality in childhood derive from a common root, i.e. 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 recent intensification of gender bias in India (specifically, the decline in juvenile female-male ratios...
between 1981 and 1991) is "a consequence of fertility decline". The basic argument is that the "parity effect" is outweighed by an "intensification effect" which takes the form of parity-specific gender bias being more pronounced at lower levels of fertility. That pattern, according to the authors, can be observed in the Khanna study. The explanation proposed 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 evidence that one force in the direction of fertility decline in India is the gradual displacement of "two sons, one daughter" by "one son, one daughter" as the most widely-preferred family pattern.¹ This is a case where the desired number of sons declines more rapidly than the desired number of children, contrary to Das Gupta and Mari Bhat's hypothesis.

The authors 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 foetuses, 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 whole 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 in the case of a reduction of fertility due to, say, more widespread literacy or a more equal valuation of boys and girls (fertility decline, for instance, has not "caused" any 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.

2.5. Interpretation of the Estimates

As 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

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¹ For some relevant evidence, see the studies cited in Basu (1991), and the more recent information made available by the National Family Health Survey (International Institute for Population Sciences, 1994).
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 i.e. 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 both of theory and data availability.

We therefore concentrate, in this paper, on the reduced forms which relate the dependent variables of interest (child mortality, fertility, and gender bias in child survival) to exogenous variables alone.\(^{49}\) 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.\(^{50}\) 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.

3. Data and Estimation

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

\(^{49}\) Given the possibility of female labour force participation being endogenous (see section 2.3), we will also treat female labour force participation as a fourth endogenous variable in some of the regressions presented further on.

\(^{50}\) Formally, the model can be written as \(Y = AX + BX\), where \(Y_{ij}\) is the value of the \(i\)th endogenous variable in the \(j\)th district and \(X_{kj}\) the value of the \(k\)th exogenous variable in the \(j\)th 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 \(Y = [I - A]^{-1}BX\), the "reduced form".
Fertility is measured by the "total fertility rate" (TFR), which represents the number of children that would be born to a woman if she were to live to the end of her child-bearing years and bear 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. 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. It is based on census questions on the number of children ever born and the number of children surviving. Gender bias in child mortality is measured as FD = (Q5F-Q5M)/Q5F, where Q5F is mortality among female children and Q5M is mortality among male children. For convenience, we shall refer to this measure of gender bias as "female disadvantage" (or FD for short). 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. Urbanisation is measured by the percentage of total population living in urban areas. We use the distributionally-sensitive Sen index as an indicator of poverty. Female labour force participation, where included, is defined as the percentage of female "main workers" in the total female population (on this definition, see footnote 11 in section 2.3). The

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

52 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).

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

54 Settlements counted as "urban areas" in the 1981 census were those with a population of over 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% of the male labour force in the non-agricultural sector.

55 On the definition and properties of the Sen index, see Sen (1976). Another possible measure of economic affluence 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 presented in this paper.
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" in the population, and the proportion of "scheduled tribes". Finally, three dummy variables are used to identify regional patterns: EAST, for districts in Bihar, Orissa and West Bengal; WEST, for Gujarat and Maharashtra; and SOUTH, for Andhra Pradesh, Karnataka, Kerala, and Tamil Nadu. 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 different Indian states, obtained by aggregation over the relevant districts.

Most of the information used in this paper is derived from the 1981 census, and 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 sample design divides the country into a number of "regions", based on agro-climatic and socio-economic criteria, and makes it possible to generate 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 the borders of one particular state, and each of the major states being divided into several regions. The 14 states included in this study are made up of 51 regions. For these regions, estimates of average per-capita expenditure, the head-count ratio, and the Sen index are available for 1972-3 (rural areas only) from Jain et al (1988), based on the 27th round of the National Sample Survey. The poverty indicator used here for each district is the Sen index of rural poverty for the region in which the district in question is situated. (For want of information on the level of poverty in rural and urban areas combined, we have used these rural estimates, and also included a separate variable indicating the level of urbanization.)

\[56\] The control region thus consists of Haryana, Punjab, Madhya Pradesh, Rajasthan and Uttar Pradesh. The regional partition used in this paper is essentially the same as that used in the Sample Registration System (see e.g. Government of India (1993), p.39), except that we have merged the SRS's "Central" and "North" regions and taken this merged unit as the control region.
Two caveats are due. First, the reference year for this poverty variable is 1972-3, rather than 1981 (as with the other variables). The justification for using 1972-3 as the reference year for the poverty variable is that the 1981 mortality estimates are based on birth and death information pertaining to the late 1970s, and that poverty levels in different regions during that period must have been quite close to those observed in 1972-3. Fortunately, the relative position of different regions in terms of poverty levels does seem to be fairly stable over time. In fact, replacing the Sen index for 1972-3 with the Sen index for 1987-8 (also available for NSS regions) has little effect on the results presented in this paper.57

Second, the use of the regional poverty estimate for each district within a particular region involves the implicit assumption that intra-regional variations in poverty are small. This is not implausible, since the NSS regions are meant to be relatively homogeneous in terms of agro-climatic and socio-economic features. However, some loss of information is certainly involved here, and the results presented below will 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 that of districts. This approach has the advantage that it involves a more accurate poverty indicator for each observation, but 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, and will receive explicit attention in section 5.

Cross-section analysis is standardly based on the assumption that the error terms are independently and identically distributed. In this case, we need to recognise that these errors may be fundamentally spatial in character. Spatial correlation refers to the positive or negative correlation of a variable between neighbouring regions of a surface, such as contiguous districts.

57 To our knowledge, 1972-3 and 1987-8 are the only two years for which poverty indicators have been calculated for the NSS regions. The 1987-8 estimates are available from unpublished tabulations of the National Sample Survey performed by Dr. P.V. Srinivasan (Indira Gandhi Institute of Development Research, Bombay).
Spatial correlation in the errors may arise because of unobserved (or unobservable) variables which may themselves be spatially correlated. In this particular context, for instance, spatial correlation may result from the influence of unobserved cultural factors on mortality or fertility. If the regression errors are spatially correlated, then the standard assumption of a spherical error covariance matrix fails to hold. The implication for ordinary least squares estimation is that it is no longer efficient. The parameter estimates will be unbiased provided the errors are uncorrelated with the explanatory variables, but the estimated standard errors will be biased and may lead to faulty inference. We therefore adopt a standard technique of spatial econometrics, which consists of modelling the spatial structure of the errors by parametrizing the error covariance matrix as a function of a spatial dependence parameter, $\lambda$, and estimating the model using maximum likelihood estimation. We test whether $\lambda=0$, i.e. 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. Details of the estimation procedure are presented in the Appendix.

4. Basic Results

Table 3 (first panel) presents the main results. Apart from indicating the signs of different 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 information given there with the mean values presented in Table 1. In the second panel of Table 3, we present separate regressions with Q5M (male child mortality) and Q5F (female child mortality) as dependent variables; these additional regressions are given for the purpose of facilitating the interpretation and discussion of the main results.

In arriving at the estimates given in Table 3, we began with fairly general specifications which included quadratic terms (for non-linearities) and cross-products. We found no evidence of non-linearities, except in the equation for female disadvantage. Visual inspection and non-

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58 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 neighbours in all directions.

59 Cultural influences on demographic behaviour in India have been stressed by Sopher (1980a, 1980b), Dyson and Moore (1983), and Basu (1992), among others.
parametric 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 will not present any cross-product terms at this stage, in order to keep the discussion relatively straightforward, but will discuss some results relating to cross-product terms in section 5.

The estimates in Table 3 treat female labour 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 labour force participation as an explanatory variable in recognition of its endogeneity (see section 2.5). In general, the conclusions that follow from Table 3 are upheld by Table 4.

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

4.1. Child Mortality and Female Disadvantage

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

(1) Female literacy: Female literacy has a negative and statistically significant effect on child mortality. Female literacy 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, according to which higher female literacy is often a tool of intensified discrimination against female children (see section 2.4).

It is worth noting that 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 the effect of male literacy 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 different regions (see section 2.4) by introducing additional interaction terms involving the female literacy variables and regional dummies. None of the coefficients of these interaction terms are 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.

(2) Female labour force participation: Higher female labour 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 (see section 2.4).

Although higher levels of female labour force participation are clearly associated with reduced anti-female bias in child survival, the relationship between female labour force participation and absolute levels of male and female child mortality is a little more complex. The basic results presented in Table 3 suggest that higher female labour force participation is associated with higher levels of male and female child mortality, though the effect is significant only in the case of male children. When examining the effects of female labour 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, and, given the limitations of the variable we have used to measure poverty (see section 3), the effect of female labour force participation on absolute levels of child mortality requires further scrutiny. We will return to this issue in section 5.1.

(3) Urbanization: Urbanization has a negative and statistically significant effect on child mortality (both sexes combined). The effect on male mortality is larger than that on female mortality, and correspondingly, urbanization is associated with higher levels of female disadvantage in child survival. The last effect is statistically significant at the 10% level, but not at the 5% level.
(4) **Medical facilities**: 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% level, but not at 5%.

(5) **Poverty**: As expected, higher levels of poverty are associated with higher levels of child mortality. This variable is not significant at the 5% level, although it is significant at 10%.\(^{60}\) Less evidently, there is a negative and statistically significant association between poverty and FD, i.e. higher levels of poverty go with lower levels of female disadvantage in child survival. This is consistent with the hypothesis, advanced by a number of authors, that anti-female discrimination is particularly strong among privileged classes.\(^ {61}\)

(6) **Scheduled tribes**: 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 labour force participation (which is generally higher among scheduled tribes than in the population as a whole). This suggests that tribal societies have other features that enhance the relative survival chances of female children. Examples of possibly relevant features are kinship systems and property rights.\(^ {62}\)

It is also worth noting that the absolute levels of male and (particularly) female child mortality seem to be 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 (e.g. relatively low levels of crowding and pollution). But the precise basis of this statistical association requires further investigation.

(7) **Scheduled castes**: There is no significant association between the proportion of scheduled castes in the population and the extent of female disadvantage in child survival. This

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\(^{60}\) The absence of statistical significance at the 5% level may reflect the lack of precision of the poverty variable, discussed in section 3.

\(^{61}\) See section 2.4, and also Drèze and Sen (1995), chapter 7.

\(^{62}\) Kishor (1993) finds that the statistically significant association between gender bias in child survival and the proportion of tribals in the population disappears after her "patrilocal exogamy" variable is included in the regression.
is consistent with recent research on gender inequality among scheduled castes, particularly relating to trends in female-male ratios. Until quite recently, the female-male ratio was considerably higher than average among disadvantaged castes, including castes now classified as "scheduled castes". Many observers have attributed this contrast to the relatively egalitarian character of gender relations among these castes. In recent decades, however, there has been a striking decline of the female-male ratio among scheduled castes, to the extent that by 1991 this ratio (0.922) was very close to the female-male ratio in the population as a whole (0.927). In other words, differences in gender relations between the scheduled castes and the rest of the population appear to have been narrowing in recent years, and have even disappeared altogether as far as the female-male ratio (a basic indicator of gender inequality) is concerned. The fact that we find no difference between scheduled castes and the rest of the population in terms of the extent of female disadvantage in child survival is in line with these recent findings.

(8) 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, so much so that female children have a survival advantage over boys in that region (see Table 2). In both respects (child mortality and gender bias), the contrast between the southern region and the rest of the country is statistically significant.

The particular demographic features of south India, including the relatively favourable survival chances of female children, have been much discussed in the literature. 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 labour force

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63 On this, see Agnihotri (1994); also Drèze and Sen (1995), chapter 7.

64 The "Sanskritization" process, involving the emulation of high-caste practices by members of the lower castes as a means of improving their social status, provides one possible 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 also other possible 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.

participation, and other variables included in the regression.\textsuperscript{66} 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 this North-South contrast.\textsuperscript{67}

4.2. Fertility

Tables 3 and 4 include further results relating to the determinants of the total fertility rate (TFR). Female literacy and female labour 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 are statistically significant.

4.3 Diagnostic tests and qualifications

Maximum likelihood estimation is based on the assumption that the regression errors are normally distributed. In each equation, we tested whether this assumption is upheld by the residuals using the Jarque-Bera (1980) test.\textsuperscript{68} The test statistic is distributed as a $\chi^2$ with two degrees of freedom. The critical value at 5% is 5.99 in small samples (and 11.38 if the Leamer-Schwarz criterion for large samples is used). In general, the residuals appear to be normally distributed except in the equation for female disadvantage. Visual inspection of the residuals suggested that this was due a few outliers.\textsuperscript{69} We therefore re-estimated the equations using

\textsuperscript{66} For a similar finding (even after including "patrilocal exogamy" as an additional explanatory variable), and further discussion, see Kishor (1993).

\textsuperscript{67} On these and related influences, see the studies cited in Drèze and Sen (1989, 1995), Gupta et al (1993) and Dasgupta (1993); also Alaka Basu (1992), Sunita Kishor (1993) and Bina Agarwal (1994), among other recent contributions.

\textsuperscript{68} The test assumes that the residuals are independent, but our residuals are spatially correlated. We therefore transformed the residuals to eliminate spatial correlation, and then performed the test on the modified residuals. See Appendix for further details.

\textsuperscript{69} There are nine districts where our equations make relatively large errors of prediction. In two of these nine districts, Hasan and Balangir, female disadvantage is considerably lower than predicted. In the other seven, female disadvantage is relatively high compared to its predicted value. These are (in decreasing order of error): Salem, Mainpuri, Mathura, Jaisalmer, Bhind, Gwalior, and Etawah. It is interesting that at least two of these districts (Salem and Jaisalmer) are notorious for high levels of
dummies for the outlying districts. The Jarque-Bera test statistics for the auxiliary regressions were 0.18 (including "female labour force participation") and 0.17 (without "female labour force participation"), and the estimated coefficients were largely unchanged. We are therefore confident that outlying districts do not unduly influence the estimates given in Tables 3 and 4.

5. Further Results and Extensions

5.1. Poverty and Female Labour Force Participation

In section 3, we have commented on some limitations of the variable we have used to measure poverty. We have noted, in particular, that the reference year for this variable is 1972-3, 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 some bias in the estimated coefficients of variables that are strongly correlated with poverty. One important example of this concerns female labour force participation, and in particular the relationship between female labour force participation and child mortality. As was discussed earlier, in estimating the effect of female labour force participation on child mortality and other demographic outcomes, it is important to control for the incidence of poverty. Indeed, female labour force participation in India is often a reflection of economic hardship, and failing to control for this factor may lead, for instance, to a spurious positive relationship between female labour force participation and child mortality (implicitly reflecting, in fact, the positive association between poverty and child mortality).70

In view of these considerations, we have explored alternative ways of dealing with the poverty variable. As far as the reference year is concerned, we have examined the effects of replacing the 1972-3 poverty estimates with the corresponding 1987-8 estimates. The basic results presented so far continue to hold, so that the choice of reference year for the poverty female infanticide (on Salem, see particularly Venkatachalam and Srinivasan [1993]).

70 This argument holds whether or not female labour force participation is exogenous.
variable does not seem to be a major issue.

Regarding the use of region-level poverty estimates (as opposed to district-level estimates) in the regressions, one way of investigating whether this procedure leads to any serious bias is to re-estimate the regression equations using region-level estimates for all the variables listed in Table 1. Region-level estimates can easily be obtained by aggregation, as weighted averages of the district-level values. This method leads to a sharp reduction in the number of observations (from 296 to 51), but eliminates any possible 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 very 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 involve 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 labour force participation is associated with lower child mortality (both sexes combined). Although this association is not statistically significant, it does suggest that the positive association between these two variables obtained in the earlier (district-level) regressions may reflect a failure to adequately control for poverty in those regressions.\(^{71}\)

5.2 Fertility and Gender Bias in Child Mortality

As discussed in section 2.4, the links between fertility and gender bias in child survival

\(^{71}\) Kishor's (1993) study, mentioned earlier, found that female labour 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 labour force participation and child mortality may reflect the lack of adequate control for poverty (the regressions presented there only include rough proxies for the "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 labour force participation).
are far from clear from the existing literature. While some authors have argued that high fertility is typically associated with high levels of female disadvantage in survival, others have taken the opposite view.

To shed some light on this issue, we have included the total fertility rate as an additional regressor in the equation for female disadvantage. We find that higher fertility is associated with higher female disadvantage in child survival, and the association is statistically significant. Thus, it appears that, after controlling for other relevant 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.

5.3. 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 (see section 2.2). 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 (e.g. female literacy has a larger impact on child mortality when medical facilities are available). We test this hypothesis by including an interaction term in the regression for child mortality, as an additional right-hand side 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. This suggests that medical facilities and female literacy do have synergistic effects in reducing child mortality.

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

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

74 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.
5.4. Structural Change

Another issue of interest is the stability of the estimated relationships over time. In due course, it will be possible to carry out regression exercises similar to those presented in this paper using 1991 data, and to compare them with the 1981 results. The relevant information from the 1991 census, unfortunately, are still awaited. Meanwhile, a tentative assessment of structural change has been attempted as follows.

We estimated an additional regression equation, with "crude birth rate" (CBR) as the dependent variable, and using 1981 district data. All the explanatory variables in Table 3 were retained, with the exception of "medical facilities". 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 level of states. These predicted CBR figures were then compared with the actual figures derived from the 1991 census.

This comparison indicates that our regressions under-predict the decline of the crude birth rate between 1981 and 1991 in all the fourteen states considered (i.e. the predicted CBR is, in each case, higher than the actual CBR). The difference between predicted and actual CBR (expressed as a proportion of actual CBR) is very small in the case of Madhya Pradesh (1.1%), and also relatively small (less than 10%) in the case of Haryana, Rajasthan and Uttar Pradesh, but particularly large in West Bengal (21%), Punjab (24%), Andhra Pradesh (25%), Kerala (41%) and Tamil Nadu (46%). The under-prediction of CBR decline in all states suggests that important dynamic processes have added to the 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, and of much greater inertia in the large North Indian states.

5.5. Sex Ratio and Child Mortality

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75 The reason for dropping the latter is that 1991 information on medical facilities is not available at the time of writing.

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

77 On this, see particularly Visaria and Visaria (1994).
Finally, we attempted to examine 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 (in so far as, in India, the health of children depends a great deal on the agency of women).

In order to test this hypothesis, we used the juvenile sex ratio (number of females per 1,000 males in the 0-10 age group) as an additional right-hand side variable in the equation for child mortality.\(^78\) The juvenile sex ratio is interpreted here as a rough indicator of basic gender inequality.\(^79\) We find that, holding other factors constant, child mortality is higher in districts with a lower juvenile sex ratio, and this effect is statistically significant.\(^80\) This lends some support to the proposed hypothesis.

6. Discussion

6.1. Women's Agency and Demographic Outcomes

The findings of this paper sharply bring out 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 rather striking that, while the variables directly relating to women's agency (specifically, the female literacy rate and female labour force participation) have a strong and statistically significant negative impact on female disadvantage (FD), those relating to the general level of economic development and modernization in the society as a whole (e.g. poverty, urbanization, male

\(^{78}\) As with other similar exercises presented in this section, the validity of this procedure depends on the added variable (in this case, the juvenile sex ratio) not being affected by the left-hand side variable (in this case, the child mortality rate).

\(^{79}\) 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 quite sensitive to migration patterns, at the district level (see Miller, 1981).

\(^{80}\) The coefficient on the juvenile sex ratio, measured as the ratio of girls to boys in the 0-10 age group, is $-0.166$, with a t-ratio of $-3.23$. 
literacy and medical facilities) do nothing to improve the relative survival chances of girls vis-a-vis boys. In fact, to the extent that these variables do have an influence on female disadvantage in child survival, this influence turns out to go in the "wrong" direction in each case, e.g. 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 Table 3 for details). The reason is that these variables reduce male child mortality more than female child mortality. In so far as a positive connection does exist 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 labour force participation.

Similarly, while indicators of development such as male literacy, reduced poverty, 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 (and similarly with male literacy and poverty)\textsuperscript{81}. It can be seen that the influence of female literacy on child mortality and gender bias is quite large, especially in comparison with that of male literacy or poverty.

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

\textsuperscript{81} The simulations in Table 6 concerning the effect of changes in the level of poverty 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.
6.2. Cross-section and Time-series Analysis

As discussed in the preceding section, our results lend little support to the notion that gender bias in India automatically declines in the process of economic development (except in so far as the latter enhances female literacy and female labour force participation). This may seem a little surprising, but it is worth noting that this finding is highly consistent with the widely-discussed phenomenon of sustained decline in India’s female-male ratio since the beginning of this century.\textsuperscript{82}

In 1901, the ratio of females to males in the Indian population was 972. From then on, India's 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 927.\textsuperscript{83} The causes of this decline are a matter of some debate, and the results presented in this paper are of some relevance in that context. The regressions presented in Table 3 suggest that the only important force that may have operated in the direction of a reduction in gender bias over this period is the expansion of female literacy. Most other developments (including the expansion of per-capita income, urbanization, and male literacy) would have worked in the other direction, if these cross-section results are any guide to the corresponding effects over time.\textsuperscript{84}

The preceding observations should not be taken to imply that economic development in India is comprehensively detrimental to the position of women in society. That statement requires at least three qualifications. First, the results suggest that gender bias goes down with an expansion of female literacy, and that expansion is part of the process of economic

\textsuperscript{82} On this issue, see Drèze and Sen (1995), chapter 7, and the literature cited there.

\textsuperscript{83} For the latest figures on female-male ratios in India and Indian states since 1901, see Nanda (1992), pp. 102-103.

\textsuperscript{84} One possible qualification concerns time trends in female labour force participation. Given the frequent changes in definition and treatment of women’s work in Indian censuses, it is difficult to state with any confidence whether female labour 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, however, unlikely that a major increase in female labour force participation has taken place over that period.
development. Even female labour force participation can be expected to increase in the future, and that too is likely to lead to some reduction of gender bias.

Second, the relationship between gender bias and the level of economic development may well be non-linear, with the relative position of women first declining and later improving as, say, the level of per-capita income increases. Some authors have indeed stressed the plausibility of such a non-linear relationship (see particularly Kishor, 1995). In our own work, we have found no evidence of this type of non-linearity, 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 in the future.

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 women have considerably improved in India in the recent past. 

6.3. Demographic Change

Since population growth in India is often a subject of intense concern, it is worth reiterating that the only variables we have found to have a significant effect on fertility (other than regional dummies and the dummy for scheduled tribes) are female literacy and female labour 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 labour force participation are likely to be more conducive to reduced fertility than indirect interventions based on promoting the general level of 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,

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85 The gender gap in literacy, for instance, has somewhat narrowed 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 come down; as a result, female life expectancy has recently overtaken male life expectancy (see Karkal [1987], Dyson [1988], and Rajan et al [1992]).
which are quite 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 right-
hand side variable in the fertility regression). Identification of the effect of child mortality
requires the inclusion in the model of at least one exogenous variable which 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 of further research.
List of References


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<table>
<thead>
<tr>
<th>Variable name</th>
<th>Definition</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFR</td>
<td>Total fertility rate, 1981</td>
<td>5.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Q5</td>
<td>Under-five mortality rate, 1981: probability that a child will die before the fifth birthday (x 1,000)</td>
<td>156.9</td>
<td>42.8</td>
</tr>
<tr>
<td>FD</td>
<td>Female disadvantage in child survival, 1981, defined as FD=(Q5F - Q5M)/Q5F (%)</td>
<td>5.4</td>
<td>10.7</td>
</tr>
<tr>
<td>Female literacy</td>
<td>Crude female literacy rate, 1981 (%)</td>
<td>22.0</td>
<td>13.7</td>
</tr>
<tr>
<td>Male literacy</td>
<td>Crude male literacy rate, 1981 (%)</td>
<td>44.8</td>
<td>12.2</td>
</tr>
<tr>
<td>Female labour force participation</td>
<td>Proportion of &quot;main workers&quot; in the female population, 1981(%)</td>
<td>14.5</td>
<td>10.5</td>
</tr>
<tr>
<td>Urbanization</td>
<td>Proportion of the population living in urban areas, 1981 (%)</td>
<td>19.8</td>
<td>12.0</td>
</tr>
<tr>
<td>Poverty</td>
<td>Sen index of rural poverty, 1972-3, for the &quot;region&quot; in which the district is situated (x 100)</td>
<td>17.6</td>
<td>8.5</td>
</tr>
<tr>
<td>Medical facilities</td>
<td>Proportion of villages with some medical facilities(%)</td>
<td>21.4</td>
<td>20.5</td>
</tr>
<tr>
<td>Scheduled castes</td>
<td>Proportion of scheduled-caste persons in the population, 1981 (%)</td>
<td>16.0</td>
<td>6.9</td>
</tr>
<tr>
<td>Scheduled tribes</td>
<td>Proportion of scheduled-tribe persons in the population, 1981 (%)</td>
<td>8.0</td>
<td>13.5</td>
</tr>
<tr>
<td>SOUTH</td>
<td>Dummy variable, with value 1 for districts in Andhra Pradesh, Karnataka, Kerala and Tamil Nadu</td>
<td>0.23</td>
<td>0.42</td>
</tr>
<tr>
<td>EAST</td>
<td>Dummy variable, with value 1 for districts in Bihar, Orissa and West Bengal</td>
<td>0.16</td>
<td>0.37</td>
</tr>
<tr>
<td>WEST</td>
<td>Dummy variable, with value 1 for districts in Gujarat and Maharashtra</td>
<td>0.14</td>
<td>0.35</td>
</tr>
</tbody>
</table>

## TABLE 2: State-level averages of the regression variables

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

Source: See Table 1. The state-level averages presented here are calculated by aggregation of the relevant district-level figures.
**TABLE 3: Basic results**
Maximum likelihood estimates of reduced forms

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>TFR</th>
<th>Q5</th>
<th>FD&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Q5M</th>
<th>Q5F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>6.594(23.10)*</td>
<td>205.822(14.37)*</td>
<td>0.857(3.00)*</td>
<td>190.642(13.86)*</td>
<td>222.505(14.28)*</td>
</tr>
<tr>
<td>Female literacy</td>
<td>-0.031(-4.28)*</td>
<td>-0.873(-2.45)*</td>
<td>-0.036(-4.46)*</td>
<td>-0.620(-1.81)**</td>
<td>-1.148(-2.93)*</td>
</tr>
<tr>
<td>Male literacy</td>
<td>-0.005(-0.70)</td>
<td>-0.489(-1.40)</td>
<td>0.015(1.97)*</td>
<td>-0.572(-1.71)**</td>
<td>-0.393(-1.03)</td>
</tr>
<tr>
<td>Female labour force participation</td>
<td>-0.017(-3.57)*</td>
<td>0.440(1.82)**</td>
<td>-0.020(-3.85)*</td>
<td>0.640(2.75)*</td>
<td>0.214(0.81)</td>
</tr>
<tr>
<td>Urbanization</td>
<td>-3.9E-04(-0.15)</td>
<td>-0.310(-2.40)*</td>
<td>0.005(1.73)**</td>
<td>-0.335(-2.70)*</td>
<td>-0.280(-1.98)*</td>
</tr>
<tr>
<td>Medical facilities</td>
<td>-0.002(-1.04)</td>
<td>-0.246(-2.23)*</td>
<td>0.005(1.84)**</td>
<td>-0.301(-2.83)*</td>
<td>-0.186(-1.54)</td>
</tr>
<tr>
<td>Poverty</td>
<td>0.007(1.14)</td>
<td>0.535(1.76)**</td>
<td>-0.021(-3.13)*</td>
<td>0.673(2.30)*</td>
<td>0.404(1.21)</td>
</tr>
<tr>
<td>Scheduled caste</td>
<td>-0.007(-1.23)</td>
<td>0.548(1.89)**</td>
<td>-0.007(-1.13)</td>
<td>0.575(2.06)*</td>
<td>0.514(1.62)</td>
</tr>
<tr>
<td>Scheduled tribe</td>
<td>-0.011(-3.40)*</td>
<td>-0.598(-3.57)*</td>
<td>-0.014(-3.96)*</td>
<td>-0.466(-2.89)*</td>
<td>-0.743(-4.05)*</td>
</tr>
<tr>
<td>South</td>
<td>-0.548(2.60)*</td>
<td>-41.504(-3.85)*</td>
<td>-0.820(-4.91)*</td>
<td>-34.945(-3.38)*</td>
<td>-48.289(-4.15)*</td>
</tr>
<tr>
<td>East</td>
<td>-0.254(-0.99)</td>
<td>-38.080(-2.91)*</td>
<td>0.154(0.81)</td>
<td>-38.963(-3.10)*</td>
<td>-37.847(-2.68)*</td>
</tr>
<tr>
<td>West</td>
<td>-0.379(-2.06)*</td>
<td>-12.245(-1.32)</td>
<td>-0.148(-0.87)</td>
<td>-10.543(-1.18)</td>
<td>-14.079(-1.40)</td>
</tr>
<tr>
<td>λ</td>
<td>0.821(25.95)*</td>
<td>0.836(28.07)*</td>
<td>0.610(11.00)*</td>
<td>0.834(27.80)*</td>
<td>0.829(27.13)*</td>
</tr>
<tr>
<td>Mean squared error</td>
<td>0.31</td>
<td>15.15</td>
<td>0.39</td>
<td>14.60</td>
<td>16.67</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.89</td>
<td>0.87</td>
<td>0.81</td>
<td>0.86</td>
<td>0.87</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-155.95</td>
<td>-1310.26</td>
<td>-190.80</td>
<td>-1298.94</td>
<td>-1337.33</td>
</tr>
<tr>
<td>Normality (χ²&lt;sub&gt;2&lt;/sub&gt;)</td>
<td>7.47</td>
<td>5.03</td>
<td>207.26</td>
<td>8.11</td>
<td>5.32</td>
</tr>
<tr>
<td>Sample size</td>
<td>296</td>
<td>296</td>
<td>296</td>
<td>296</td>
<td>296</td>
</tr>
</tbody>
</table>

<sup>a</sup>: The dependent variable is a logistic transform of FD.

Notes: Asymptotic t-ratios in brackets. * significant at 5% ** significant at 10%
<table>
<thead>
<tr>
<th>Independent variables</th>
<th>TFR</th>
<th>Q5</th>
<th>FD&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Q5M</th>
<th>Q5F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>6.378 (21.90)*</td>
<td>210.72 (14.09)*</td>
<td>0.658 (2.21)*</td>
<td>198.058 (14.44)*</td>
<td>224.862 (14.72)*</td>
</tr>
<tr>
<td>Female literacy</td>
<td>-0.025 (-3.52)*</td>
<td>-1.009 (-2.88)*</td>
<td>-0.028 (-3.46)*</td>
<td>-0.823 (-2.42)*</td>
<td>-1.214 (-3.17)*</td>
</tr>
<tr>
<td>Male literacy</td>
<td>-0.010 (-1.49)</td>
<td>-0.352 (-1.03)</td>
<td>0.008 (1.01)</td>
<td>-0.376 (-1.13)</td>
<td>-0.326 (-0.87)</td>
</tr>
<tr>
<td>Female labour force participation</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Urbanization</td>
<td>1.7E-04 (-0.06)</td>
<td>-0.318 (-2.46)*</td>
<td>0.006 (1.88)**</td>
<td>-0.349 (-2.78)*</td>
<td>-0.284 (-2.00)*</td>
</tr>
<tr>
<td>Medical facilities</td>
<td>-0.002 (-1.07)</td>
<td>-0.245 (-2.21)*</td>
<td>0.005 (1.92)**</td>
<td>-0.299 (-2.78)*</td>
<td>-0.186 (-1.54)</td>
</tr>
<tr>
<td>Poverty</td>
<td>0.007 (1.14)</td>
<td>0.530 (1.73)**</td>
<td>-0.021 (-3.05)*</td>
<td>0.649 (2.18)*</td>
<td>0.406 (1.22)</td>
</tr>
<tr>
<td>Scheduled caste</td>
<td>-0.005 (-0.82)</td>
<td>0.498 (1.72)**</td>
<td>-0.004 (-0.54)</td>
<td>0.506 (1.80)**</td>
<td>0.488 (1.54)</td>
</tr>
<tr>
<td>Scheduled tribe</td>
<td>-0.012 (-3.68)*</td>
<td>-0.565 (-3.37)*</td>
<td>-0.015 (-4.11)*</td>
<td>-0.420 (-2.60)*</td>
<td>-0.727 (-3.98)*</td>
</tr>
<tr>
<td>South</td>
<td>-0.664 (-3.01)*</td>
<td>-37.915 (-3.58)*</td>
<td>-1.022 (-5.77)*</td>
<td>-30.257 (-2.92)*</td>
<td>-46.460 (-4.08)*</td>
</tr>
<tr>
<td>East</td>
<td>-0.115 (-0.42)</td>
<td>-40.416 (-3.10)*</td>
<td>0.261 (1.21)</td>
<td>-41.933 (-3.29)*</td>
<td>-39.15 (-2.81)*</td>
</tr>
<tr>
<td>West</td>
<td>-0.415 (-2.17)*</td>
<td>-11.095 (-1.19)</td>
<td>-0.230 (-1.26)</td>
<td>-9.020 (-1.00)</td>
<td>-13.51 (-1.35)</td>
</tr>
<tr>
<td>λ</td>
<td>0.838 (28.43)*</td>
<td>0.833 (27.66)*</td>
<td>0.679 (14.05)*</td>
<td>0.837 (28.18)*</td>
<td>0.827 (26.71)*</td>
</tr>
<tr>
<td>Mean squared error</td>
<td>0.31</td>
<td>15.26</td>
<td>0.39</td>
<td>14.76</td>
<td>16.72</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.89</td>
<td>0.87</td>
<td>0.81</td>
<td>0.86</td>
<td>0.87</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-162.05</td>
<td>-1311.91</td>
<td>-197.24</td>
<td>-1302.69</td>
<td>-1337.65</td>
</tr>
<tr>
<td>Normality (χ&lt;sup&gt;2&lt;/sup&gt;)</td>
<td>13.61</td>
<td>5.60</td>
<td>136.25</td>
<td>9.42</td>
<td>5.35</td>
</tr>
<tr>
<td>Sample size</td>
<td>296</td>
<td>296</td>
<td>296</td>
<td>296</td>
<td>296</td>
</tr>
</tbody>
</table>

<sup>a</sup>: The dependent variable is a logistic transform of FD.
Notes: Asymptotic t-ratios in brackets. * significant at 5% ** significant at 10%
### TABLE 5: Basic results for NSS regions
Maximum likelihood estimates of reduced forms

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Dependent variables</th>
<th>TFR</th>
<th>Q5</th>
<th>FD</th>
<th>Q5M</th>
<th>Q5F</th>
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</thead>
<tbody>
<tr>
<td>Constant</td>
<td></td>
<td>6.666</td>
<td>136.994</td>
<td>13.081</td>
<td>128.726</td>
<td>155.061</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(9.62)*</td>
<td>(4.32)*</td>
<td>(1.95)**</td>
<td>(4.20)*</td>
<td>(4.16)*</td>
</tr>
<tr>
<td>Female Literacy</td>
<td></td>
<td>-0.044</td>
<td>-1.838</td>
<td>-0.692</td>
<td>-1.184</td>
<td>-2.286</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-2.47)**</td>
<td>(-2.41)*</td>
<td>(-4.57)**</td>
<td>(-1.61)</td>
<td>(-2.48)*</td>
</tr>
<tr>
<td>Male Literacy</td>
<td></td>
<td>0.019</td>
<td>1.167</td>
<td>0.383</td>
<td>0.765</td>
<td>1.387</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.09)</td>
<td>(1.41)</td>
<td>(2.24)*</td>
<td>(0.96)</td>
<td>(1.47)</td>
</tr>
<tr>
<td>Female Labour Force Participation</td>
<td></td>
<td>-0.030</td>
<td>-0.345</td>
<td>-0.308</td>
<td>0.011</td>
<td>-0.823</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-2.82)*</td>
<td>(-0.65)</td>
<td>(-3.56)*</td>
<td>(0.02)</td>
<td>(-1.45)</td>
</tr>
<tr>
<td>Urban</td>
<td></td>
<td>-0.005</td>
<td>-0.395</td>
<td>0.033</td>
<td>-0.476</td>
<td>-0.264</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-0.080)</td>
<td>(-1.27)</td>
<td>(0.47)</td>
<td>(-1.58)</td>
<td>(-0.79)</td>
</tr>
<tr>
<td>Medical Facilities</td>
<td></td>
<td>0.002</td>
<td>-0.294</td>
<td>0.080</td>
<td>-0.393</td>
<td>-0.144</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.46)</td>
<td>(-1.29)</td>
<td>(1.84)**</td>
<td>(-1.79)**</td>
<td>(-0.58)</td>
</tr>
<tr>
<td>Poverty</td>
<td></td>
<td>5.6E-04</td>
<td>0.737</td>
<td>-0.156</td>
<td>0.784</td>
<td>0.662</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.06)</td>
<td>(1.73)**</td>
<td>(-1.61)</td>
<td>(1.90)**</td>
<td>(1.46)</td>
</tr>
<tr>
<td>Scheduled Caste</td>
<td></td>
<td>-0.023</td>
<td>1.038</td>
<td>-0.006</td>
<td>1.206</td>
<td>0.877</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-1.78)**</td>
<td>(1.63)</td>
<td>(-0.41)</td>
<td>(1.96)*</td>
<td>(1.30)</td>
</tr>
<tr>
<td>Scheduled Tribe</td>
<td></td>
<td>-0.012</td>
<td>0.093</td>
<td>-0.295</td>
<td>0.309</td>
<td>-0.179</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-1.54)</td>
<td>(0.24)</td>
<td>(-3.95)*</td>
<td>(0.81)</td>
<td>(-0.42)</td>
</tr>
<tr>
<td>South</td>
<td></td>
<td>-0.253</td>
<td>-12.295</td>
<td>-8.340</td>
<td>-8.934</td>
<td>-17.574</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-0.77)</td>
<td>(-0.72)</td>
<td>(-4.19)*</td>
<td>(-0.54)</td>
<td>(-0.92)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-0.92)</td>
<td>(-1.82)**</td>
<td>(-1.44)</td>
<td>(-1.81)</td>
<td>(-1.67)</td>
</tr>
<tr>
<td>West</td>
<td></td>
<td>-0.436</td>
<td>2.944</td>
<td>0.497</td>
<td>3.811</td>
<td>2.982</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-1.65)**</td>
<td>(0.22)</td>
<td>(0.24)</td>
<td>(0.29)</td>
<td>(0.20)</td>
</tr>
<tr>
<td>(\lambda)</td>
<td></td>
<td>0.594</td>
<td>0.656</td>
<td>-0.409</td>
<td>0.642</td>
<td>0.682</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4.45)*</td>
<td>(5.42)*</td>
<td>(-1.98)*</td>
<td>(5.35)*</td>
<td>(6.13)*</td>
</tr>
<tr>
<td>Mean Squared Error</td>
<td></td>
<td>0.36</td>
<td>18.14</td>
<td>3.71</td>
<td>17.56</td>
<td>19.27</td>
</tr>
<tr>
<td>Adjusted R^2</td>
<td></td>
<td>0.74</td>
<td>0.68</td>
<td>0.79</td>
<td>0.67</td>
<td>0.70</td>
</tr>
<tr>
<td>Log Likelihood</td>
<td></td>
<td>-23.45</td>
<td>-223.23</td>
<td>-140.17</td>
<td>-221.57</td>
<td>-226.73</td>
</tr>
<tr>
<td>Normality ((\chi^2))</td>
<td></td>
<td>1.68</td>
<td>0.29</td>
<td>1.35</td>
<td>0.40</td>
<td>0.85</td>
</tr>
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<td>51</td>
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<td>51</td>
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</tr>
</tbody>
</table>

Notes: Asymptotic t-ratios in brackets. * significant at 5%  ** significant at 10%
### 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 (%) | 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

<table>
<thead>
<tr>
<th></th>
<th>Q5</th>
<th>FD</th>
<th>TFR</th>
<th>Q5</th>
<th>FD</th>
<th>TFR</th>
<th>Q5</th>
<th>FD</th>
<th>TFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>166.4</td>
<td>10.7</td>
<td>5.38</td>
<td>172.9</td>
<td>-2.0</td>
<td>5.18</td>
<td>151.5</td>
<td>9.8</td>
<td>4.79</td>
</tr>
<tr>
<td>20</td>
<td>157.7</td>
<td>5.9</td>
<td>5.07</td>
<td>168.0</td>
<td>-0.1</td>
<td>5.13</td>
<td>152.7</td>
<td>8.5</td>
<td>4.85</td>
</tr>
<tr>
<td>30</td>
<td>149.0</td>
<td>1.1</td>
<td>4.76</td>
<td>163.1</td>
<td>1.8</td>
<td>5.08</td>
<td>153.8</td>
<td>7.1</td>
<td>4.91</td>
</tr>
<tr>
<td>40</td>
<td>140.2</td>
<td>-3.3</td>
<td>4.45</td>
<td>158.2</td>
<td>3.9</td>
<td>5.03</td>
<td>154.9</td>
<td>5.8</td>
<td>4.97</td>
</tr>
<tr>
<td>50</td>
<td>131.5</td>
<td>-7.1</td>
<td>4.15</td>
<td>153.3</td>
<td>5.9</td>
<td>4.98</td>
<td>156.0</td>
<td>4.4</td>
<td>5.03</td>
</tr>
<tr>
<td>60</td>
<td>122.8</td>
<td>-10.3</td>
<td>3.84</td>
<td>148.4</td>
<td>8.0</td>
<td>4.93</td>
<td>157.2</td>
<td>3.1</td>
<td>5.09</td>
</tr>
<tr>
<td>70</td>
<td>114.0</td>
<td>-12.8</td>
<td>3.53</td>
<td>143.5</td>
<td>10.1</td>
<td>4.88</td>
<td>158.3</td>
<td>1.8</td>
<td>5.15</td>
</tr>
<tr>
<td>80</td>
<td>105.3</td>
<td>-14.8</td>
<td>3.22</td>
<td>138.7</td>
<td>12.2</td>
<td>4.83</td>
<td>159.5</td>
<td>0.5</td>
<td>5.21</td>
</tr>
</tbody>
</table>

* For convenience of interpretation, the "Sen index" has been replaced here by the "head-count ratio" (ie. 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.