Fertility, Education and Development*

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Abstract

There has been a significant decline in fertility in many parts of India since the early 1980s. This paper re-examines the determinants of fertility levels and fertility decline, using panel data on Indian districts for 1981 and 1991. We find that women's education is the most important factor explaining fertility differences across the country and over time. Low levels of child mortality and son preferences also contribute to lower fertility. By contrast, general indicators of modernization and development such as urbanisation, poverty reduction and male literacy bear no significant association with fertility. *En passant*, we probe a subject of much confusion – the relation between fertility decline and gender bias.

Keywords: fertility, demographic transition, female literacy, India.

JEL Nos.: J13, O15, J16, I12.

1 Introduction

India is in the midst of a significant demographic transition. In Kerala, a state well known for its advanced social indicators, fertility is below the replacement level (2.1 children per woman). What is less well known is that substantial fertility decline is taking place far beyond the boundaries of Kerala. For instance, fertility is also below replacement level in Tamil Nadu, and Andhra Pradesh is only a couple of years away from the same benchmark. The decline, however, is highly uneven: in the 1980s, for instance, the total fertility rate declined by 25 percent in Punjab but virtually stagnated in Bihar.

Aside from the intrinsic importance of understanding these patterns of fertility decline, the diversity of the Indian experience is a valuable opportunity to reexamine various interpretations of the fertility transition. India, it may be recalled, was one of the first countries in the world to introduce a national family planning programme, in the 1950s. In the early days, 'population control' (as it was then called) appeared to assume some urgency, with world authorities such as Paul Ehrlich (1968) warning of the impending 'population bomb', and the spectre of famine hovering over India itself. Then came a more gentle approach, stressing that 'development is the best contraceptive'. Initially this was taken to mean that economic growth would automatically reduce poverty and slow down the growth of population. The notion of 'development', however, itself underwent some revision as awareness grew that economic growth per se did not mean a rapid improvement in the quality of life. Over time, the focus shifted from economic growth to 'social development', with the latter calling for economic growth to be supplemented with direct action in fields such as public health, elementary education and social security. The emphasis on social development gained acceptance as a growing body of empirical research substantiated the view that public action in these fields had much to contribute both to better living conditions and to reducing population growth. In recent years, however, doubts have been expressed about the effectiveness of the social development approach. Attention has been drawn, for instance, to the successes of Bangladesh and Tamil Nadu in achieving rapid fertility declines, allegedly without abiding by the rules (at least not all the rules) of the social development book.

Disenchantment with the social development approach has prompted some to argue that 'contraceptives are the best contraceptive' after all. Renewed concern about the so-called population explosion, notably from environmental lobbies, has further tilted the balance in favour of energetic family planning programmes, Chinese-style if needed.[1] The alarmist backlash has even taken concrete forms. Family planning messages, for instance, now refer to 'population control' and a single-child norm (see Drèze, 1998), and several Indian states have introduced laws barring parents of more than two children from contesting local elections. Many other proposals in the same vein have been floated.[2]

We shall argue that the Indian experience does not warrant this disenchantment with the social development approach. India is not a model of social development by any means, but it is making reasonable progress with fertility decline through non-authoritarian methods. This progress owes a great deal to the improvement of female literacy and the decline of child mortality, and much more can be achieved in that direction. Experiments with authoritarian intervention, by contrast, have had disastrous results. This is not to deny, of course, that more can and should be done in India in the field of family planning. Indeed, providing convenient and informed access to contraception (including non-terminal methods) is an essential component of the social development approach, much neglected in India so far.

The relation between female education and fertility has a crucial bearing on this whole debate. Indeed, female education plays a key role in the social development approach. A large body of Indian and international evidence points to the role of rising female education in lowering fertility.[3] In recent years, however, challenging questions have been raised about the nature

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[1] Among recent outbursts of alarmism is Lester Brown and Brian Halweil's widely-publicised article 'India Reaching 1 Billion on August 15: No Celebration Planned' (International Herald Tribune, 11 August 1999). The authors warn that India 'risks falling into a demographic dark hole, one where population will begin to slow because death rates are rising' – a bold prediction, considering that fertility and mortality rates in India are steadily falling year after year.

[2] See e.g. Singh (1999), who argues that the only solution to the population problem 'is to classify having more than two children as an act of sedition resulting in losing the right to universal adult franchise'.

[3] On the international evidence, see Bulatao and Lee (1983), Cleland and Wilson (1987), United Nations (1987), Subbarao and Raney (1995), and Schultz (1997), among others. For studies relating to India, see Jain and Nag (1985, 1986), Sharma and Retherford (1990), Satia and Jejeebhoy (1991), Basu (1992), United Nations (1993), International Institute for Population Sciences (1995), Jejeebhoy (1995), Murthi, Guio and Drèze (1995), Government of India (1997), and Gandotra et al. (1998).

and interpretation of the Indian evidence (Jeffery and Basu, 1996b). Several studies failed to find much evidence of a positive link between women's education and 'female autonomy', casting doubt on one of the major pathways through which the former was supposed to reduce fertility (see, e.g., Jeffery and Jeffery, 1996; Vlassoff, 1996; and Visaria, 1996). Further, some studies - mainly at the village level - report no significant correlation between female education and fertility. In these studies, observed differences in fertility across groups or over time are attributed to other factors, including reductions in infant mortality (Kolenda, 1998), family planning programmes and the rising cost of children (Vlassoff, 1996), and different risk environments (Jeffery and Jeffery, 1997). Without necessarily disputing the general statistical association between female education and low fertility, this body of literature asserts that the association is neither universal nor well-established, and that the process through which female education influences fertility - if such a causal link exists at all - remains far from clear (Jeffery and Basu, 1996b).

This paper is an attempt to move forward on these issues. It examines the determinants of fertility in India in a multivariate framework, using a district-level panel data set linking the two most recent Censuses, 1981 and 1991.[4] A *district* is the basic unit of administration and is the lowest level at which spatially disaggregated information on fertility is available (there are over four hundred districts in India). The panel aspect of the data allows us to control for district-specific effects which might otherwise produce a spurious correlation between fertility and female literacy (or other explanatory variables). Even after controlling for fixed effects, women's education emerges as the most important factor explaining fertility differences across the country and over time. Low levels of child mortality and son preference also contribute to lower fertility. By contrast, general indicators of modernization and development such as urbanization, poverty reduction and male literacy bear no significant association with fertility decline.

[4] We hope that the use of panel data will help to address earlier doubts about the use of cross-section analysis in this context: 'Populations live through time. But a disproportionate share of research on [South Asia's] demographic evolution has relied upon the dual blunderbusses of cross-sectional censuses and surveys' (Dyson, 1999, p.2).

2 Issues and Hypotheses

2.1 Female education and fertility

Although much has been written on the subject of female education and fertility, there appears to be some lack of clarity as to the pathways through which it operates. Following our earlier work with Anne-Catherine Guio (see Murthi et al., 1995), we find it useful to distinguish between the influence of female education on (i) desired family size, (ii) the relationship between desired family size and planned number of births, and (iii) women's ability to achieve the planned number of births.

Female education can be expected to reduce desired family size for a number of reasons. First, education raises the opportunity cost of women's time and, generally, opens up greater opportunities for women that often conflict with repeated child-bearing. This may lead educated women to want fewer children.[5] Second, in a country such as India where there is marked son preference, the education of women may reduce their dependence on sons for social recognition or support in old age. This too may lead to some reduction in desired family size, to the extent that large families are the consequence of a desire for an adequate number of surviving sons. Third, educated women may have higher aspirations for their children, combined with lower expectations of them in terms of labour services. This may also reduce desired family size, especially if there is a trade-off between the number of children and the time available for each child.[6] Fourth, educated women may be more receptive to modern social norms and family planning campaigns. For example, according to the National Family Health Survey (1992-3), less than 60 percent of illiterate women in India consider family planning messages in the media to be 'acceptable', compared with over 90 percent of women who have completed high school education (International Institute for

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[5] This is the argument most emphasized in family economics and originates from the work of Leibenstein (1957) and Becker (1960). For extensions of this literature, see Schultz (1975) and Rosenzweig and Stark (1997).

[6] This is known as the quantity-quality trade-off in the family economics literature. For empirical evidence from rural Maharashtra, see United Nations (1993).

Population Sciences, 1995, Table 6.28). The overall negative relation between female education and desired family size is borne out in a wide range of studies.[7]

In addition to reducing desired family size, female education is likely to affect the relationship between desired family size and planned number of births. In particular, female education reduces infant and child mortality.[8] Educated mothers thus need to plan fewer births in order to achieve a given desired family size.

Finally, female education may assist in achieving the planned number of births, especially by facilitating knowledge of and access to contraception and by enhancing women's bargaining power within the family. For example, the National Family Health Survey (1992-3) found that six percent of illiterate women in India have no knowledge of *any* contraceptive method, compared with less than half a percent of women who have finished high school. Among those with some knowledge of contraception, 16 percent of illiterate women did not know where to obtain it (the corresponding figure for women with high school education was around 1 percent). Similarly, communication between spouses regarding contraception was observed to increase with education: 71 percent of women who completed high school had discussed family planning with their husbands compared with 42 percent of illiterate women. Female education was also found to be positively related to the *use* of contraception, with the biggest difference observed between illiterate women and those with basic education (International Institute for Population Sciences, 1995, Tables 6.2, 6.6 and 6.29,). These indicators suggest that educated women not only have different fertility goals, but are also better able to translate their aspirations into reality.

Note that 'female autonomy' (a much-discussed issue in this context) is *one* of the variables

[7] See e.g. International Institute for Population Sciences (1995), Table 7.8. The only contrary evidence we are aware of appears in Vlassoff (1996), who observes no difference in desired fertility among women with different levels of schooling in rural Maharashtra. However, this is in a context where desired fertility had fallen below 3 at all levels of education in the community surveyed. In earlier work in the same region, Vlassoff (1980) found a clear association between desired number of children and the education levels of adolescent girls.

[8] The evidence is fairly strong. For India specifically, see Jain (1985), Nag (1989), Beenstock and Sturdy (1990), Bourne and Walker (1991), Satia and Jejeebhoy (1991), Basu (1992), International Institute for Population Sciences (1995), Murthi et al. (1995), Govindaswamy and Ramesh (1997), Jeffery and Jeffery (1997), Bhargava (1998) and Pandey et al. (1998).

that potentially mediate the link between female education and fertility, for instance by giving women greater control over their fertility.[9] The relationship between female education and autonomy is itself somewhat controversial. Some studies suggest that the two are, in fact, poorly correlated.[10] Much also depends on how one defines female autonomy.[11] These outstanding issues, however, have a limited bearing on the overall relation between female education and fertility, since female autonomy (however defined) is only one of the possible intervening variables. Thus, the doubts that have been raised about the empowerment value of female education (Jeffery and Basu, 1996b) should not be casually extended to the relation between the latter and fertility. That relation, as will be seen below, is very robust.

2.2 Other determinants of fertility

Many of the above arguments apply to men as well as women. Thus, improvements in male education may also lower fertility. However, the impact of male education on fertility is likely to be smaller than that of female education, because women bear the primary responsibility for child-rearing. It is also possible, in principle, for male education to matter more than female education, e.g. if fertility decisions are dominated by men. However, this does not seem to be the case in practice. Indeed, most of the studies that have investigated both effects support the hypothesis that female education has a greater impact on fertility than male education.

The effect of income on fertility is harder to predict than that of education.[12] At least two basic issues are involved. First, income effects are likely to depend on whether children are

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[9] See e.g., LeVine (1980), Cleland and Wilson (1987), Lindenbaum (1990), World Bank (1991).

[10] See various contributions in Jeffery and Basu (1996a), particularly Jeffery and Jeffery (1996), Visaria (1996) and Vlassoff (1996). For a different perspective, see The PROBE Team (1999).

[11] A range of indicators of female autonomy have been investigated. Examples are whether a woman is consulted about the choice of her marriage partner, whether she forms a nuclear family after marriage or becomes part of her husband's joint family, whether she has control over a portion of household resources, whether she is free to take certain budgeting decisions, how often she visits her parental home, and whether she uses contraception.

[12] For useful discussions of income effects in the household demand framework, and reviews of the empirical evidence, see Hotz et al. (1997) and Schultz (1997).

generally perceived as an economic burden or a productive asset. In the literature on family economics in developed countries, the tendency has been to see children as a consumption good, leading inter alia to a focus on the 'cost of children' and the 'quantity-quality trade-off'. In this framework, higher incomes make children more 'affordable', but negative income effects on fertility are also possible, e.g. if parents substitute quality for quantity as income rises or if higher incomes are associated with a higher opportunity cost of time. In developing countries, on the other hand, children may be regarded as economic assets by some parents, e.g. because they are a source of labour power and old-age security. This is likely to reinforce negative income effects, as higher incomes reduce the economic dependence of parents on their children. Indeed, the notion that children are economic assets effectively turns the 'affordability' argument (the main argument for positive income effects on fertility) on its head. Second, income effects are not independent of the *source* of additional income ('pure' income effects are elusive in the real world). For instance, if higher incomes reflect high adult wages, or a high participation of women in the labour force (both of which raise the opportunity cost of time), the relationship between income and fertility is likely to be negative. On the other hand, if higher incomes reflect higher endowments of productive assets (such as land) that also raise the marginal product of child labour, they may be associated with a higher demand for children.[13] Unfortunately, available data do not enable us to distinguish between different sources of income.

Access to public health services may also have a role to play in reducing fertility, independently of education and income. Aside from direct effects through improved access to contraception, public health services may reduce fertility by enhancing child survival.[14] However, these effects may be small where services are of poor quality, as applies in much of north India. Moreover, services delivered through heavy-handed methods may prove

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[13] Rosenzweig and Evenson (1977) present some evidence of this effect, with reference to land ownership; see also Cain (1985), Nagarajan and Krishnamoorty (1992) and Säävälä (1996), and the literature cited there.

[14] Evidence on the relation between child survival and access to health services in India is limited as things stand. Using district-level data for 1981, Murthi et al. (1995) found that access to public health services reduces child mortality, but has no significant effect on fertility (preliminary analysis of 1991 data points to similar results). A later study by the World Bank (1998), based on NFHS data, found no effect of public health services on child mortality. Bhargava (1998), using NFHS data for Uttar Pradesh, finds that family planning and immunization programmes do have a strong effect on infant survival.

counterproductive, as India's sobering experience with compulsory sterilisation illustrates.[15]

The role of urbanization has also been emphasized in the literature (e.g. Schultz, 1981, 1994). Urbanization is believed to reduce fertility because children are less likely to contribute to household production and more difficult to supervise in an urban setting. In so far as fertility decline is in part a 'diffusion process', it is also likely to proceed at an accelerated pace in urban areas, where people have greater exposure to mass media as well as wider opportunities to observe and discuss the lifestyles of other social groups.

Diverse regional and cultural factors also affect fertility patterns in the Indian population (see Sopher, 1980, Dyson and Moore, 1983, Basu, 1992, Maharatna, 1998a, and Mari Bhat, 1998, among others). For instance, fertility rates tend to be somewhat higher among Muslims than in other communities, though the extent to which this relationship holds after controlling for various socio-economic disadvantages experienced by Indian Muslims (e.g. lower incomes and literacy rates) is a matter of some debate.[16] Tribal populations have distinct kinship patterns and gender relations, including higher rates of female labour force participation, which may encourage lower fertility. Similarly, the higher status of women and weaker hold of patriarchy in the southern region of India are believed to contribute to relatively low fertility rates.

In addition to these relatively familiar determinants of fertility, we shall examine the possible role of 'son preference' in enhancing fertility. This concern arises from the common-sense observation that desire for a specified number of sons often interferes with the transition towards small-family norms, particularly in north India. To illustrate, if the probability of a new-born child reaching adulthood is, say, 0.75 (a plausible value for states such as Uttar Pradesh), a mother who wants the risk of ending up without an adult son to be lower than 0.05 has to give birth to three sons; this would require six births on average.[17] By contrast, if

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[15] Compulsory methods were taken to a short-lived extreme during the Emergency (1975-77). Birth rates, which had been falling prior to the Emergency, stagnated for roughly ten years thereafter, before resuming their decline.

[16] For an insightful discussion of this issue, see Jeffery and Jeffery (1997), chapter 6.

[17] For detailed simulations of this type, based on all-India data, see May and Heer (1968). On the relation between son preference and fertility, see also Mutharayappa et al. (1997) and Arnold et al. (1998), and

sons and daughters are considered equally valuable (so that the predicament to avoid is that of ending up with no adult son *or* daughter), three births are enough. If the probability of survival to adulthood rises from 0.75 to 0.8, two births are enough. As this simple example illustrates, the *interaction* of son preference and high child mortality is apt to have quite a dramatic effect on fertility rates.

2.3 Endogenous factors

So far, we have focused on variables that might reasonably be expected to influence fertility but not be influenced by it. Examples of variables which stand in a relation of mutual interdependence with fertility (or are jointly determined) are infant mortality, female labour force participation, and age at marriage. There are good reasons for infant mortality to affect fertility. Parents may have more children than they ultimately desire in anticipation of losing some (so-called 'hoarding' behavior). They may also replace lost children. At the same time, high fertility itself is likely to raise infant mortality, due to both biological and behavioural reasons.[18] Likewise, higher female labour force participation may both lead to and result from lower fertility.[19] Age at marriage and fertility are likely to be jointly determined by factors such as education and culture.

When explanatory variables are influenced by the 'dependent variable' (in this case fertility), or when both are influenced by the same unobserved variables, standard estimators are biased and inconsistent. Unbiased estimation (e.g. using two-stage techniques) is possible if adequate 'instruments' can be found for the endogenous variables, but credible instruments are hard to find in this context. In the case of infant mortality, for instance, this would require specifying an exogenous factor which affects infant mortality but is not otherwise correlated

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the literature cited there. Both studies suggest that son preference has a positive effect on fertility.

[18] High fertility is associated with short birth spacing, and with bearing children at relatively young or old ages, both of which increase the risk of infant mortality (see Wolpin, 1997, for a review of this literature). If high fertility is motivated by the desire for sons, it may go hand in hand with high mortality among unwanted girls. See Das Gupta (1987) for evidence of high mortality among higher birth-order girls in Punjab.

[19] The association between fertility and female labour force participation in India is discussed in Murthi et al. (1995).

with fertility. To avoid these difficulties, this paper focuses mainly on *reduced forms*, in which we consider the effects of variables that can reasonably be expected to be exogenous. The estimated coefficients measure the total impact of each variable on fertility, without determining the relative importance of different mechanisms through which the relevant variable operates. Thus, for example, the female literacy variable picks up the total effect of female education, including any impact it might have via reduced infant mortality, higher age at marriage, and so on. While this procedure helps to remove the simultaneity bias, it means that we remain uncertain as to the specific contribution of, say, declining infant mortality to fertility reduction. In section 4, one attempt is made to identify this effect based on two-stage estimation.

The possible endogeneity of 'son preference' (captured here by the ratio of female to male child mortality) is also an issue. That issue is discussed in Appendix 1, where it is shown that (1) the main conclusions of this paper are not sensitive to different treatments of the son-preference indicator (including two-stage estimation), and (2) the hypothesis of exogeneity of the son-preference indicator is difficult to reject, even if we allow a large probability of type-1 error. Following on this, we treat the son-preference indicator as an exogenous variable in the text, for clarity of exposition. Our interpretation of the coefficient of this variable is conditional on the exogeneity assumption, which appears to be plausible as things stand. The other conclusions are quite robust with respect to different treatments of the son-preference indicator.

3 Statistical Analysis

3.1 Data

The dependent variable analyzed in this paper is the district-level total fertility rate (henceforth TFR), available from Government of India (1997) for both 1981 and 1991. The TFR is the sum of prevailing age-specific fertility rates (births per woman per year in a given age group), derived from Census questions on births during the previous year and number of children ever born. Thus, the TFR measures the number of children that would be born to a woman during her lifetime if at each age she were to bear children in accordance with the prevailing age-specific fertility rate. [20] District-level estimates of the total fertility rate are not available for Censuses prior to 1981.

Note that the district is a useful unit of analysis in this context, considering the social dimension of fertility change (which would be difficult to capture in household-level analysis). To illustrate, the effect of rising education on fertility at the district level may be larger than one would predict from cross-section estimates based on household data, if education contributes to the spread of small-family norms not only among the educated but throughout the community. Indeed, the importance of community effects and motivational externalities is one possible reason why some micro-studies based on comparisons between households within a specific community (e.g. Jeffery and Jeffery, 1997) have failed to find much evidence of a major effect of women's education on fertility.[21]

Turning to the explanatory variables (listed in Table 1 below), our indicator of female education is literacy in the 15+ age group ('adult female literacy' for short), and similarly with male education.[22] Poverty is measured by the rural head-count index - the proportion of the rural population below the poverty line.[23] Urbanization refers to the share of the population residing in urban areas. The shares of scheduled castes, scheduled tribes and

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[20] For our purposes, the TFR is a more useful indicator of fertility than the crude birth rate (births per 1,000 population), as the latter is not independent of the age distribution of the population.

[21] For further discussion of this point, see Sen (1999), pp. 218-9. Another possible reason is high standard errors, due to small sample sizes.

[22] In the absence of more detailed indicators of educational achievements, the terms 'literacy' and 'education' are used interchangeably in this paper. In principle, it would be useful to distinguish between different levels of education, and to take into account the *quality* of education.

[23] The poverty line is the widely-used benchmark proposed by Dandekar and Rath (1971): Rs 15 per capita per month at 1960-61 prices. The reason for focusing on *rural* poverty is that the relevant poverty estimates for rural and urban areas combined are not available. Since we control for the level of urbanization, and since rural and urban poverty are highly correlated, this is not a major concern.

Muslims in the population are used as indicators of the social composition of different districts. We use five dummy variables to identify regional patterns: 'South' for (districts in) the states of Andhra Pradesh, Karnataka, Kerala and Tamil Nadu, 'East' for Orissa and West Bengal, 'West' for Gujarat and Maharashtra, 'North' for Madhya Pradesh, Rajasthan and Uttar Pradesh, and 'Bihar' for Bihar.[24] The control region consists of Haryana and Punjab.

We use the ratio of female to male child mortality as an index of 'son preference'. There is indeed much evidence that son preference gets reflected in differential child mortality rates between boys and girls. Alternative indices were also tried, including the female-male ratio, lagged values of the female-male ratio, and the juvenile female-male ratio. The results are much the same in each case. Note that we use the same son-preference indicator for both 1981 and 1991; given the slow pace of change in this domain, short-term variations in mortality ratios are unlikely to be useful measures of underlying changes in son preference.

All the information is available from standard Census sources (see Table 1 for details). The only exception is poverty. In India, poverty estimates are usually calculated from National Sample Survey (NSS) data. The NSS sample frame rules out district-level poverty estimates, but it does permit the calculation of poverty indicators at the level of NSS 'divisions'.[25] The latter are intermediate units between district and state. Every state consists of several divisions (three to five of them in most cases), and each division in turn is made up of several contiguous districts that are meant to be reasonably homogeneous in agro-climatic and socio-economic terms. For each district, we use the head-count index applying to the division where the district is situated as the relevant poverty estimate. Since division-level poverty estimates are available only for specific years (not including 1981 or 1991), we calculate estimates for the Census years by interpolation.[26] Further discussion of the procedure used to pool Census

[24] We introduced a separate dummy variable for Bihar, which consistently turned out not to conform to predicted patterns for the northern or eastern regions. The fact that Bihar seems to stand in a category of its own as far as demographic indicators are concerned (in particular, it has surprisingly 'low' mortality rates) has been noted earlier by demographers; see e.g. Dyson and Moore (1983) and Dyson (1984).

[25] The standard term is 'region', but we reserve the latter for other purposes, and use the ad hoc term 'division' here to avoid confusion. The 'divisions' of this paper are the same as the 'NSS regions' of Murthi et al. (1995) and Drèze and Srinivasan (1996).

[26] Division-level estimates are available from published sources only for 1963-64, 1972-73, 1973-74, 1987-88, and 1993-94 (see Jain et al., 1988, Pal and Bhattacharya, 1989, Drèze and Srinivasan, 1996, and

Table 1: Variable Definitions and Sample Means

Variable name	Definition	1981	1991
TFR	Total Fertility Rate	5.1 (0.9)	4.4 (1.0)
Female 15+ literacy	Proportion of women aged 15 and above who are literate (%)	22.2 (15.2)	29.9 (17.7)
Male 15+ literacy	Proportion of men aged 15 and above who are literate (%)	52.3 (14.3)	59.4 (14.1)
Poverty	Proportion of population below the poverty line (%)	40.3 (13.6)	32.3 (13.8)
Urbanization	Proportion of population resident in urban areas (%)	20.5 (15.1)	22.4 (16.1)
Scheduled castes	Proportion of scheduled castes in total population (%)	15.9 (7.1)	16.7 (7.2)
Scheduled tribes	Proportion of scheduled tribes in total population (%)	8.9 (15.2)	8.9 (15.5)
Muslim	Proportion of Muslims in total population	9.8 (9.1)	10.7 (10.1)
Son preference index	Ratio of female to male child mortality, 1981	1.07 (0.13)	
South dummy	Dummy = 1 for districts in the states of Andhra Pradesh, Karnataka, Kerala and Tamil Nadu	0.21 (0.41)	0.21 (0.41)
North dummy	Dummy = 1 for districts in the states of Madhya Pradesh, Rajasthan and Uttar Pradesh	0.39 (0.49)	0.37 (0.48)
Bihar dummy	Dummy=1 for districts in Bihar	0.10 (0.29)	0.12 (0.32)
East dummy	Dummy = 1 for districts in Orissa and West Bengal	0.09 (0.28)	0.08 (0.28)
West dummy	Dummy = 1 for districts in Gujarat and Maharashtra	0.14 (0.34)	0.13 (0.34)
Child mortality	Probability that a child will die before reaching his or her fifth birthday (x 1000)	156.7 (42.9)	106.3 (36.7)
Access to drinking water	Proportion of households with access to safe drinking water (%)	34.7 (22.8)	59.8 (22.4)
Sample size (no. of districts)		326	362

Notes: Means are unweighted. Standard deviations in parentheses.
Sources: Government of India (1997), for TFR and child mortality. For poverty, see footnote 21. The remaining variables are calculated from Census of India 1981, Social and Cultural Tables, Part IV-A; Census of India 1981, General Economic Tables, Part 3; Census of India 1981, Series 1, Paper 1 of 1982, 'Final Population Totals'; Census of India 1981, Primary Census Abstract, Part 2-B(i); Census of India

1981, Series 1, Paper 4 of 1984, ‘Household Population by Religion of the Head of the Household’; Census of India 1991, Social and Cultural Tables, Part IV-B, Table C-3; Census of India 1991, Primary Census Abstract, General Population, Part II B(i); and Government of India (1989, 1994); Census of India 1991, Paper 1 of 1995, ‘Religion’.

and NSS data may be found in Murthi et al. (1999).

Using the division-level poverty estimate for each district within a particular division can be justified on the grounds that the divisions are meant to be reasonably homogenous in this respect. Thus poverty levels may not vary a great deal between districts within a division. If they do vary, the coefficient of poverty remains unbiased (though there is some loss of precision), but the coefficients of variables that are correlated with poverty may be biased.[27] We therefore examine the basic relationships at both the district and the division level, where the division-level aggregates are constructed as population-weighted averages of the district-level variables. The division-level regressions (reported in the Appendix 2) are free of estimation bias, although there is some loss of precision as the shift from district to division reduces the number of observations. As it turns out, the division-level results are highly consistent with the district-level results.

As Table 1 indicates, fertility fell by 0.7 (from 5.1 to 4.4 children per woman) between 1981 and 1991.[28] During the same period, there was an increase in adult literacy, with female literacy achieving a larger improvement but from a much lower base. In 1991, adult female literacy was still as low as 30 percent, barely half of the corresponding figure for men. Urbanization increased relatively slowly between 1981 and 1991. The head-count index of poverty fell from 40.3 percent to 32.3 percent, and child mortality (defined here as the probability of dying before age five) registered a major drop - from 157 to 106 per 1,000.

There is considerable cross-sectional variation in the data, as illustrated in Tables 2A and 2B

Dubey and Gangopadhyay, 1998). For 1981, we interpolate between 1972-73 and 1987-88, and for 1991 we interpolate between 1987-88 and 1993-94.

[27] The standard errors-in-variables result is that if one variable is measured with error, the OLS estimator of its coefficient is biased towards zero (see e.g. Greene, 1993). If a variable is replaced by group means (which involves a measurement error with a difference viz., the sum of errors is identically zero), the OLS estimator is unbiased and consistent, although there is some loss of efficiency. Estimates of other coefficients, however, may be biased if the measurement error is correlated with these variables.

[28] The census-based fertility estimates used here are higher than the corresponding estimates from the Sample Registration System (on this issue, see also Mari Bhat, 1998). Fortunately, the extent of overestimation seems to be relatively uniform; for instance, the correlation coefficient between SRS-based and census-based estimates of state-level fertility rates in 1991 is 0.968. Uniform overestimation does not matter much for our purposes.

‘Table 2A: Sample means and standard deviations for major states, 1981 and 1991

	TFR		**Female 15+ literacy**		**Male 15+ literacy**		**Poverty**		**Urbanization**	
	1981	*1991*	*1981*	*1991*	*1981*	*1991*	*1981*	*1991*	*1981*	*1991*
Andhra Pradesh	4.3 (0.4)	3.6 (0.4)	18.5 (10.8)	25.5 (11.4)	43.0 (10.2)	49.5 (9.0)	31.4 (4.0)	19.5 (2.7)	22.8 (17.8)	26.1 (18.3)
Assam	n.a.	4.6 (1.0)	n.a.	36.7 (7.8)	n.a.	59.7 (7.3)	n.a.	36.5 (5.3)	n.a..	10.3 (7.1)
Bihar	5.2 (0.4)	5.0 (0.5)	12.8 (4.6)	17.1 (6.6)	44.8 (7.8)	48.6 (9.4)	54.8 (2.3)	52.1 (1.7)	11.7 (10.4)	12.2 (11.3)
Gujarat	4.8 (0.6)	4.2 (0.5)	31.1 (10.9)	41.5 (15.1)	60.0 (10.9)	68.3 (11.2)	34.3 (11.1)	23.0 (7.2)	26.4 (16.0)	30.5 (16.5)
Haryana	5.4 (0.3)	4.3 (0.5)	20.7 (6.5)	31.3 (8.3)	54.3 (7.7)	64.2 (8.3)	14.3 (3.9)	16.0 (3.7)	21.4 (8.2)	23.8 (9.2)
Karnataka	4.7 (0.4)	3.8 (0.6)	26.2 (12.7)	35.9 (13.6)	56.9 (9.2)	62.3 (10.1)	33.9 (6.3)	25.3 (8.9)	24.5 (11.3)	26.1 (15.1)
Kerala	3.4 (0.9)	2.6 (0.6)	69.5 (10.5)	82.8 (7.2)	84.1 (10.6)	92.1 (4.1)	41.5 (5.6)	27.9 (4.7)	15.4 (11.3)	23.4 (15.2)
Madhya Pradesh	5.6 (0.8)	5.0 (0.7)	15.2 (8.1)	21.7 (9.4)	46.4 (11.2)	54.6 (11.0)	43.5 (8.5)	30.0 (9.7)	19.6 (15.2)	22.5 (15.2)
Maharashtra	4.3 (0.5)	3.8 (0.5)	30.7 (11.5)	40.2 (13.1)	65.4 (8.4)	71.0 (8.1)	49.7 (6.0)	40.4 (11.5)	26.0 (19.0)	27.5 (19.4)
Orissa	4.8 (0.5)	4.2 (0.5)	18.3 (9.2)	26.0 (12.1)	54.3 (15.3)	59.0 (13.3)	63.2 (13.0)	49.1 (11.7)	11.6 (6.7)	13.0 (7.4)
Punjab	5.0 (0.3)	3.8 (0.3)	32.5 (8.2)	42.8 (10.0)	52.8 (12.1)	61.2 (10.1)	12.8 (1.5)	9.4 (2.9)	26.6 (7.5)	27.9 (8.9)
Rajasthan	6.0 (0.4)	5.0 (0.5)	11.0 (4.7)	15.1 (5.9)	40.9 (8.7)	49.9 (9.1)	37.2 (15.2)	25.2 (9.2)	19.3 (10.2)	20.7 (9.8)
Tamil Nadu	3.9 (0.6)	3.1 (0.4)	35.2 (13.7)	43.7 (12.7)	65.8 (10.5)	70.1 (8.7)	43.5 (7.6)	35.3 (9.9)	32.2 (21.6)	33.4 (19.9)
Uttar Pradesh	5.8 (0.6)	5.4 (0.6)	14.6 (7.6)	21.3 (9.7)	46.9 (11.7)	55.1 (11.8)	36.5 (6.9)	30.6 (11.6)	17.2 (11.8)	19.1 (14.8)
West Bengal	4.6 (0.7)	3.9 (0.6)	30.1 (13.9)	38.7 (14.6)	56.9 (11.6)	64.3 (11.3)	52.1 (7.2)	40.6 (6.1)	23.2 (24.0)	25.0 (24.1)

Notes: Means are unweighted. Standard deviations in parentheses. For sources, see Table 1.

Table 2B: Sample means and standard deviations for major states, 1981 and 1991 (continued)

	Scheduled castes		Scheduled tribes		Muslim		Son pref index	Child mortality		Access to drinking water	
	1981	*1991*	*1981*	*1991*	*1981*	*1991*	*1981*	*1981*	*1991*	*1981*	*1991*
Andhra Pradesh	15.0 (3.6)	15.9 (3.7)	6.4 (5.7)	6.8 (5.9)	8.7 (7.4)	9.0 (8.0)	0.94 (0.05)	142.6 (21.4)	71.6 (19.7)	25.7 (14.6)	55.6 (19.1)
Assam	n.a.	7.3 (3.7)	n.a.	16.8 (17.5)	n.a.	25.9 (21.4)	n.a.	n.a.	117.0 (23.1)	n.a.	n.a.
Bihar	15.0 (5.2)	15.1 (5.3)	6.7 (13.9)	6.1 (12.7)	14.1 (7.9)	14.6 (8.4)	1.18 (0.10)	141.8 (17.9)	100.8 (21.3)	38.5 (21.0)	59.7 (23.1)
Gujarat	6.9 (2.9)	7.3 (3.2)	17.6 (25.9)	18.0 (26.2)	8.1 (4.3)	8.3 (4.5)	1.07 (0.09)	124.2 (19.9)	93.8 (18.1)	48.9 (20.3)	66.8 (17.5)
Haryana	18.9 (3.3)	19.8 (3.5)	0.0	0.0	4.5 (8.9)	4.9 (9.7)	1.22 (0.08)	139.2 (20.4)	86.1 (15.2)	54.1 (16.5)	73.5 (15.6)
Karnataka	15.1 (4.6)	16.6 (4.9)	5.1 (3.7)	4.8 (3.6)	10.9 (3.6)	11.4 (3.9)	0.97 (0.06)	150.9 (37.3)	82.8 (15.7)	30.6 (10.7)	64.3 (23.0)
Kerala	9.8 (4.0)	9.8 (3.7)	2.2 (4.8)	2.3 (4.5)	20.5 (16.6)	21.7 (17.2)	0.90 (0.02)	80.9 (19.2)	55.2 (12.8)	12.0 (8.3)	18.9 (10.5)
Madhya Pradesh	14.9 (5.7)	15.2 (5.7)	21.1 (20.1)	21.5 (20.1)	5.3 (4.2)	5.4 (4.4)	1.06 (0.11)	203.2 (34.3)	157.4 (28.6)	19.5 (14.3)	53.1 (18.4)
Maharashtra	7.3 (3.6)	11.8 (4.5)	9.9 (10.0)	10.0 (10.8)	8.7 (3.5)	8.9 (4.3)	0.98 (0.04)	156.3 (38.6)	90.3 (24.6)	34.4 (19.0)	63.5 (16.3)
Orissa	14.2 (3.6)	15.4 (4.0)	27.7 (20.2)	27.5 (20.0)	1.2 (1.3)	1.4 (1.5)	0.96 (0.04)	175.4 (25.6)	145.4 (17.2)	14.2 (11.1)	38.1 (11.7)
Punjab	26.7 (4.3)	28.3 (5.1)	0.0	0.0	1.0 (1.7)	1.2 (1.9)	1.12 (0.06)	110.5 (8.9)	81.4 (18.2)	83.7 (7.7)	92.1 (4.4)
Rajasthan	16.6 (5.4)	16.9 (5.1)	13.8 (18.3)	14.1 (18.7)	7.6 (4.3)	8.2 (4.4)	1.12 (0.12)	174.5 (40.2)	120.8 (26.1)	26.9 (10.6)	59.0 (11.6)
Tamil Nadu	17.7 (5.4)	18.7 (5.4)	1.1 (1.1)	1.0 (1.1)	5.3 (2.1)	5.4 (1.8)	0.98 (0.08)	126.8 (25.2)	71.5 (14.2)	41.3 (19.2)	61.3 (15.9)
Uttar Pradesh	20.6 (5.6)	21.0 (5.6)	0.5 (1.6)	0.4 (1.3)	14.1 (10.1)	15.3 (10.8)	1.19 (0.12)	185.0 (34.3)	126.4 (28.8)	34.2 (21.9)	62.0 (20.3)
West Bengal	22.9 (10.6)	24.6 (10.8)	7.2 (6.7)	7.0 (6.5)	21.1 (15.3)	22.9 (15.7)	1.01 (0.05)	122.9 (35.1)	95.1 (25.8)	61.9 (25.5)	75.6 (21.0)

Notes: Means are unweighted. Standard deviations in parentheses. For sources, see Table 1.

which report state-specific means for India's 15 major states (those with a population of more than 10 million). The total fertility rate ranged from 6.0 in Rajasthan to 3.4 in Kerala in 1981, and from 5.4 in Uttar Pradesh to 2.6 in Kerala in 1991. Rates of fertility decline have also been highly uneven. Compared to an all-India decline of about 14 percent over the reference period, fertility declined by over 20 percent in the states of Kerala (3.4 to 2.6), Punjab (5.0 to 3.8), and Tamil Nadu (3.9 to 3.1). The large proportionate reductions in Kerala and Tamil Nadu are all the more remarkable considering that they were achieved from a relatively low base. Compared to these reductions, fertility in the largest state, Uttar Pradesh, declined by less than 8 percent (5.8 to 5.4), while in its eastern neighbour, Bihar, the decline was under 3 percent (5.2 to 5.0).

3.2 Estimation

Our main results pertain to panel data regressions of the form:

$$TFR_{dt} = \alpha_d + \beta X_{dt} + \gamma_t + \varepsilon_{dt}$$

where TFR_{dt} is total fertility in district d at time t, α_d is a district-specific effect, β is a vector of coefficients, X_{dt} is a vector of explanatory variables, γ_t is a time dummy, and ε_{dt} is an error term. In this section we focus on a reduced-form equation, which excludes child mortality (the latter is examined in section 4). Our explanatory variables are adult female literacy, adult male literacy, poverty, urbanization, caste, tribe, religion, son preference and regional location (see Table 1 for precise definitions). Our sample consists of 326 districts, covering 14 of the 15 major states and over 96 percent of the population. The missing major state is Assam, where no Census took place in 1981.[29]

We can think about the district-specific effects (α_d) in two ways, as fixed-effects or as

[29] There were 326 districts in the 14 major states in 1981, rising to 362 districts in 1991 owing to the partitioning of districts between the two Censuses (see Murthi et al. 1999 for details). To construct the panel for 1981-91, we use the 1981 district map as an anchor and calculate the 1991 value of a variable for a particular district as a population-weighted average over the relevant 1991 districts (in cases where the district was partitioned between 1981 and 1991).

random-effects. In the fixed-effects approach, the regression intercept is assumed to vary across districts. Estimation is by OLS using a dummy variable for each district (or rather, a suitable transformation to facilitate computation). In the random-effects approach, the district-specific effect is modelled as an additional, time-invariant error term for each district. The composite error term, $\alpha_d + \varepsilon_{dt}$, has a particular covariance structure, allowing estimation by generalized least squares (GLS). The random-effects approach has the advantage that it saves many degrees of freedom (using a dummy for every district effectively halves the number of observations). Also, unlike the fixed-effects approach, it does not preclude the inclusion of time-invariant variables such as regional dummies. However, the random-effects approach assumes that the district-specific random error is uncorrelated with the other explanatory variables, which may not be the case. To check whether the random-effects approach is appropriate, we test for the orthogonality of the random effects and the regressors using a test devised by Hausman (1978). To perform all tests (including tests of significance and the Hausman test) we use the robust Huber-White estimate of variance which allows for different error variances across districts as well as serial correlation for given districts.

3.3 Main Results

Table 3 presents our main results. We begin by considering the relationship in the individual cross-sections. Column (1) reports estimates for 1981, and column (2) for 1991.

Looking at the first column of Table 3, we see that the explanatory variables account for around three-fourths of the variation in fertility across districts in 1981. The coefficient of female literacy is negative and highly significant. The coefficient of the son-preference index is positive and significant, confirming that son preference enhances fertility. By contrast, we find no significant relation between fertility levels and general indicators of development and modernization such as the poverty index, male literacy, and urbanization. The poverty index has a negative sign, contrary to the notion that poverty is a cause of high fertility.[30] Male

[30] There may be some 'positive feedback' from fertility to poverty, in so far as high fertility rates contribute to the incidence of poverty (especially when the latter is measured without taking into account economies of scale in household consumption). This is likely to lead to an *upward* bias in the poverty

literacy does not make any contribution to fertility reduction, after controlling for female literacy. Among the caste and religion variables, only the Muslim population share is significant, with a positive sign.[31]

Column (2) presents the corresponding estimates for 1991. Here we are able to explain nearly four-fifths of the variation in fertility across districts. The results are very similar to those obtained for 1981. Female literacy continues to be negative and highly significant. Moreover, its effect is even larger in 1991 than in 1981. However, the female literacy coefficients for 1981 and 1991 are, statistically speaking, indistinguishable.

Next we pool the data, allowing for a different intercept in 1991 and district-specific effects. In column (3) we estimate a random-effects model and in column (4) a fixed-effects model.[32] Both models broadly confirm the cross-section findings. Under the assumption that the district-specific effects are random, the results are very similar to the cross-section results. When the district effects are taken as fixed as in column (4), the coefficients are estimated with less precision (in general, the standard errors more than double). This is because a great deal of the cross-section information is absorbed in the district-specific dummies. However, even in this specification, female literacy remains negative and highly significant. Apart from female literacy and the time dummy, none of the other variables is significant at 5 percent. However, the large standard errors suggest that the coefficients are not significantly different from the random-effects estimates. This is confirmed by the Hausman test, which does not reject the null hypothesis that the district-specific effects are orthogonal to the regressors. In other words, we need not reject the random-effects model in favour of fixed-effects.

Taken together, these results yield a consistent picture of the relation between female literacy

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coefficient in the fertility regressions. The fact that the poverty coefficient is negative in spite of this possible upward bias casts further doubt on the hypothesis that poverty *per se* is a cause of high fertility.

[31] In separate estimates (not presented here), we examine the role of access to medical facilities and find that it is not significantly associated with fertility levels.

[32] Note that the son-preference index has to be excluded from the fixed-effects regression; this is because this index, being time-invariant, is not linearly independent from the district dummies. Also, for ease of exposition we maintain the equality of coefficients across years. Alternative estimates, where we allow the coefficients to vary across years, are available from the authors on request. They do not alter the main arguments of the paper.

Table 3: Fertility in India: Main Results
(Dependent variable: TFR)

	1981: OLS	1991: OLS	Panel 1981-91: GLS-RE	OLS-FE
	(1)	(2)	(3)	(4)
Constant	3.338** (8.28)	2.760** (6.04)	3.343** (9.18)	-
Female 15+ literacy	-0.019** (4.32)	-0.025** (6.66)	-0.022** (7.37)	-0.022** (2.80)
Male 15+ literacy	0.0001 (0.02)	0.004 (0.87)	0.001 (0.24)	-0.005 (0.68)
Poverty	-0.005 (1.50)	0.002 (0.99)	-0.001 (0.68)	-0.001 (0.15)
Urbanization	-0.003 (1.18)	-0.002 (1.51)	-0.002 (1.53)	0.003 (0.33)
Scheduled castes	0.005 (1.03)	0.001 (0.13)	0.003 (0.78)	0.002 (0.17)
Scheduled tribes	0.002 (0.84)	0.004 (1.26)	0.002 (0.99)	-0.038* (1.71)
Muslim	0.016** (4.98)	0.021** (6.76)	0.019** (7.39)	0.053* (1.81)
Son preference index	1.98** (5.98)	1.66** (5.19)	1.83** (6.49)	-
1991 time dummy	-	-	-0.52** (13.48)	-0.50** (5.96)
Regional dummies	yes (see Table 4)	yes (see Table 4)	yes (see Table 4)	no
Adjusted R^2	0.73	0.79		0.94
F (p-value)	64.3 (0.00)	116.0 (0.00)		76.09 (0.00)
Pseudo-R^2			0.77	
Wald, χ^2 (12) (p-value)			2503.0 (0.00)	
Sample size	326	326	652	652
GLS vs. FE, χ^2 (8) (p-value)			8.4 (0.39)	

* significant at 10 percent level ** significant at 5 percent level

Notes: 1. Absolute t-ratios in parentheses. All standard errors are robust.
2. The *F*- and Wald-tests are tests of the joint hypothesis that all coefficients (except the constant term) equal zero; the Hausman test (GLS vs. FE) is a test of random versus fixed effects.

and fertility. Female literacy is significantly associated with lower fertility, and the size of the effect is also similar across the regressions. This effect is upheld even when we allow for other factors, such as male literacy, poverty, urbanization, caste and religion, and for unobserved district-specific influences on fertility. The continued significance of female literacy in the fixed-effects model challenges the view that low fertility and high female literacy are jointly driven by some common third factor (such as the status of women), and that the observed correlation in the cross-section is in this sense 'spurious'.

It is worth reflecting on the possible reasons why we find no association between fertility and poverty.[33] This finding contrasts with the common notion that children are typically seen as economic assets in poor households, and that poverty therefore contributes to high fertility. Here, it is useful to distinguish between two different reasons why parents might see children as economic assets. One is that children (particularly sons) provide old-age security, the other is that they sometimes take part in productive work. The latter reason might lead us to expect poverty to be an important cause of high fertility.[34] There is little evidence, however, that Indian parents see children as economic assets in that particular sense; qualitative survey responses suggest they tend to consider children as a short-term economic burden, made worthwhile first and foremost by the prospect of security in old age.[35] The latter motive, for its part, may or may not be closely related to income levels. For one thing, concern for old-age security is partly a desire to maintain one's *acquired* living standard in old age, rather than some absolute level of living. For another, what is at stake is not just income security, but also other material and psychological aspects of well-being that are associated with being able to live with one's children in old age. These needs, again, may or may not decline as income

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[33] We note in passing that the *bivariate* correlation between poverty and fertility happens to be positive and statistically significant in 1991. This contrast is a useful reminder of the potentially misleading nature of bivariate correlations in this context. The main reason why poor districts have higher fertility rates seems to be that the same districts also have low literacy rates; after controlling for that, the positive association between poverty and fertility no longer holds.

[34] This was a central theme of Mahmood Mamdani's (1973) classic debunking of the 'myth of population control'. Mamdani argued that the Khanna experiment with family planning in rural Punjab in the late 1950s and early 1960s had failed because parents could not afford to dispense with children's labour power. The parents in question, however, took to family planning like ducks to water soon after the publication of Mamdani's study, which now tends to be remembered as a damp squib.

[35] Relevant evidence on this includes Vlassoff (1979), Cain (1986), Jejeebhoy and Kulkarni (1989), Säävälä (1996), Jeffery and Jeffery (1997), Drèze and Sharma (1998), among others. Note also that the productive value of children need not decline as income rises; land ownership, for instance, raises both.

rises. Even then, one would still expect the old-age security motive to have more influence on fertility at low levels of income, e.g. due to restricted access to credit and other insurance mechanisms. But this relation need not be strong, and the implied negative association between fertility and income could easily be neutralised by positive income effects (relating in particular to the 'affordability' argument).

It is also possible that the absence of any significant association between fertility and poverty in Table 3 reflects the lack of precision of our poverty indicators (the latter refer to 'divisions' rather than districts, and are based on interpolations from reference years other than 1981 and 1991). Further, the relationship between poverty and fertility may be non-linear. There is scope for further research on this issue, based for instance on various income proxies at the district level. Meanwhile, this study suggests that it would be unwise to rely on income effects to reduce fertility levels on their own.

3.4 Regional effects

We now turn to regional effects. Table 4 presents the estimated coefficients of the regional dummies, which were excluded from Table 3 for expositional clarity. The first three columns present estimates corresponding to the first three columns of Table 3. For obvious reasons no regional dummies were estimated in the fixed-effects specification (column 4 in Table 3). Estimates in the last column of Table 4 will be discussed further on.

As Table 4 indicates, regional location exerts a strong influence on fertility even after controlling for other factors. In particular, fertility in south India is distinctly lower than the control region (Haryana and Punjab), by around 0.4 children per woman. We experimented with many variants of the baseline regressions to see whether the lower fertility levels in the southern region could somehow be 'accounted for' by including other explanatory variables or changing the functional form. However, the distinctiveness of the southern region in this respect is a very robust pattern. Similarly, fertility is distinctly higher in the northern region than in the control region (by about 0.5 children per woman), and the gap persists in alternative specifications. Fertility rates in the east (Orissa and West Bengal) and west

Table 4: Fertility in India: Regional Effects

	1981: OLS (1)	1991: OLS (2)	Panel 1981-91: GLS-RE (3)	 2SLS-RE (4)
Other variables as in:	*Table 3 (1)*	*Table 3 (2)*	*Table 3 (3)*	*Table 5 (3)*
South dummy	-0.43** (3.38)	-0.42** (3.59)	-0.45** (4.48)	-0.46** (4.07)
North dummy	0.45** (3.91)	0.52** (5.06)	0.47** (6.04)	0.28* (1.94)
Bihar dummy	-0.21 (1.21)	0.17 (1.14)	-0.03 (0.26)	0.002 (0.14)
East dummy	-0.16 (0.82)	-0.24 (1.63)	-0.22 (1.64)	-0.30** (2.13)
West dummy	-0.17 (1.17)	0.03 (0.27)	-0.08 (0.80)	-0.15 (1.18)

* significant at 10 percent level ** significant at 5 percent level

Note: This table should be read as a continuation of Table 3 (columns 1, 2, 3) and Table 5 (column 3). It gives regression coefficients and absolute t-ratios of regional dummies in the relevant regressions. All standard errors are robust.

(Gujarat and Maharashtra) are fairly close to the control region. The existence of these location specific effects in no way compromises the effects of the other explanatory variables reported earlier.

3.5 Fertility decline and gender bias

We end this section with a short digression on the relation between our findings on son preference and the striking thesis, advanced by Das Gupta and Mari Bhat (1995, 1997), that 'intensified gender bias' in India is 'a consequence of fertility decline'. In their discussion of the relation between fertility decline and gender bias in child mortality, the authors make a useful distinction between the 'parity effect' and the 'intensification effect': 'In societies characterized by a strong preference for sons, fertility decline has two opposing effects on discrimination against girls. On one hand, there are fewer births at higher parities where discrimination against girls is strongest, and this reduces discrimination (the 'parity' effect). On the other hand, parity-specific discrimination becomes more pronounced…, and makes for increased discrimination (the intensification effect).'[36] The parity effect is highly plausible, since female child mortality in India rises sharply with birth parity, as we know inter alia from Monica Das Gupta's (1987) pioneering work on this subject. Das Gupta and Mari Bhat attempt to establish not only the existence of an intensification effect, but also that in India this effect outweighs the parity effect.

The evidence for this comes in two forms. First, the authors convincingly document the spread of sex-selective abortion. The latter does make a contribution to fertility decline and also has the effect of raising parity-specific discrimination (if we count abortion as a form of 'pre-natal mortality', following Das Gupta and Mari Bhat). The relevance of this observation, however, depends on the spread of sex-selective abortion itself being 'a consequence of fertility decline'; this has not been argued. With or without fertility decline, one would expect the introduction of sex-selection technology in India to have many takers. In any case, the spread of sex-selective abortion is a very minor channel of fertility decline, as the authors

[36] Das Gupta and Mari Bhat (1997), p. 313.

themselves note. Evidence on sex-selective abortion, therefore, has a limited bearing on the general relationship between gender bias and fertility decline.

Second, using fertility and mortality data from the 'Khanna re-study' in Punjab (Das Gupta, 1987), the authors present direct evidence of the intensification effect in this particular case: parity-specific gender bias in child mortality is higher among women with lower fertility. Further, this intensification effect is strong enough to induce an *overall* negative association between fertility and gender bias (i.e. it outweighs the parity effect). The sample, however, is small, and in the absence of statistical tests it is difficult to assess the significance of this pattern, let alone its wider applicability.

Our own results indicate that in India as a whole, the association between fertility and gender bias is firmly positive, rather than negative.[37] In itself, this is not a conclusive refutation of the claim that the intensification effect (such as it may be) dominates the parity effect, since that claim is concerned with fertility decline *over time* rather than with cross-section patterns. However, our findings do cast doubt on the argument used by Das Gupta and Mari Bhat to substantiate their thesis.

Further research is needed to settle this issue. Meanwhile, there is little reason to fear an intensification of gender bias in India as a consequence of fertility decline. Indeed, there has been virtually no change in the ratio of female to male child mortality in India between 1981 and 1991, a period of rapid fertility decline. Sex-selective abortion did spread, but that is best seen as a social problem in its own right (linked primarily with technological change) rather than as a consequence of fertility decline.

4 Fertility and child mortality

[37] Das Gupta and Mari Bhat's study raises the possibility of endogeneity of son preference in the fertility regressions. Note, however, that their argument suggests a *negative* 'feedback' from fertility to son preference; this *reinforces* the finding that son preference has a positive effect on fertility (since negative feedback suggests a downward bias in the coefficient of son preference). The possible endogeneity of son prefrence is addressed in Appendix 1.

So far we have focused on reduced forms. In particular, we have discarded child mortality from the list of independent variables to avoid simultaneity bias (see section 2.3). In this section we make an attempt to estimate the effect of child mortality on fertility, and the extent to which this effect mediates the relation between fertility and female literacy. Summary statistics on child mortality are given in Tables 1 and 2.

As explained earlier, the fact that fertility and child mortality are mutually interdependent means that estimating the impact of one on the other is not straightforward. To remove the simultaneity bias, we need an instrument for child mortality -- an exogenous variable that is correlated with child mortality but is not otherwise associated with fertility. One possible instrument is access to safe drinking water. Childhood diarrhoea is an important cause of child mortality in India (International Institute for Population Sciences, 1995). Aside from reflecting various household characteristics (such as maternal education and income), childhood mortality is likely to be associated with the quality of the household's environment, including its access to safe drinking water (see, e.g., Rosenzweig and Wolpin, 1982). At the same time, there is no obvious reason why access to safe drinking water should have an independent effect on fertility. Information on access to safe drinking water in 1981 and 1991 is available from Government of India (1994) and Government of India (1989), respectively, and is summarized in Tables 1 and 2.[38] This variable is used to instrument child mortality in the regressions that follow.

Table 5 presents two-stage least squares (2SLS) estimates using panel data for 1981-1991.[39] For comparison purposes, column (1) reproduces the random-effects (GLS) estimate of the reduced form, excluding child mortality (this is the same regression as in Table 3, column 3). Column (2) includes child mortality as an additional regressor, assuming it is exogenous. Column (3) instruments for child mortality, while column (4) presents the first stage regression. Our primary interest is in column (3).

A comparison between columns (2) and (3) enables us to test whether child mortality is

[38] The variable measures the proportion of households with access to drinking water supplied from a tap, hand-pump or tube-well (as opposed to a river, canal or tank).

[39] On 2SLS estimation with panel data, see Hsiao (1986), chapter 5.

Table 5: Fertility and Child Mortality
(IV Estimation, based on 1981-91 panel)

	Dependent variable:			
	TFR (GLS-RE) (1)	**TFR (GLS-RE) (2)**	**TFR (2SLS-RE) (3)**	**Child mortality (GLS-RE) (4)**
Constant	3.343** (9.18)	2.764** (7.99)	2.830** (6.14)	150.481** (21.41)
Female 15+ literacy	-0.022** (7.37)	-0.020** (7.19)	-0.020** (6.50)	-0.529** (3.02)
Male 15+ literacy	0.001 (0.24)	0.002 (0.75)	0.002 (0.68)	-0.291 (1.42)
Poverty	-0.001 (0.68)	-0.004 (1.62)	-0.002 (0.91)	0.173 (1.45)
Urbanization	-0.002 (1.53)	-0.001 (0.55)	-0.001 (0.49)	-0.078 (0.81)
Scheduled castes	0.003 (0.78)	0.002 (0.56)	0.002 (0.61)	0.223 (0.93)
Scheduled tribes	0.002 (0.99)	0.002 (0.92)	0.002 (0.95)	0.021 (0.17)
Muslim	0.019** (7.39)	0.020** (8.20)	0.020** (7.42)	0.070 (0.49)
Son preference index	1.83** (6.49)	1.68** (6.32)	1.70** (6.56)	27.51* (1.85)
1991 time dummy	-0.52** (13.48)	-0.33** (6.74)	-0.35** (3.37)	-30.53** (12.93)
Child mortality	-	0.005** (6.21)	0.004* (1.73)	-
Access to drinking water	-	-	-	-0.461** (7.10)
Regional dummies	yes (see Table 4)	yes	yes (see Table 4)	yes
Pseudo- R^2	0.77	0.80	0.78	0.70
Wald - χ^2 (p-value)	2503.0 (0.00)	2834.9 (0.00)	1918.4 (0.00)	2432.7 (0.00)
Sample size	652	652	652	652

* significant at 10 percent level ** significant at 5 percent level

Notes: 1. Absolute t-ratios in parentheses. All standard errors are robust.
2. The Wald (χ^2) test is a test of the joint hypothesis that all coefficients (except the constant term) equal zero.

exogenous (assuming safe drinking water to be a valid instrument).[40] As it turns out, we cannot reject the null hypothesis that child mortality is exogenous, $\chi^2(1)=0.02$ (0.90). Indeed, the GLS estimates in column (2) and the 2SLS estimates in column (3) are very similar. Child mortality is found to have a positive and significant effect on fertility. The size of the coefficient implies that a fall in child mortality of 50 per 1,000 (as happened between 1981 and 1991) would reduce fertility by 0.2 children per woman. Correspondingly, the inclusion of child mortality in the regression reduces the coefficient of the 1991 time dummy, from 0.52 in column (1) to 0.35 in column (3). Controlling for child mortality also reduces the coefficient of female literacy. The reduction, however, is small (and not statistically significant), suggesting that the bulk of the effect of female literacy on fertility is a 'direct' effect, rather than an indirect effect mediated by child mortality.[41]

The other coefficients are largely unchanged. The regional dummies (reported in the final column of Table 4) are much the same as before. The main difference is that controlling for child mortality leads to a substantial narrowing of the fertility gap between the northern region and the control region: about half of this gap is accounted for by higher child mortality rates in the northern region. Another difference is that the 'east' dummy crosses the threshold of statistical significance.

The first-stage regression (Table 5, column 4) is of some interest on its own. None of the variables have a counter-intuitive sign. Note that, much as with the fertility regressions, general indicators of development such as the poverty index, male literacy and urbanization turn out to have little explanatory power. Far more important are variables that have a direct bearing on child health - in this case female literacy, son preference and the availability of safe drinking water. The coefficient of drinking water is quite large: improved access to drinking water alone accounts for more than one fifth of the decline in child mortality between 1981 and 1991.

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[40] The test, due to Hausman (1978), is similar to the test for random versus fixed effects discussed earlier (see also Appendix 1).

[41] By contrast, Schultz (1997) estimates that roughly half of the total effect of female education on fertility operates via child mortality, on the basis of international data.

Using the coefficients in column 3 of Table 5, combined with information on sample means (Table 1), we can tentatively assess the contribution of different factors to fertility decline. As noted earlier, TFR declined by 0.7 births between 1981 and 1991. Taken together, the improvement of female literacy and the decline of child mortality account for a decline of 0.35 births. Other regression variables make a negligible contribution to fertility decline, so that the balance of 0.35 births is accounted for by the time dummy.

5 Concluding remarks

Several lessons emerge from the results presented in this paper. First, our findings consolidate earlier evidence on the association between female literacy and fertility in India. This link turns out to be extremely robust. In all the specifications we have explored (only a few of which are reported in this paper), female literacy has a negative and highly significant effect on the fertility rate. The fact that the coefficient of female literacy is quite robust to the inclusion of other variables, as well as of district-level fixed effects, suggests that the driving force behind it is a direct link between female education and fertility, rather than the joint influence of unobserved variables on both. These findings should help to dispel recent skepticism about the role of female education in fertility decline. The estimates in column (3) of Table 3 suggest that an increase in female literacy from its base level of 26 percent in 1981 to, say, 70 percent would reduce the total fertility rate by 1.0 children per woman. This is very substantial, considering for instance that the gap separating the current TFR in India (about 3.2) from the replacement rate of 2.1 is of a similar order of magnitude. Of course, it would be absurd to rely exclusively on female literacy to reach the replacement level (and even the preceding simulation exercise involves strong assumptions about causality and linearity). But the calculations do illustrate the crucial role of women's education in reaching that goal. The fact that female education plays such a central role in fertility decline is not surprising, given that women are the primary agents of change in this context.

Second, the preceding analysis reinstates 'son preference' as an important determinant of fertility levels. If parents value sons and daughters more or less equally, so that they are satisfied with, say, two surviving *children* irrespective of their sex (rather than wanting two *sons*), the pressure for repeated births is correspondingly lower. As discussed in the text, the positive association found here between fertility and son preference is difficult to reconcile with the view that fertility decline in India is a cause of intensified gender bias. Contrary to that view, our findings suggest that fertility decline and reduction of gender bias are highly compatible goals.

Third, the strong effects of female literacy, child survival and son preference on fertility levels contrast with the tenuous correlation between the latter and various indicators of overall development and modernisation such as male literacy, urbanization and even poverty. None of these variables exert a statistically significant influence on fertility. Fertility decline is not just a byproduct of unaimed development; it depends on improving the specific conditions that are conducive to changed fertility goals, and that help parents to realise these goals.

Much remains to be explained. In particular, it is important to unpack the time dummy, which accounts for a large part of the decline in fertility between the two Censuses. We have made a first step in that direction by attempting to estimate the effect of reductions in child mortality on fertility. Although we regard our estimates as tentative, they suggest that a reduction in child mortality of around 50 per 1,000 (as occurred between the two Censuses) would reduce fertility by around 0.2 children per woman - about two fifths of the effect initially imputed to the time dummy. As with the time dummy, the regional dummies have strong effects that need to be unpacked. There is plenty of scope for further research.

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Appendix 1

This appendix explores alternative treatments of the son-preference indicator, bearing in mind the possibility of a "feedback" from fertility to son preference (e.g. due to the "parity effect"), as well as the possibility that both might be jointly determined by unobserved variables. The first table below focuses on the cross-section regressions for 1981. The first column omits the son-preference indicator; in that sense, it is a "reduced form" equation (see section 2.3). In the second column, son preference is included on the assumption that it is an exogenous variable, as in the text. That regression is the same as in Table 3, column 1. In the third column, the 1901 female-male ratio is used as an instrument for son preference, and the equation is estimated by two-stage least squares. The fourth column presents the first-regression, where son preference is the dependent variable.

The rationale for using the 1901 female-male ratio as an instrument for son preference is that the latter has deep historical roots (relating inter alia to kinship systems and regional cultures), and must have manifested itself in female-male ratios at that time. Areas of strong son preference, such as north-west India, already had low female-male ratios in 1901. On the other hand, there have been profound changes in fertility patterns between 1901 and 1981, so that the female-male ratio in 1901 is unlikely to have a direct relation with fertility in 1981.

As the first table below indicates, the main results are robust with respect to different treatments of the son-preference variable. The only notable variation is that, when son preference is omitted (column 1), the poverty variable crosses the threshold of significance, with a negative sign as in Tables 3 and 5. This is of no consequence for the main conclusions of this paper. Also, there is no ground for rejecting the hypothesis that son preference is exogenous, even if we allow a large probability of type-1 error (F(1,311)=0.45, p-value=0.50).[1]

The second table presents the corresponding regressions for 1991. Once again, the patterns of interest are robust with respect to different treatments of the son-preference variable. In this case, it is even harder to reject the hypothesis of exogeneity of son preference (F(1,311)=0.01, p-value=0.91).

The first-stage regressions (last column in both tables) are worth noting in passing. We find no support for the common view that son preference is particularly high among Muslims (on this myth, see also Drèze and Sen, 1995, chapter 7). On the other hand, son preference does seem to be relatively low among scheduled tribes, in line with earlier studies. Female education tends to reduce the gender bias in child mortality, contrary to some earlier analyses (for further discussion, see Murthi et al., 1995). As with mortality and fertility, general indicators of development and modernisation are not associated with any improvement (i.e. decline) in the extent of gender bias. The positive coefficient of male literacy is best interpreted as an indication that gender biases in mortality and education are correlated.

[1] The test (Hausman, 1978) effectively consists of using the residuals of the first-stage regression as an additional right-hand side variable in the second-stage regression, and rejecting exogeneity if the coefficient of this variable is significant. If there is a strong feedback effect from fertility to son preference, we would indeed expect the "mistakes" involved in predicting the latter from the 1901 female-male ratio to be correlated with current fertility.

Fertility and Son Preference
(IV Estimation, based on 1981 data)

	Dependent variable:			
	TFR **(OLS)** **(1)**	**TFR** **(OLS)** **(2)**	**TFR** **(2SLS)** **(3)**	**Son preference index** **(OLS)** **(4)**
Constant	5.709** (24.41)	3.338** (8.28)	2.225* (1.76)	1.547** (18.78)
Female 15+ literacy	-0.023** (5.28)	-0.019** (4.32)	-0.017** (2.85)	-0.003** (4.18)
Male 15+ literacy	0.001 (0.27)	0.0001 (0.02)	-0.005 (0.01)	0.001** (2.05)
Poverty	-0.008** (2.42)	-0.005 (1.50)	-0.003 (0.77)	-0.001 (-1.51)
Urbanization	-0.002 (0.71)	-0.003 (1.18)	-0.003 (1.44)	-0.0001 (0.34)
Scheduled castes	0.006 (1.15)	0.005 (1.03)	0.005 (0.91)	-0.033 (0.33)
Scheduled tribes	-0.003 (0.97)	0.002 (0.84)	0.005 (1.15)	-0.003** (6.35)
Muslim	0.019** (5.55)	0.016** (4.98)	0.015** (3.87)	0.001 (1.45)
Son preference index	-	1.98** (5.98)	2.92* (1.92)	-
Female-male ratio, 1901	-	-	-	-0.0004** (4.93)
Regional dummies	yes	yes	yes	yes
Adjusted R^2	0.69	0.73	0.72	0.63
F (p-value)	59.8 (0.00)	64.3 (0.00)	57.0 (0.00)	40.9 (0.00)
Sample size	326	326	326	326

* significant at 10 percent level ** significant at 5 percent level

Notes: 1. Absolute t-ratios in parentheses. All standard errors are robust.
2. The F-test is a test of the joint hypothesis that all coefficients (except the constant term) equal zero.

Fertility and Son Preference
(IV Estimation, based on 1991 data)

	Dependent variable:			
	TFR	**TFR**	**TFR**	**Son preference index**
	(OLS)	**(OLS)**	**(2SLS)**	**(OLS)**
	(1)	**(2)**	**(3)**	**(4)**
Constant	4.756** (19.87)	2.760** (6.04)	2.630** (2.20)	1.580** (18.80)
Female 15+ literacy	-0.029** (7.22)	-0.025** (6.66)	-0.024** (5.72)	-0.003** (4.09)
Male 15+ literacy	0.005 (1.10)	0.004 (0.87)	0.004 (0.84)	0.002** (2.16)
Poverty	0.002 (0.69)	0.002 (0.99)	0.002 (1.01)	0.001 (0.79)
Urbanization	-0.002 (0.96)	-0.002 (1.51)	-0.003 (1.42)	-0.0002 (0.43)
Scheduled castes	-0.0003 (0.07)	0.001 (0.13)	0.001 (0.14)	-0.001 (1.31)
Scheduled tribes	-0.002 (0.70)	0.004 (1.26)	0.004 (0.90)	-0.003** (7.53)
Muslim	0.023** (7.08)	0.021** (6.76)	0.021** (6.57)	0.001 (1.06)
Son preference index	-	1.66** (5.19)	1.76* (1.82)	-
Female-male ratio, 1901	-	-	-	-0.0004** (5.39)
Regional dummies	yes	yes (see Table 4)	yes	yes
Adjusted R^2	0.77	0.79	0.79	0.61
F (p-value)	113.0 (0.00)	116.0 (0.00)	111.0 (0.00)	40.7 (0.00)
Sample size	326	326	326	326

* significant at 10 percent level ** significant at 5 percent level

Notes: 1. Absolute t-ratios in parentheses. All standard errors are robust.
2. The F-test is a test of the joint hypothesis that all coefficients (except the constant term) equal zero.

Appendix 2

Fertility in India: Main Results using Divisions as the Basic Units
(Dependent variable: TFR)

	1981: OLS (1)	1991: OLS (2)	Panel 1981-91: GLS-RE (3)	OLS-FE (4)
Constant	3.342** (3.626)	2.201** (2.72)	3.210** (4.54)	-
Female 15+ literacy	-0.023 (1.62)	-0.032** (4.75)	-0.026** (3.22)	-0.032* (1.69)
Male 15+ literacy	0.002 (0.17)	0.015* (1.95)	0.006 (0.70)	-0.011 (0.49)
Poverty	-0.006 (1.02)	-0.001 (0.22)	-0.003 (0.96)	0.001 (0.12)
Urbanization	-0.005 (0.82)	-0.004 (1.25)	-0.005 (1.31)	0.020 (1.08)
Scheduled castes	-0.178 (1.22)	-0.007 (0.85)	-0.001 (1.05)	0.019 (0.77)
Scheduled tribes	3.8e-05 (0.01)	0.007 (0.90)	0.002 (0.31)	-0.061** (2.40)
Muslim	0.015* (1.78)	0.022** (4.36)	0.017** (3.35)	-0.004 (0.10)
Son preference index	2.51** (3.38)	1.97** (3.82)	2.15** (4.13)	-
1991 time dummy	-	-	-0.58** (7.76)	-0.47** (3.09)
Regional dummies	yes	yes	yes	no
Adjusted R^2	0.84	0.92	0.83	0.95
F (p-value)	20.5 (0.00)	44.5 (0.00)		27.6 (0.00)
Pseudo-R^2				
Wald, χ^2			1293.2 (0.00)	
Sample size	48	48	96	96
GLS vs. FE, χ^2 (8) (p-value)			15.1 (0.06)	

Notes: See Table 3. In this table, the unit of observation is the 'division' rather than the district (see section 3.1). The division-level values of each variable were calculated as a population-weighted average of the relevant district-level values.