Missing Women, the Marriage Market and Economic Growth

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Abstract

Panel data from green-revolution India are used to re-assess (i) whether gender differences in survival rates reflect returns to human capital and (ii) to what extent policies promoting economic growth can affect the female survival deficit. Consistent with the implications of a general equilibrium framework that incorporates patrilocal exogamy and human captial-technological change, we show empirically that (i) local demand for literate wives increases significantly in areas in which agricultural growth is expected to rise, and (ii) relative survival rates, sex-preference, and schooling completion of boys and respond in opposite directions to changing local and regional rates of technological progress.

Keywords: Sex-differentials in mortality; technological change, human capital, marriage markets, developing countries.

JEL: O33; J24; J16; J12

"Ladki ko padhaane ke baad bhi woh apne ghar chali jaati hai. Padhaane se koi faida naheen"

(There is no point teaching a girl; she marries and goes away)[1]

One increasingly documented feature of many low-income countries is the disparity in household resource allocations between boys and girls (e.g., Strauss and Thomas, 1998) and men and women (e.g., Udry, 1996). Perhaps the most salient manifestation of these gender differentials, as emphasized by Sen (1990, 1992), is the difference in sex-specific survival rates, particularly in South Asian countries, as reflected, for example, in ratios of the number of males to the number of females that are significantly higher than those observed in most developed countries. The consensus is that the tens of millions of "missing women" in these societies reflect gender disparities in human capital investments, which make girls and women relatively more vulnerable to sickness and disease that are more prevalent in low-income environments.

Much of the literature concerned with differential survival rates has focused on factors affecting the economic value to the household of women relative to men. These include the differential male intensity of agricultural technology (Boserup, 1970; Bardhan, 1974, 1988; Jacoby,1995)), opportunities for women to earn (Bardhan, 1977; Rosenzweig and Schultz, 1985), and patriarchal kinship systems (Dyson and Moore, 1993). All of these factors, however, appear to be slow-moving, endemic features of the societies in which the female "deficit" is observed and suggest that income change would be ineffective at least in any reasonable time period in altering the skewness of male-female survival differentials. For example, one important institutional feature of rural India identified as a root cause of gender differentials in human capital investments there is the practice of patrilocal exogamy, whereby sons remain with the origin or "parental" household and contribute to income while daughters migrate from their household's village to move into, upon marriage, their husband's parental household.[2] Investments in sons are seen as paying off for the

[1]Quote from one of 1,221 Indian parents interviewed in a survey covering school facilities in 188 villages in four Indian states for the Public Report on Basic Education (India Today, 1998).

[2]We provide evidence in the next section that this institutional arrangement is widespread in India and cuts across northern and southern cultures.

parents, while those in daughters, who leave, do not. Increases in productivity in that context would appear to even worsen the relative returns to parents from investments in daughters and sons. Indeed, Drèze and Sen (1998) conclude in their comprehensive book on Indian development that there is little evidence that income has a significant relationship to gender differentials and that therefore “It is important to aim at more radical and rapid social change based on public action” (p. 178).

There is reason to be skeptical about the existing empirical evidence on the determinants of sex-specific survival, particularly as it relates to either whether differential survival rates respond to economic incentives or the efficacy of growth-promoting polices that do not also effect fundamental social change. For example, many empirical studies have exploited the spatial variation in sex-ratios within India to assess the fundamental causes of differential survival rates. A common finding of the cross-sectional studies based on Indian state and district data is that where women work more, sex ratios are more favorable to women (Bardhan, 1976; Rosenzweig and Schultz 1985; Kishor, 1993; Murthi *et al*., 1995)). However, as Sen (1990) has pointed out, the joint association between female labor force participation and sex differentials in survival may be due to a third, unmeasured cultural factor, so that the interpretation of this association is unclear. Moreover, the common inference from these findings that mother’s earnings measure the returns to the investments in their daughters neglects the fact that the daughters when adults do not reside in the same village as the mothers.

Drèze and Sen base their specific conclusion about the ineffectiveness of income growth on the finding in Murthi et al.(1995) that across Indian districts in 1981 poverty and the female survival disadvantage were negatively related, although this seems to be inconsistent with the finding in Rose (forthcoming) that female survival is enhanced when there are favorable weather shocks.[3] The relationship between income and survival rates, however, whatever its sign or magnitude, may have little relevance for assessing the consequences of growth. Economic growth is not just an exogenous rise in income, but usually results from a change in productivity that can significantly alter the returns to investments in human capital.

[3]Sen and Drèze also find that upwardly-mobile lower castes were no less biased with respect to male/female survival chances.

Income effects can be small, but growth-induced changes in returns to investments can have large effects. The Indian “green revolution”, for example, substantially increased the productivity of agricultural production in many areas of India and raised the returns to schooling for men and women, particularly in those areas where the new crop varieties were most productive (Foster and Rosenzweig, 1996; Behrman et al., 1999).

In this paper we use panel data from India during the period of the initial years of the India green revolution to re-assess (i) whether gender differences in survival rates reflect gender differentials in the value of human capital and (ii) to what extent policies promoting economic growth can affect the female survival deficit in the absence of fundamental changes in cultural practices that differentiate the roles of men and women. In particular, we adopt a general equilibrium framework in which, consistent with patrilocal exogamy, sons contribute to parental household incomes and daughters do not, and therefore local productivity increases favor boys. We show that in this context advances in agricultural productivity can improve the survival chances of girls as long as there is a marriage market and the returns to the human capital of women are enhanced even if income effects on relative survival rates or preferences are insignificant. Moreover, we also demonstrate that it is not possible to identify empirically in the context of India how growth affects gender bias in household human capital investments or survival without taking into account the marriage market because of the marital migration of daughters. We find empirically, exploiting this feature of Indian social relations by constructing spatial marriage markets, that (i) the effects of variation in wealth on sex differentials in survival are weak, as found in previous studies, but (ii) the local demand for literate wives increases significantly in areas in which agricultural growth is expected to rise, as signaled by elevated land prices for given current productivity, and (iii) relative survival rates of boys and girls, differences in maternal preferences for girls and boys, and relative schooling completion rates of boys and girls respond in opposite directions to changing local and regional returns to human capital associated with expected economic growth.

In section 1 we describe the patterns of mortality differentials by sex in India using census data, relate them to survey data providing information on the gender preferences of rural mothers, and provide information from both census and survey data on the differential rates of migration associated with patrilocal exogamy of adult women and men by region. In section 2 we set out the general equilibrium model incorporating the export of daughters for marriage. The model highlights the role of expectations about future technology change in determining human capital investments . In section 3 we use the model to show how information on land prices help provide identification of the distinct roles of local and marriage-market growth effects when households are forward-looking. Section 4 describes the data and section 5 provides evidence on the relationships between land prices and current and future yields. The construction of spatial marriage markets is discussed in section 6, which also contains estimates of the demand for literate brides. Section 7 contains the estimates of the determinants of sex-differences in survival rates, maternal preference bias and sex differences in schooling attainment that also incorporate tests of the extent of the scope of the marriage market. The results are summarized in section 8.

1. The Indian Setting: The Female "Deficit" and Patrilocal Exogamy

India is a particularly appropriate context for studying the relationship between economic growth and gender bias in survival rates because of the large variation in both sex-specific survival rates and the productivity-enhancing effects of the green revolution across regions of India. Figure 1 displays the ratios of male to female children aged 0-4 in rural areas across 15 major Indian states from the 1971 Indian Census ranked from the highest to the lowest sex ratio. There are five Indian states where the sex ratio exceeds that in most Western industrialized societies for this age group, at approximately 1.[4] For example, the ratios in Punjab and Haryana are over seven percentage points higher than the industrialized-country baseline. If the latter is close to the biological norm, then given that the number of male children aged 0-4 in Punjab and Haryana in 1971 was 1,405,133, the number of missing girls less than age five in those two states is over 91,000. This implies a mortality rate for girls that is over three times that of boys.

There are also apparently a few states with a "deficit" of males. This feature of the Indian Census data has not been much discussed; however, the state-specific sex ratios do appear to reliably reflect the

[4]The ratio at birth is 1.04. Higher male infant mortality lowers the ratio to parity in the first year of life.

spatial variation in prevailing attitudes towards sons and daughters. Data from national surveys of 4,118 and 4,650 rural households in 1971 (ARIS) and 1982 (REDS), respectively, used in our analysis of the determinants of sex differentials in mortality and designed to be representative of the rural population of India,[5] elicited from married women their "ideal" numbers of male and female children. Figure 1 provides the average differences in the ideal number of boys and girls as reported by the respondent women in the 1971 survey for the fifteen states alongside the Census child sex-ratios for that year. The figure suggests that, with the exception of the state of Kerala, most Indian women preferred boys, even in the "male deficit" states. However, there is also wide interstate variation in the gender preferences that corresponds to that for the sex ratios. For example, in Punjab and Haryana, the states with the highest female deficits for the age groups 0-4, women on average prefer to have families in which the number of boys exceeds the number of girls by one, while in Madhya Pradesh, a male deficit state, the preferred number of boys exceeds that for girls by only .35. The overall correlation between the gender differential in family size and the male/female sex-ratio is .64.

The patterns of male and female deficits observed in the 1981 Census are also exhibited in the censuses of 1951, 1961 and 1981. This persistence of differential mortality patterns by sex has led researchers to look to cultural features of India as the root cause of the skewness in the allocation of resources to girls. An important feature of the social organization of India is patrilocal exogamy. The relative movements of men and women from their origin villages in rural areas of India is depicted in the 1981 Census of India, which ascertained information on whether individuals had moved from their village and district of birth. The first column of Table 1 reports the proportion of rural men and women over age 15 who reported that were not residing in their birth village and birth district. As can be seen, in the 1981 rural population almost 69% of women over age 15 had left their origin village, compared to less than 18% of comparably-aged men. 16% of the rural women had crossed district boundaries, compared with less than 6% of men.

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[5]The 1971 Additional Rural Investment Survey (ARIS) and 1982 Rural Economic Development Survey (REDS) are described in detail below.

It has been argued in a well-known article (Dyson and Moore 1983) that there are important differences across India in kinship systems that roughly correspond to a north-south division, with patrilocal exogamy alleged to be a marked feature of north India only. However, it appears that the marital migration of women is a pervasive feature of the rural Indian population.[6] We have geocoded the 100 districts and over 250 villages represented in the ARIS and REDS data providing information on gender preferences, which therefore permits an examination of north-south differences in patterns of migration. The last three columns of Table 1 report based on the 1981 Indian Census the rural migration rates by sex for the full sample of 100 districts and those sample districts in the north and in the south.[7] The figures indicate that (i) the populations in the 100 sample districts are characterized by rates of sex-specific migration that closely match those for India as a whole, as indicated by a comparison of columns one and two, as would be expected in a sample that is meant to be representative of the rural Indian population, and (ii) differences in the patterns of mobility by sex across the north-south divide, although conforming to the north-south hypothesis, are not very large, particularly with respect to the extent to which women leave their origin villages and districts. Indeed, the largest north-south differentials are in the extent to which men migrate rather than in the migration rates of women. However, the female rate of inter-village migration exceeds the rate of male migration even in the southern areas where the ratio is the lowest by a factor of almost 2.7.

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[6]This conclusion is not in fact new. Libbee and Sopher (1975), which was cited by Dyson and Moore (1983), carried out an analysis of marital migration using migration data by sex from the 1961 census and drew the following conclusion:

> In general, local exogamy and the fetching of brides from some distance seem to be more widely practised *throughout* India than is generally acknowledged in the literature, although by no means as universally in the north as is supposed" (p 356 italics in the original).

Note that we do not take issue here with the central thesis of Dyson and Moore, that differences in female autonomy across India importantly underlie regional differences in mortality differentials by sex. Dyson and Moore (p49) convincingly show, for example, that such cultural practices as purdah are lower in the south where female relative to male mortality is also lower. Indeed, our analysis explicitly incorporates cultural heterogeneity in female autonomy and shows how this may impact sex-differences in mortality..

[7]Following Dyson and More we divide north and south using the Satpura hill range as a basis. In particular, we use a straight line that runs through the points 19.65 N, 69.25 E and 88.77 N, 23.14E to divide our sample villages into northern and southern samples. This line runs through northern Maharashtra, southern Madhya Pradesh, and northern Orissa.

A more recent survey, the Population and Gender Inequality and Reproductive Choice Survey (PGIRCS) (Rao et al., 1998), provides more direct evidence on marital migration patterns in northern and southern India. This survey was designed in part to obtain more precise information on north-south differences in the extent and scope of marital migration in rural areas and was administered in one southern (Karnataka) and one northern state (Uttar Pradesh). The survey was administered using a stratified sampling design to 1200 households in rural Uttar Pradesh and 800 households in rural Karnataka.[8] Thirty-five villages in five districts are included in each sub-sample, with each sub-sample being representative of the rural area of its respective state. Figure 2 reports the cumulative distributions of the distances associated with the marriages for all ever-married women aged 15-49 in the sample areas of the two Indian states. As can be seen, while the proportion of women not leaving their origin villages is slightly higher in the northern state (15% versus 9%), the overall distributions are almost identical. Indeed, a Kruskal-Wallis rank test leads to non-rejection of the hypothesis that the "northern" and "southern" distributions of marital distances are from the same population ($\chi^2(1)$=.007, ρ=.93).

Despite the persistence and pervasiveness of the practice of patrilocal exaogamy, the successive cross-sections from the ARIS and REDS data suggest that, contrary to the cross-sectional findings, gender preferences are not invariant to change, and may have been affected by economic growth. Figure 3 plots the increase in a Laspeyres-weighted index of crop productivity over the period 1971 through 1982 across the same Indian states as in Figure 1, ranked by the magnitude of the productivity increase, along with the change in the state-specific average preferences for excess male children across the two surveys. As can be seen, there are considerable differences across states in the extent to which, due mainly to the introduction of new high-yielding seed varieties in the late 1960's, agricultural productivity was augmented. For example, among the states with the highest productivity increase (Karnataka, Punjab and Gujurat) crop productivity rose by over 150%, while in the three lowest productivity change states (Madhya Pradesh, Kerala and Bihar)

[8]The PGIRCS was carried out under a collaborative arrangement between the Population Council (New York), Institute of Social Studies Trust (New Delhi/Bangalore), and the National Council for Applied Economic Research (New Delhi).

productivity rose by only 11% in the 11- year period. Most interestingly, the change in boy bias over the same time period is negatively correlated with the productivity increase (r=-.52) - in all three of highest growth states, for example, the "preferred" girl deficit fell (by a third of a child on average), while the deficit actually increased in the three lowest growth states.

2. The Model

To clarify the role of economic growth propelled by technical change in altering gender-specific human capital investments within the context of the "traditional" rural setting of India, we construct a simple general equilibrium model incorporating two major organizational features of Indian agriculture - the gender-based division of labor and patrilocal exogamy. Households produce an agricultural product utilizing the human capital of the male head, his sons and, depending on the local "culture", his wife; import the human capital of the wife; produce the human capital of girls and boys utilizing the human capital of the wife, and export the human capital of girls for marriage. In the model married women, and their human capital, are thus productive even if they do not directly contribute to agricultural production because they contribute to the production of the human capital of male and female children. However, we assume that women have no decision-making power and daughters, unlike sons, do not contribute directly to (origin) family income or human capital.[9] Returns to investments in daughters must accrue through the regional marriage market.

In particular, we first consider an adult male in village i who is young in period t and old in period t+1. He seeks to maximize his lifetime utility, given by

(1) $u(c_{ti},c_{t+1i},h_{si},h_{di},h_{wi})$,

which has as arguments household consumption when the household is young, c_{ti}, and old, $c_{t+1i,}$ and the human capital of his sons $h_{si,}$ his daughters $h_{di,}$ and his wife h_{wi} subject to stage-specific budget constraints. We assume that the human capital of the spouse and children of both sexes is a normal good and that boys' and girls' human capital are substitutes. In young households, the household head selects the human capital

[9]We make these assumptions in order to show that it is not necessary to change fundamentally women's role in decision-making for economic growth to benefit women. Behrman et al. (1999) provide evidence that women played almost no role in agricultural decision-making, and this was unaffected by agricultural technical change.

of his spouse $h_{wi,}$ paying a market-determined "bride" price of $p_{ht}h_{wi}$, invests in his children's human capital, undertakes agricultural production, and consumes. In the second stage, which takes place in the subsequent period, he marries his daughter to another household receiving a price of p_{ht+1} per unit of human capital, produces agricultural income, and also consumes.[10] We initially assume perfect foresight - all second-stage parameters are known when first-stage decisions are made. We consider uncertainty with respect to the second-stage human capital price and technology and the formation of expectations with respect to these variables below.

The human-capital production function for children of sex k depends on the wife's human capital h_{wi} and human capital goods x_{ki} purchased in the market

(2) $$h^{p}(h_{wi},x_{ki}),$$

with wife's human capital and the child x-good complements. Agricultural incomes $\pi()$ and $\Pi()$ accrue in the young and old stages, respectively. In the young stage, agricultural income is determined by household assets A_i, by the human capital of the husband h_{hi}, and his wife h_{wi}, and by the local technology θ_{ti} in that time period indexed by a scalar. When the household is old, a new technology is employed θ_{t+1i} and agricultural income is, in addition, influenced by the human capital of the sons h_{si} We assume that the technology augments the productivity of all inputs used in agricultural production. To simplify, and in keeping with evidence of credit market imperfections in rural areas of developing countries, we assume that households may not borrow and lend across stages. The two budget constraints for the young and old stages are thus

(3) $$c_{ti}+p_{ht}h_{wi} + p_x(x_{si}+ x_{di}) = \pi(\theta_{ti},A_i,h_{hi},\kappa_i h_{wi})$$

and

[10]The fact that we assume that there is a positive price of brides' human capital does not exclude the possibility that there are substantial net transfers from brides' to grooms' households. The model can easily account for the presence of culturally-determined dowries or bride prices by incorporating a fixed payment for marital transactions or by appropriately normalizing the measure of female human capital used. Explicitly incorporating such payments would not alter the main conclusions of the model as long as the marriage market rewards the human capital of women by either decreasing the dowry paid to grooms or increasing the bride price for brides with higher levels of human capital. For evidence on the relationship between dowry and the schooling of brides and grooms in India, see Rao (1993) and Rosenzweig and Stark (1989).

(4) $$c_{t+1i} = \Pi(\theta_{t+1i}, A_i, h_{hi}, h_{si}, \kappa_i h_{wi}) + p_{ht+1} h_{di}$$

respectively, where κ_i ($0 \le \kappa_i \le 1$) is a culturally-determined scalar indicating the extent to which the wife engages in agricultural production in the local area, p_x is the price of x.

The marginal rate of substitution, derived from the model, between the human capital of boys and girls is given by

(5) $$mrs_{h_s h_d} = \frac{(\partial h_d^p/\partial x_d)}{(\partial h_s^p/\partial x_s)} \frac{[p_x - \frac{\lambda_{t+1}}{\lambda_t}(\partial\pi/\partial h_s)(\partial h_s^p/\partial x_s)]}{[p_x - \frac{\lambda_{t+1}}{\lambda_t} p_{ht+1}]},$$

where λ_t and λ_{t+1} are the marginal utilities of income in the two stages. Expression (5) indicates that the relative net costs of boys' and girls' human capital investments depend on the locally-determined contribution of the boys' human capital to the household's agricultural profits and the market-determined price of female human capital. If there were no market price for the latter, then it is clear that, even with sex-neutral preferences, investments in girls would be locally more costly than that in boys. If there is a market equilibrated price of female human capital p_{ht+1} , however, then it is not clear from (5) which gender is more costly to parents or how changes in farm technology alter the differential returns to gender-specific investments, because (imported) adult girls produce both locally-productive male human capital and female human capital that receives a return in the marriage market.

a. Partial Equilibrium Demand and Supply of Male and Female Human Capital.

The model permits the derivation of both the partial equilibrium (conditional on human capital prices) demand for and supply of sex-specific human capital and the derivation of the equilibrium prices p_{ht} and p_{ht+1} of the traded good, female human capital, in the two stages, and thus an assessment of how changes in local and market-area technology affect investments in boys and girls. In the first stage of the model, in which the demand for imported female human capital is determined, the first-order condition for the human capital of the wife is

(6) $$\lambda_{t+1}\left(\frac{\partial\pi_{t+1}}{\partial h_s}\frac{dh_s^S}{dh_{wi}} + p_{ht+1}\frac{dh_d^S}{dh_{wi}} + \frac{\partial\pi_{t+1}}{\partial h_{wi}}\right) + \lambda_t\frac{\partial\pi_t}{\partial h_{wi}} = \lambda_t p_{ht},$$

which indicates that the marginal cost of a unit of the wife's human capital purchased in the marriage market,

p_{ht}, is equated to its marginal return, which accrue in both the agricultural and household sectors of the household. The demand equation for the wife's human capital is thus a function of the determinants of household and farm productivity, the extent to which women participate in the agricultural sector, and the marriage-market equilibrium prices:

(7) $$h_{wi}^{D} = h_{w}^{D}(\theta_{ti}, \theta_{t+1i}, \kappa_{i}, A_{i}, h_{hi}, p_{ht}, p_{ht+1}, p_{x}).$$

The model delivers the result that where women participate to a greater extent in earnings activities there is greater demand for importing female human capital because female human capital contributes to the production of sons' human capital, as long as sons' and mother's human capital are not strong substitutes in agricultural production. It also indicates that increases in first-stage technology, for given second-stage technology, locally will increase the import demand for female human capital,

(8) $$\frac{\partial h_{w}^{D}}{\partial \theta_{ti}} = -\frac{\partial^{2}\pi}{\partial \theta_{ti}\partial(\kappa_{i}h_{w})}\kappa_{i}\frac{dh_{w}^{c}}{dp_{ht}} + \frac{\partial \pi}{\partial \theta_{ti}}\frac{dh_{w}}{d\pi},$$

where the superscript c denotes a compensated price effect and $dh_{w}/d\pi$ denotes the effect of an exogenous increase in first-stage income on wives human capital.

Women's participation in farming is not, however, a necessary condition for future local increases in farm productivity to increase the demand for imported female human capital. The effect of variation in the local farm technology in period t+1, derived from (7), is given by

(9) $$\begin{aligned}\frac{\partial h_{w}^{D}}{\partial \theta_{t+1i}} &= -\frac{\lambda_{t+1}}{\lambda_{t}}\left(\frac{\partial^{2}\Pi}{\partial \theta_{t+1i}\partial(\kappa_{i}h_{w})}\kappa_{i} + \frac{\partial^{2}\Pi}{\partial \theta_{t+1i}\partial h_{s}}\frac{\partial h_{s}^{p}}{\partial h_{w}}\right)\frac{dh_{w}^{c}}{dp_{h_{t}}} \\ &\quad - \frac{\lambda_{t+1}}{\lambda_{t}}\frac{\partial^{2}\Pi}{\partial \theta_{t+1i}\partial h_{s}}\frac{\partial h_{s}^{p}}{\partial x_{s}}\frac{dh_{w}^{c}}{dp_{xs}} + \frac{\lambda_{t+1}}{\lambda_{t}}\frac{\partial \Pi}{\partial \theta_{t+1i}}\frac{dh_{w}}{d\Pi}\end{aligned}$$

where $dh_{w}/d\Pi$ denotes the effect of an exogenous increase in second-stage income on wives human capital. Expression (9) indicates that an increase in second-stage agricultural technology will raise the demand for adult female human capital for three reasons: it increases the productivity of women in agriculture if women participate ($\kappa_{i}>0$), it raises the productivity of adult sons and thus the returns from producing sons with female human capital, and it increases income. Thus even if women do not participate in agricultural production ($\kappa_{i}=0$) and even if income effects are insignificant, increases in local second-stage agricultural productivity lead to an increase in the local demand for female human capital that is derived from their complementary role in producing sons, sons who will be more productive as a result of the local technology change.

While the effects of technology in the young and old stages on the demand for adult female human capital are of the same sign, the same cannot be said for the effects of the corresponding marriage-market prices. In particular, an increase in the price in the young stage raises the cost of purchasing female human capital in the marriage market yielding the standard negative own price effect:

$$(10) \qquad \frac{\partial h_w^D}{dp_{ht}} = \frac{dh_w^c}{dp_{ht}} - h_w \frac{dh_w}{d\pi}$$

By contrast, increases in the old-stage price, given the young-stage price, raise the return to adult female human capital by increasing the potential return in the marriage market to daughters' human capital:

$$(11) \qquad \frac{\partial h_w^D}{\partial p_{ht+1}} = -\frac{\lambda_{t+1}}{\lambda_t}\left(\frac{\partial h_d^p}{\partial x_d}\frac{dh_w^c}{dp_{xd}} + \frac{\partial h_d^p}{\partial h_w}\frac{dh_w^c}{dp_{ht}}\right) + h_d \frac{dh_w}{d\Pi}$$

assuming that maternal human capital and market inputs used in the production of daughters' human capital are not too complementary.

In contrast to the effects of local technology on the demand for women, future local increases in productivity do not favor investments in girls, conditional on the market price of female human capital p_{ht+1}, as girls do not participate in the local economy. Solving the model conditional on the wife's human capital h_{wi} and the market prices of female human capital in the two stages yields the set of partial equilibrium human capital "supply" equations for children of sex k of the form:

$$(12) \qquad h_{ki}^S = h_k^S(\theta_{ti}, \theta_{t+1i}, \kappa_i, A_i, h_{hi}, h_{wi}, p_{ht}, p_{ht+1}, p_x)$$

The effect of an increase in local technology θ_{ti} when the household is in its young stage on the differential supply of gender-specific human capital is purely an income effect

$$(13) \qquad \frac{\partial h_s^S}{\partial \theta_{ti}} - \frac{\partial h_d^S}{\partial \theta_{ti}} = \frac{\partial \pi}{\partial \theta_{ti}}\left[\frac{dh_s^S}{d\pi} - \frac{dh_d^S}{d\pi}\right],$$

with a sign depending on the relative magnitudes of the income effects for human capital investment by sex.[11] The effect of an increase in the local technology θ_{t+1i} when the household is in its old stage, conditional

[11]Note that there are no price effects because sons and daughters are assumed not to contribute to production in the young stage and because, as specified, the human-capital supply equations condition on maternal human capital.

on the mother's human capital and for a fixed human-capital price, however, favors boys:

(14) $$\frac{dh_s^S}{d\theta_{t+1i}} - \frac{dh_d}{d\theta_{t+1i}} = \frac{\lambda_2}{\lambda_t}[\frac{dh_d^c}{dp_{xs}} - \frac{dh_s^c}{dp_{xs}}]\ \frac{\partial h_s^p}{\partial x_s}\frac{\partial^2\Pi}{\partial h_s \partial\theta_{t+1i}} + \frac{\partial\Pi}{\partial\theta_{t+1i}}\ [\frac{dh_s}{d\Pi} - \frac{dh_d}{d\Pi}],$$

as long as boy and girl human capital are substitutes and income effects do not strongly favor girls. Similarly, but perhaps more surprisingly given the focus in the literature on the relationship between the mothers' rate of participation and differential investments in boys and girls, because girls do not participate in the household's production sector, the extent to which their mothers participate does not lead to increases in investments in girls. In particular,

(15) $$\begin{aligned}\frac{\partial h_s^S}{\partial\kappa_i} - \frac{\partial h_d^S}{\partial\kappa_i} &= \frac{\lambda_{t+1}}{\lambda_t}[\frac{\partial^2\Pi}{\partial(\kappa_i h_w)\partial h_s}\frac{\partial h_s^p}{\partial x_s}][\frac{dh_d^c}{dp_{xs}} - \frac{dh_s^c}{dp_{xs}}]\\ &+ \frac{\partial\pi}{\partial(\kappa_i h_w)}[\frac{dh_s}{d\pi} - \frac{dh_d}{d\pi}] + \frac{\partial\Pi}{\partial(\kappa_i h_w)}[\frac{dh_s}{d\Pi} - \frac{dh_d}{d\Pi}]\end{aligned}$$

Expression (15) indicates that if the mother's human capital and that of her sons are (plausibly) complements in agricultural production, where married women participate more heavily in the farming sector, investments in girls will actually be lower relative to boys, for given marriage-market returns.

Thus, in this model changes in the local role of women as earners, either via changes in culture (supply) or through changes in technology that make women more productive as workers (demand), do not lead to increased relative investments in girls unless there are also changes in the market price of female human capital p_{ht+1} in the life-cycle stage of the household when the girls are being married. The observed positive cross-sectional relationships between sex-ratios in labor force participation and in child survival thus must reflect the joint operation of unmeasured cultural factors on gender preference, bargaining power influences or non-local factors that affect p_{ht+1}. Increases in the marriage-market price of female human capital when the household is old and is marrying off daughters, p_{ht+1}, however, will lead to relatively more investments in girls:

(16) $$\frac{\partial h_s^S}{\partial p_{ht+1}} - \frac{\partial h_d}{\partial p_{ht+1}} = \frac{\lambda_{t+1}}{\lambda_t}(\frac{dh_d^c}{dp_{xd}} - \frac{dh_s^c}{dp_{xd}})\ \frac{\partial h_d^p}{\partial x_d} + h_d\ [\frac{dh_s}{d\Pi} - \frac{dh_d}{d\Pi}],$$

unless there are strong offsetting differential income effects. Again, changes in the market price of human capital when the household is young, conditional on the human capital of the mother, only influence differential human capital investment through a differential income effect

(17) $$\frac{\partial h_s^S}{\partial p_{ht}} - \frac{\partial h_d^S}{\partial p_{ht}} = - h_w \left[\frac{dh_s}{d\pi} - \frac{dh_d}{d\pi}\right],$$

b. Uncertainty and General Equilibrium

Although equations (7) and (12) provide clear implications for how technical change in an environment characterized by patrilocal exogamy affects the demand for sex-specific human capital, there are two important simplifications that must be addressed before practical testable implications may be derived. First, the assumption that technologies in both stages are known with certainty over the relevant time horizon is difficult to reconcile with the process of technical change in India. In particular the green revolution in India was essentially unanticipated in the mid 1960s but the initial gains had largely been realized less than 15 years later, a period that corresponds roughly to a single interval between stages of the model (the time between the marriage of a woman and her daughter). We thus need to incorporate expectations formation in the model. Second, the assumption that the human capital price is exogenously determined needs to be relaxed. Clearly, if there is a market for human capital, then this price is likely to be affected by technical change.

To incorporate uncertainty while keeping the model as simple as possible we assume risk neutrality and replace second-stage technology and prices in (7) and (12) by their expected values

(18) $$h_{wi}^D = h_w^D(\theta_{ti}, \mathrm{E}\theta_{t+1i}, \kappa_i, A_i, h_{hi}, p_{ht}, \mathrm{E}p_{ht+1i}, p_x)$$

(19) $$h_{ki}^S = h_k^S(\theta_{ti}, \mathrm{E}\theta_{t+1i}, \kappa_i, A_i, h_{hi}, h_{wi}, p_{ht}, \mathrm{E}p_{ht+1i}, p_x),$$

where $\mathrm{E}\theta_{t+1i}$ is the expectation at time t of technology in the next period.[12] To take into account the endogenous determination of the human capital price, we assume a marriage market in which the demand for and the supply of female adult human capital are equated. Because the maternal human capital being acquired in any given period was produced in the prior period, based in part on expectations about conditions that would obtain subsequently, the equilibrium condition in the marriage market in any time period t is given by

(20) $$\sum_{i\in I_D} h_w^D(\theta_{ti}, \mathrm{E}\theta_{t+1i}, A_i, h_{hi}, p_{ht}, \mathrm{E}p_{ht+1}, p_x) = \sum_{i\in I_S} h_d^S(\theta_{t-1i}, \mathrm{E}\theta_{ti}, A_i, h_{hi}, h_w, p_{ht-1}, \mathrm{E}p_{ht}, p_x)$$

[12]Under these conditions the comparative static property discussed above are preserved, with the derivatives with respect to, for example, θ_{t+1i} replaced with derivatives with respect to $\mathrm{E}\theta_{t+1i}$.

where I_D denotes the set of 'young' households in time period t who are acquiring a spouse and I_S denotes the set of 'old' households supplying a daughter to the market in that period. Solving implicitly gives expressions for the time-t equilibrium price, noting that the expectation in t (t-1) of the future marriage-market human capital price is determined by the expectation in t (t-1) of next-period technology and the period-t characteristics of the supplying and demanding households:

(21) $$p_{ht}=p_h(\boldsymbol{\theta}_{t-1},\boldsymbol{\theta}_t,\mathbf{E}\boldsymbol{\theta}_{ti},\mathbf{E}\boldsymbol{\theta}_{t+1i},\boldsymbol{\kappa},\boldsymbol{A}_t,\boldsymbol{h}_{ht},\boldsymbol{h}_{wt},\boldsymbol{p}_{xt}),$$

where the bold arguments denote vectors of the corresponding variables within all of the localities in the relevant marriage market. Because, up to a linear approximation, the characteristics in each village have the same impact on the equilibrium price, one may conveniently summarize the vector of technologies and endowments in each village by its mean yielding a price function of the form [13]

(22) $$p_{hy}=p_h^*(\bar{\theta}_{t-1},\bar{\theta}_t,\mathrm{E}\bar{\theta}_t,\mathrm{E}\bar{\theta}_{t+1},\bar{\kappa},\bar{A}_t,\bar{h}_{ht},\bar{h}_{wt},\bar{p}_{xt})$$

Substitution of (22) into (12) yields an expression for the supply of daughters' and sons' human capital by young households in village i at time t

(23) $$h_{ki}^S=h_k^{S*}(\theta_{ti},\mathrm{E}\theta_{t+1i},\kappa_i,A_i,h_{hi},h_{wi},p_x,\bar{\theta}_{t-1},\bar{\theta}_t,\mathrm{E}\bar{\theta}_{ti},\mathrm{E}\bar{\theta}_{t+1i},\bar{\kappa},\bar{A}_t,\bar{h}_{ht},\bar{h}_{wt},\bar{p}_{xt})$$

in terms of (local) household characteristics as well as the vectors of household characteristics in the marriage market. Similarly, substitution of (22) into (7) yields an expression for the demand for the human capital of newly married wives in young households in village i.

(24) $$h_{wi}^D=h_w^{D*}(\theta_{ti},\mathrm{E}\theta_{t+1i},\kappa_i,A_i,h_{hi},p_x,\bar{\theta}_{t-1},\bar{\theta}_t,\mathrm{E}\bar{\theta}_{ti},\mathrm{E}\bar{\theta}_{t+1i},\bar{\kappa},\bar{A}_t,\bar{h}_{ht},\bar{h}_{wt},\bar{p}_{xt})$$

Equations (23) and (24) distinguish between local and marriage-market effects. This distinction is important not only because it captures a realistic feature of marriage patterns in rural India. It also suggests that inattention to the operation of the marriage market can potentially lead to misleading inferences about the effects of technology change.

The model clearly predicts, for example, that expected local future technology favors boys given marriage market conditions. If variation in marriage-market conditions are not accounted for, however, the

[13] We assume that information is fully shared within the marriage market so that villages do not have different expectations about future average marriage-market technology.

observed relationship between expected future technology and relative human capital investments in boys and girls across localities can be zero or even negative. Assuming for illustrative purposes that the income effects for sons and daughters are approximately equal, the total effect of expected future (period t+1) local technology, given period-t local technology, on differential human capital investment is given by

$$(25)\qquad \frac{dh_{si}^{S}}{dE\theta_{it+1}} - \frac{dh_{di}}{dE\theta_{it+1}} = \frac{E\lambda_{t+1}}{\lambda_t}\left(\frac{dh_d^c}{dp_{xs}} - \frac{dh_s^c}{dp_{xs}}\right)\left(\frac{\partial h_s^p}{\partial x_s}\frac{\partial^2\Pi}{\partial h_s \partial\theta_{t+1i}} - \frac{\partial h_d^p}{\partial x_d}\frac{dEp_{ht+1}}{dE\bar{\theta}_{t+1}}\frac{dE\bar{\theta}_{t+1}}{dE\theta_{it+1}}\right)$$

This expression has two additive terms. The first term is positive and corresponds to the future local technology effect that favors boys because of the complementarity between future local agricultural technology and the human capital of matured stay-at-home boys. The second term reflects the degree to which a locality's expectations and those in the marriage market are correlated and the fact that increases in expected future technology raise the relative returns to human capital investments in girls in the marriage market. This second term is negative assuming that the expected t+1 market price of human capital is positively correlated with expected t+1 average technology[14] and that expectations of period t+1 technology are spatially autocorrelated. Depending, among other things, on the degree of spatial autocorrelation this second term may partially or fully offset the positive term yielding an overall effect that is small or even negative.

3. Empirical Implementation of the Model: Expectation Formation and Land Prices

An obvious difficulty with (23) and (24) from the standpoint of estimation is that these expressions condition on expectations of future variables. To derive testable implications in the absence of actual expectations data requires that the model be reformulated in terms of observables. Three ways to proceed are: (i) replace expected values with their realized values; (ii) replace expected variables with observable variables that characterize the information on which these expectations condition; or (iii) identify actual variables that directly reflect expectations and incorporate these into the analysis. We argue below that only the third approach provides clear testable and interpretable implications for the model.

Approach (i) is the most obviously problematic. First, most data sets are not likely to have

[14]It can be shown that this term is positive as long as the expectation in time t of period t+2 expected technology is positively correlated with expectation in time t period t+1 technology.

information on the future values of variables over the relevant period, in our case at an interval of at least 15 years. Second, realizations of stochastic variables measure with error the lagged expectations they are meant to represent. At a minimum, use of realizations to proxy expectations leads to classical measurement-error bias. Moreover because expectations will in general be correlated with other observables in the model, bias will not be limited to the coefficients on the expectations variables. Third, in circumstances in which the time horizon of the data set is short it is not obvious that the difference between realizations and expectations will on average be zero. Technology realizations are in fact likely to be correlated across space – if a new high-yielding variety seed is discovered one is likely to have unexpectedly higher yields in many regions of the country. Thus even if suitable excluded variables were available, the usual approach of instrumenting to address measurement error will be inadequate.

Approach (ii), the substitution for expectations of observable variables that influence expectations, does not lead to bias but makes difficult the identification of the separate human capital investment effects of marriage-market and local changes in expected future agricultural technology, key distinctions in our model. To illustrate this point we explicitly characterize the information set used to form expectations about future technology and human-capital prices. We assume, in particular, that period-t expectations of local period t+1 technology are formed based on three pieces of data: period-t local technology θ_{it}, period-t average marriage-market technology $\bar{\theta}_t$, and other information ζ_{it} and that expectations of regional outcomes (marriage-market prices and technologies) are formed based on $\bar{\theta}_t$ and $\bar{\zeta}_t$.[15] In particular, with $E\theta_{it+1}=E\theta(\theta_{it},\bar{\theta}_t,\zeta_{it})$ and $E\bar{\theta}_{t+1}=E\theta(\bar{\theta}_t,\bar{\zeta}_t)$, the expected second-period marriage-market price is then

(26) $$Ep_{ht+1}=Ep_{ht+1}^{**}(\bar{\theta}_{t-1},\bar{\theta}_t,\bar{\kappa},\bar{A}_t,\bar{h}_{ht},\bar{h}_{wt},\bar{p}_{xt},\bar{\zeta}_{t-1},\bar{\zeta}_t).$$

and the equilibrium price at time t and the supply and demand functions for young households in village i at time t are

(27) $$p_{ht}=p_h^{**}(\bar{\theta}_{t-1},\bar{\theta}_t,\bar{\kappa},\bar{A}_t,\bar{h}_{ht},\bar{h}_{wt},\bar{p}_{xt},\bar{\zeta}_{t-1},\bar{\zeta}_t)$$

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[15]The key restrictions here is that, consistent with out model, there are no additional unobservables influencing expectations about marriage-market prices that do not also influence expectations about technology.

(28) $h_{ki}^{S}=h_{k}^{S**}(\theta_{ti},\kappa_i,A_i,h_{hi},h_{wi},p_x,\zeta_{ti},\bar{\theta}_{t-1},\bar{\theta}_t,\bar{\kappa},\bar{A}_t,\bar{h}_{ht},\bar{h}_{wt},\bar{p}_{xt},\bar{\zeta}_{t-1},\bar{\zeta}_t)$

and

(29) $h_{wi}^{D}=h_{w}^{D**}(\theta_{ti},\kappa_i,A_i,h_{hi},p_x,\zeta_{ti},\bar{\theta}_{t-1},\bar{\theta}_t,\bar{\kappa},\bar{A}_t,\bar{h}_{ht},\bar{h}_{wt},\bar{p}_{xt},\bar{\zeta}_{t-1},\bar{\zeta}_t)$

respectively.

There are two barriers to identification of the distinct effects of marriage-market and local technologies on the differential demand for male and female human capital implied by the model. First, current and future effects of technology change are essentially aggregated so that their distinct effects cannot be disentangled. This is clearly evident in the effect of changes in first-period local technology on differential human capital investments in boys and girls,

$$(30)\qquad \frac{\partial h_s^{S**}}{\partial\theta_{ti}}-\frac{\partial h_d^{S**}}{\partial\theta_{ti}} = \frac{\partial\pi}{\partial\theta_{ti}}\left[\frac{dh_s}{d\pi}-\frac{dh_d}{d\pi}\right]+\left(\frac{\partial h_s}{\partial E\theta_{t+1i}}-\frac{\partial h_d}{\partial E\theta_{t+1i}}\right)\frac{\partial E\theta}{\partial\theta_{ti}}$$

It is not possible to even sign this effect unless it is assumed that the direct effect of changes in the current technology, which is purely a differential income effect, is necessarily dominated by the effect that operates through the expectations of future technology.

Second, and perhaps more importantly, as long as changes in technology in the marriage-market affect expectations about local future technology, it is not possible to identify the direct effects of marriage-market technology on the demand for exported human capital. This can be seen in the expression relating changes in average marriage-market technology on the sex differentials in a household's human-capital investments derived from (28):

$$(31)\qquad \frac{\partial h_s^{S**}}{\partial\bar{\theta}_t}-\frac{\partial h_d^{S**}}{\partial\bar{\theta}_t} = \left(\frac{\partial h_s^{S}}{\partial E\theta_{t+1i}}-\frac{\partial h_d^{S}}{\partial E\theta_{t+1i}}\right)\frac{\partial E\theta}{\partial\bar{\theta}_t}+\left(\frac{\partial h_s^{S}}{\partial Ep_{ht+1}}-\frac{\partial h_d^{S}}{\partial Ep_{ht+1}}\right)\frac{\partial Ep_{h2}^{**}}{\partial\bar{\theta}_t} - h_w\left[\frac{dh_s}{d\pi}-\frac{dh_d}{d\pi}\right]\frac{\partial p_{h1}^{**}}{\partial\bar{\theta}_t}$$

There are three terms. The first term reflects the fact that regional technology is used to form expectations about future local technology. Because higher future local technology favors sons, this term is positive. Higher current technology in the marriage market, however, is also associated with increased returns, via higher expected future human capital prices, to investing in daughters, as reflected in the second term. Expression (31) thus cannot be signed, although the finding of a negative effect of current changes in technology at the marriage-market level, conditional on current local agricultural technology, on the human capital differential would be consistent with the prediction of the model that increases in the marriage-market return to human capital increase investment in daughters relative to sons.[16] Similar complications arise in the interpretation of the effects of local and regional technology on maternal human capital demand.

We adopt the third approach, distinguishing empirically between actual and expected values of technology by exploiting the fact that in the agricultural sector the price of land at a given point in time reflects both current profitability (and thus current technology) and expectations about the stream of future profitability (and thus expectations about future technology). We assume that the price of land depends on current and expected period t+1 productivity[17] as well as time-invariant productivity characteristics of local land, ν_i,

(32) $$p_{Ati}=p_A(\theta_{ti},E\theta_{t+1i},\nu_i)=p_A^*(\theta_{ti},\bar{\theta}_{t+1},\zeta_i,\nu_i),$$

where $\frac{\partial p_A}{\partial \theta_{ti}}>0$ and $\frac{\partial p_A}{\partial E\theta_{t+1i}}>0$.[18] Key assumptions of this approach are that (i) land prices in locality i are not directly influenced by prices outside of i - spatial correlations in land prices reflect only spatial correlations in the determinants of p_{Ati} inclusive of the fact that individuals make use of market average technology levels in forming technological expectations; (ii) expectations of future local technology are determined by factors (ζ_t) other than current local and market technology, so that p_{Ati} and θ_{ti} are not perfectly correlated given $\bar{\theta}_i$; and (iii) expected productivity after t+1 can itself be written as a function of technology in t and expected productivity in t+1. By taking linear approximations aggregating to the marriage-market level, inverting with respect to $E\theta_{t+1i}$ and $E\bar{\theta}_{t+1}$, and substituting into (28) and (29) one obtains[19]

(33) $$h_{ki}^S=h_k^{S***}(\theta_{ti},\bar{\theta}_{ti},p_{Ati},\bar{p}_{Ati},\kappa_i,A_i,h_{hi},h_{wi},p_x,\bar{\theta}_{t-1},\bar{\kappa},\bar{A}_t,\bar{h}_{ht},\bar{h}_{wt},\bar{p}_{xt},\zeta_{t-1})$$

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[16]This is true even if the unsignable third term, which is an income effect associated with the fact that an increase in the first-stage technology increases the cost of the mother's human capital, is negligible.

[17]We formalize this notion in a particular example below.

[18]We assume that ν_i is measured. In the empirical implementation we will use village fixed effects to capture differences in time-persistent land qualities.

[19]As technological change had not taken place by the initial period of the data will drop the period-0 terms in the analysis. We therefore do not solve out the period t-1 term for notational simplicity.

(34) $$h_{wi}^{D} = h_{w}^{D***}(\theta_{ti}, \bar{\theta}_{i}, p_{Ati}, \bar{p}_{At}, \kappa_{i}, A_{i}, h_{hi}, p_{x}, \bar{\theta}_{t-1}, \bar{\kappa}, \bar{A}, \bar{h}_{h}, \bar{h}_{w}, \bar{p}_{x}, \zeta_{t-1})$$

The interpretation of the derivatives of the sex differential in human capital investment with respect to local and regional land prices in terms of expected technology is now straightforward. The effect of a change in the local land price, conditional on current local technology, the regional marriage-market land price and current technology, is given by

(35) $$\frac{\partial h_{s}^{S***}}{\partial p_{Ati}} - \frac{\partial h_{d}^{S***}}{\partial p_{Ati}} = \left(\frac{\partial h_{s}^{S}}{\partial \mathrm{E}\theta_{t+1i}} - \frac{\partial h_{d}^{S}}{\partial \mathrm{E}\theta_{t+1i}} \right) \frac{1}{\partial p_{A} / \partial \mathrm{E}\theta_{t+1i}}$$

In contrast to the effects of current local technology on differential human capital investment (30), the current own-land price effect, up to a positive multiplicative scalar, isolates the effects of future expected technology, which the model predicts is positive (equation (14)).

The effect of the marriage-market land price on the sex differential in human capital investments is somewhat more complex because both the current, first-stage human capital price, which affects income, and the expected second-stage human capital price, which affects the expected local returns to investing in daughters, reflect expectations about future technology. However, in contrast to (31), where direct marriage market effects were confounded with the effects of changes in broader-area technology on expectations of local technology, direct marriage-market effects are identified:

(36) $$\frac{\partial h_{s}^{S***}}{\partial \bar{p}_{At}} - \frac{\partial h_{d}^{S***}}{\partial \bar{p}_{At}} = \left[- h_{w} \left[\frac{dh_{s}}{d\pi} - \frac{dh_{d}}{d\pi}\right] \frac{\partial p_{h}^{*}}{\partial \mathrm{E}\bar{\theta}_{t+1}} + \left(\frac{\partial h_{s}^{S}}{\partial \mathrm{E}p_{ht+1}} - \frac{\partial h_{d}^{S}}{\partial \mathrm{E}p_{ht+1}} \right) \frac{d\mathrm{E}p_{ht+1}}{d\mathrm{E}\bar{\theta}_{t+1}} \right] \frac{1}{\partial p_{A} / \partial \mathrm{E}\theta_{t+1i}}$$

This expression contains only two terms, (i) a term reflecting the effects due to changes in first-stage income arising from changes in the current price paid for brides (current mothers) that result from changes in expected future technology, and (ii) the effect of changes in expected future technology in the marriage market on the expected price paid for exported daughters. Current and future effects of the marriage-market are combined because of the absence of direct information on period-specific human capital pricing. The overall effect can be signed, however, if the differential income effect is small because the second term is unambiguously negative - increases in expected technology in the destination areas of exported daughters raise the return to investments in girls relative to boys in the local area.

Similarly, in the maternal human capital equation the effect of variation in the local price of land

(37) $$\frac{\partial h_{w}^{D***}}{\partial p_{Ati}} = \frac{\partial h_{w}^{D}}{\partial \mathrm{E}\theta_{t+1i}} \frac{1}{\partial p_{A} / \partial \mathrm{E}\theta_{t+1i}}$$

is readily interpreted. An increase in the current local price of land, given current local technology and the technology level and the price of land in the marriage market, should be positively associated with the local demand for higher human-capital wives, as in equation (9), for three reasons: because maternal human capital may be more directly productive in high-technology areas, because locally-higher future technology raises incomes, and because the future returns to sons' human capital are increased.

As in (36) the effects of increases in the average price of land in the marriage-market on the local demand for the human capital of wives in period one, given local prices, also combines both current and future effects of the market prices of human capital:

$$\text{(38)} \qquad \frac{\partial h_w^{D***}}{\partial \bar{p}_{At}} = \left(\frac{\partial h_w^D}{\partial p_{ht}} \frac{\partial p_h^*}{\partial \mathrm{E}\bar{\theta}_{t+1}} + \frac{\partial h_w^D}{\partial \mathrm{E}p_{ht+1}} \frac{d\mathrm{E}p_{ht+1}}{d\mathrm{E}\bar{\theta}_{t+1}} \right) \frac{1}{\partial p_A / \partial \mathrm{E}\theta_{t+1i}}$$

In this case, however, current and future maternal human capital prices have opposite effects on demand. Expectations of future higher technology in the marriage market, as reflected in higher current land prices in that market, are associated with expectations of greater returns to local investments in girls and thus raise the demand for maternal human capital in the current period, as reflected in the second tem in equation (38). On the other hand, the higher expected return to both boys' and girls' human capital investments is reflected in higher current prices for human capital, which reduce demand, as indicated in the first term. In the absence of the sons' investment effect the period t price rise would only partially offset demand and maternal human capital would be increasing in average land price given average yields.

Finally, of less direct interest are the effects of current local and regional technology, given current local and regional land prices. These coefficients capture, in particular, whether the relative weights of current and future technology in the price of land equation are the same as those in the corresponding human capital equations. For example, the effect of changes in first-stage local technology on the sex differential in human capital investment is

$$\text{(39)} \qquad \frac{\partial h_s^{S***}}{\partial \theta_{ti}} - \frac{\partial h_d^{S***}}{\partial \theta_{ti}} = \left(\frac{\partial h_s^S}{\partial \theta_{ti}} - \frac{\partial h_d^S}{\partial \theta_{ti}} \right) - \left(\frac{\partial h_s^S}{\partial \mathrm{E}\theta_{t+1i}} - \frac{\partial h_d^S}{\partial \mathrm{E}\theta_{t+1i}} \right) \frac{\partial p_A / \partial \theta_{ti}}{\partial p_A / \partial \mathrm{E}\theta_{t+1i}}$$

This coefficient would be negative if the effect of current relative to expected future technology on land prices exceeded the effect of current relative to expected future technology on differential human capital investment. This term can also be informative about the presence of a differential income effect. As the second additive term is negative (inclusive of the minus sign), a positive effect of local technology on differential human capital investment suggests the presence of a positive differential income effect favoring boys.

4. Data

The model suggests that to identify whether and how economic growth affects economic incentives to invest in the human capital of boys and girls in the rural Indian context requires time-series data that provides information on mortality rates, land prices and land productivity and enables the construction of local and regional (marriage-market) variables. We use data from two national probability surveys of rural Indian households carried out in 1970-71, the National Council of Applied Economic Research (NCAER) Additional Rural Investment Survey (ARIS), and 1981-82, the NCAER Rural Economic Development Survey (REDS). Both surveys were of approximately 4500 households . The first was administered to households in 259 villages in 16 Indian states. The second survey was administered in the same villages, except for villages in the state of Assam. Each survey is meant to be representative of the entire rural population in the included set of states. The surveys elicited information on the demography of the households, inclusive of a complete birth and death history for children; the family size and sex preferences of mothers; the socioeconomic characteristics of all household members; aspects of production costs and returns, and village infrastructure.

The existence of comparable household surveys at two points in time separated by 11 years enables the construction of a panel data set at the lowest administrative level, the village, for 245 villages that can be used to assess the effects of the changing local and marriage market economic circumstances on household allocations and preferences. There are four other key features of the data: First, the first survey took place in the initial years of the Indian green revolution, when rates of agricultural productivity growth began to increase substantially in many areas of India, and contains a short panel covering the crop years. 1968-69 through 1970-71. Second, two-thirds of the households surveyed in 1981-82 were the same as those in 1970-71. This merged household panel, the original 1968-71 panel and information on profits, inputs and capital stocks were used by Behrman et al. (1999) based on methodology developed in Foster and Rosenzweig

(1996) to estimate rates of technical change for each of the villages between the two survey dates and between 1968 and 1971. Third, in each survey there is information provided on the prices of irrigated and unirrigated land, as well as information on crop prices, crop- and seed-specific output and planted area by land type that permit the construction of yield rates for high-yielding variety crops on the two types of land. Fourth, because the names of the villages are provided in the data along with their district and state affiliations and because of the spatially clustered sample design, it is possible to identify and construct variables characterizing regional marriage markets that, as the model suggests, may be critical determinants of sex differentials in human capital investments in the context of patrilocal exogamy and that are not based on arbitrary administrative boundaries.[20] An important limitation of the data sets, however, is that there is no information on the geographic origins of the married women in the sampled households so that it is not possible to use the data to directly assess the extent of patrilocal exogamy or the geographic scope of marriage markets. We use information from the PGIRCS, as described below, to construct marriage markets.[21]

Crop "technology" and land prices play a prominent role in our model. In addition to the measure of technology change obtained from the household panel data on profits, we characterized the level of crop technology in 1971 and 1982, by constructing village-specific yield rates for the high-yielding seed varieties of the four major green revolution crops - wheat, rice, corn and sorghum - on irrigated land. We aggregated the total output in each of the years for these crop/seeds using 1971 prices and sample weights and divided by the weighted sum of the irrigated area devoted to these crops for each village and survey year. The 1982 survey data provides information at the village level on the prices of irrigated and unirrigated land. The 1971 survey provides information on the value and quantity of owned land, by irrigation status, for each household. We constructed the village median price of irrigated land for 1971 from the weighted household-

[20]Another advantage of the data set over those constructed from district aggregates is that we can match the characteristics of children to their parents and, in general, respondents to their behavior. The matching of parents to children cannot be performed with aggregate census data.

[21]Another limitation is that there is no information on dowries. Such information could in principal be used to examine more directly the role of local and marriage-market technical change in affecting the equilibrium price for human capital in the marriage market.

level data, and deflated the 1982 village-level irrigated land prices to 1971 equivalents using the rural consumer price index.

The measures of the village-specific rates of technical change over the period 1971-82, the land price and yield data, and the household survey data aggregated at the village and marriage-market levels were used to form three panel data sets in order to estimate the determinants of changes in sex-differences in mortality, differences in rates of primary school completion of boys and girls and the demand for literate wives. We constructed village-level rates of mortality by sex at the two survey dates from the individual retrospective fertility/mortality histories for all children born no more than five years preceding each survey, to minimize recall error, by summing, using the appropriate survey-specific sampling weights, all the deaths and births in each of the five-year periods for each village. We then obtained for each village/year the mean differences in the preferred number of boys minus girls in the "ideal' family elicited from the mothers having any births in the five-year intervals and the mean schooling levels (literate or not, completed primary schooling or not) and mean wealth of the parents of those children.[22] The number of villages with at least one sample household having experienced one or more births in the preceding 5-year interval in the two survey years is 216.[23]

A fundamental assumption of our approach is that the sex differentials in child mortality reflect differentials in human capital investments that are in turn responsive to the returns to human capital. To supplement our analysis of mortality differentials we therefore also look at the determinants of another measure of human capital, schooling. In particular, we look at differentials in the completion rates of primary schooling by teen-agers. The completion of primary schooling by male farmers, but not higher levels of schooling, appears to have played an important role in facilitating both the adoption and more efficient use of the new seed varieties associated with the green revolution in India (Foster and Rosenzweig, 1995, 1996).

[22]Wealth includes the value of all assets, inclusive of houses, livestock, farm equipment, and financial assets. Although 90% of wealth is land wealth, wealth and land prices do not covary perfectly, enabling identification of distinct land price and wealth effects.

[23]The sample sizes reported are also smaller due to the lack of information on the location of some villages, as described below.

Most children complete primary school by age 15. Because girls tend to leave the household for marriage after age 14, we chose a sample of households with children aged 13 or 14 years of age and constructed the proportions of girls and boys in that age group who had completed primary schooling, again using sample weights. As for the mortality sample, we also constructed village -level aggregates of the schooling and wealth of the parents of the children in this age group.

The rationale for selecting the 13-14 year age group and the operation of patrilocal exogamy are seen in Figure 4, which shows, based on the 1971 sample, the sex ratio of resident children (daughters and sons) from ages eight through 19 and their primary school completion rates by sex and age. The figure indicates both the importance of patrilocal exogamy - the proportion of children who are girls falls substantially starting at age 15, from 46% at age 14 to 38% at age 15 to 22% at age 19 - and the relevant age of primary school completion - the proportion of boys who completed primary schooling remains roughly constant starting at age 14. The figure also shows that there is a substantial difference in primary school completion rates between boys (54% completed primary school) and girls (35% completed primary school) at age 13 and 14. However, that differential appears to be substantially lower after age 17. Assuming that women and men complete primary schooling at the same age, this increase by age in the schooling attainment of resident daughters indicates that there is substantial selectivity with respect to schooling associated with marital migration after that age. Evidently, less schooled girls marry at younger ages. Sex differentials in schooling for children above age 14 in a given village thus do not accurately reflect the schooling allocation decisions of the rural villagers. The figure thus illustrates one of the hazards of not being attentive to patrilocal exogamy in the study of sex-differentials in schooling investments in rural India. A cost of obtaining a more accurate measure of household allocations with respect to schooling, given the ages of primary school completion and of the departure of daughters, is a smaller sample size. The number of villages meeting the restriction that at least one sample household had to have a child in the relevant age group at both survey dates is 172.

As indicated by Figure 4, an analysis of the demand for the schooling of women over age 15 in Indian villages must look not at the schooling of the daughters of village residents but at that of imported daughters-in-law. To carry out the analysis of the local demand for schooled women a third village-level panel was constructed from the two household surveys containing information on the proportion of women who had married in the villages in the five year interval preceding each survey and who were literate, the proportion of their new husbands who had completed primary schooling and the mean wealth of the husbands' families. The number of villages in which at least one women had married within the five years preceding both survey dates is 168.[24]

Table 2 provides the means and standard deviations for the constructed village-level variables for the 1970-71 survey round and the mean change for each variable over the 1971-82 period. As can be seen, as observed from the Census-based sex-ratio data, the average death rate differential between boys and girls born in the period 1966-71 favored boys, and this differential worsened somewhat over the period 1971-82. Both the mortality differential favoring boys and its change over time are consistent with the level of and change in the sex preferences expressed by the surveyed mothers - on average mothers preferred to have a completed family size with slightly more than one half more boys than girls in 1970-71, and this differential also increased slightly, to .7, by 1982. In the same period, however, there was a substantial fall, by 65%, in the deficit in primary school completion rates among children aged 13-14, the rates of literacy among women who were new brides rose by over 80%, and the literacy rates of the mothers of the children more than tripled. Moreover, output per acre of HYV crops rose by 81% between the 1970-71 and 1981-82 crop years and the real price of irrigated land increased by a factor of 2.4 over the same period, suggesting that expectations of growth rose more than did real output. These descriptive statistics appear to suggest that sex differentials in mortality were much less sensitive to changes in the human capital of mothers and to growth (and expected growth) than were schooling differentials over the period. As we will see, however, these

[24]Sample size is reduced because in some villages there was no marriage in the last five years among the sampled households in one or both surveys. Note that we do not restrict the sample only to villages with households importing women, because, as noted, the data do not indicate origins of married women. It is possible, therefore that in some villages none of the sampled marriages involved a cross-village move. Information on which women did not come from outside the sampled village might be useful in assessing to what extent the relationship between the schooling of brides and characteristics of the regions is spurious.

aggregate statistics mask important relationships between economic growth and differential survival by sex.

5. Land Prices and Expected Future Yields

There are two empirical challenges posed by the theory in assessing the effects of growth on the human capital decisions of households. The first is to show that land price variation captures, in accordance with economic theory, variation in expectations about future productivity that are assumed to condition the current decisions of the forward-looking households. The second is to characterize the scope of marriage markets. In this section, we exploit the availability of data on yields and land prices at two points in times to directly assess to what extent the relationship between land prices, current yields and future yields conform to the assumptions incorporated in the model. In the next section we consider the marriage market.

In order to evaluate whether land prices incorporate information on expected technical change and to more precisely interpret the estimates of the coefficients on land price in the behavioral equations we estimate, it is necessary to be more specific about the relationship between expected future technology and land prices. In particular, assume that the growth rate of technology from time t forward is a constant random variable γ that is realized at time t+1 and that period t profitability is a product of technology and land quality ν_i, $\pi_{it}=\theta_{it}\nu_i$ Thus profitability at time t+1 is $\pi_{it+1}=(1+\gamma)\pi_{it}$ and the measured land price is

$$(40) \qquad p_{Ait}=\pi_{it}\ \omega_{it}\ E_t \sum_{\tau=0}^{\infty}(\frac{1+\gamma}{1+r})^{\tau}=\pi_{it}\ \omega_{it}\ E_t\ \frac{1}{1-(1+\gamma)/(1+r)}$$

where r is the discount rate and ω_{it} is a mean one random variable denoting the error with which land price is measured. Substituting the profit expressions into (40) and carrying out a first-order Taylor expansion in the logs of current and expected future profitability around the point $E_t\ln\pi_{it+1}=\ln\pi_{it}$, one obtains

$$(41) \qquad \ln p_{Ait}=\eta_0+(1-\frac{1}{r})\ln\pi_{it}+\frac{1}{r}\ E_t\ \ln\pi_{it+1}+\ln\omega_{it}$$

where η_0 is a constant.[25] This equation indicates that the effect of expected future profitability on current prices depends on the discount rate r. Because expected profitability is not observed directly, a more useful expression may be obtained by solving this equation with respect to expected profitability and noting that actual future log yields may be written as expected future log yields plus expectations error ξ_{it},

[25]Note that substituting the expression for profits and expected profits into (41) yields a linear approximation to (32).

$$(42) \qquad \ln\pi_{it+1} = \mathrm{E}_t\ln\pi_{it+1}+\xi_{it} = r\eta_0+rp_{Ait}+(1-r)\ln\pi_{it}-\ln\omega_{it}+\xi_{it} = \beta_0 + \beta_1 p_{Ait} + \beta_2\ln\pi_{it} + e_{it}$$

Although expectations error is, by definition, uncorrelated with information known at time t, inclusive of profitability and the land price, the land price is positively correlated with the measurement-error term, yielding classic measurement error bias. This problem may be addressed through instrumental variables. Any variables that predict future profitability given current profitability suffice as instruments.

Estimation of the β parameters of equation (42) provides testable restrictions (e.g., $\beta_1 + \beta_2 = 1$) and enables identification of both expected productivity and the discount rate r. We estimate (42) using data on land prices and HYV yields from the 1971 round of the data and "future" yields from the 1982 data. We instrument the log price of land in 1971 using the estimated village-level technical change measure for the interval 1968-71. In addition to this variable, we make use of the fact that the Indian government made a forecast "announcement" at the initial stages of the green revolution. In the late 1960's, two programs - the Intensive Agricultural District Program (IADP) and the Intensive Agricultural Advancement District Program (IAADP) - were introduced in selected districts, roughly one in each state. These programs were purposively placed in areas the government had identified as having substantial potential for agricultural productivity growth due to the newly-available high-yielding seed varieties. The programs were designed to provide more assured supplies of credit and fertilizer. As part of the ARIS sampling design, moreover, households residing in these program districts were oversampled (as reflected in the sample weights), so that roughly a third of the households (villages) are represented in each program area. We assume that the existence of these well-publicized programs affected positively farmer's expectations about future growth in addition to augmenting yields.

The first column of Table 3 reports the first-stage regression estimates of the log of the 1971 land price on the technical change estimate, on indicators for whether the village was located in either of the program districts, and on indicators of adverse weather in the villages in 1971 and 1982. The set of variables explains a statistically significant proportion of the variance in the log land price, with both measured actual technical change prior to 1971 and the IADP being positive and statistically significant predictors of the land price in 1971. The second and third columns report OLS and two-stage least squares (TSLS) estimates, respectively, of the relationship between the log of HYV crop yields in 1982 and the log of HYV crop-yields and land prices in 1971. In both columns 1982 yields are positively related to land prices lagged by 11 years. As expected, moreover, relative to the TSLS estimates the OLS estimates of β_1 are biased downward, due presumably to measurement error, although the TSLS land price coefficient is measured imprecisely. The TSLS point estimate, given (42) and the 11-year interval, however, indicate a plausible annual discount factor of 1/(1+r)^1/11 of .95. And in neither the OLS set of estimates nor in the TSLS set can the hypothesis be rejected that the log land price and log yield coefficients add to one, although this may in part be due to the imprecision of the lagged log yield estimate.

6. Characterizing the Marriage Market

A central implication of the model, given the presence of patrilocal exogamy and geographically determined marriage-markets, is that the relative return to sons and daughters should be differentially affected by local (i.e., village)[26] and regional (i.e., marriage-market specific) expectations of technical change, with expected local technical change increasing the expected relative return to sons and expected regional technical change increasing the expected relative return to daughters. Identification of economic growth effects on sex bias in human capital investments in the Indian context thus requires distinguishing between local and marriage market influences. To construct the marriage-market aggregates for our data, we geo-coded all of the survey villages by latitude and longitude based on the village names, their district-state affiliations, and detailed district-level maps.[27] A critical empirical issue, however, is the geographic span of the marriage market. Because the data sets we use do not provide information on the geographic origins of the married women in the sample, we used information from the PGIRCS household survey, which provides

[26]The assumption that "local" in our model coincides with the village is supported by the fact labor markets in rural India are largely restricted to the village. Rosenzweig (1988) reports, based on a survey of six villages in the semi-arid tropics of rural India, that over 85% of daily-labor earnings transactions accrue from inside the village and that the mean distance traveled for employment outside the village is 6.5 km. This is far below the average distance of a marital move based on the PGIRCS of over 36 km. Moreover, given high levels of on-farm employment the 85% figure substantially underestimates the share of total labor employed within the village.

[27]11 villages could not be located on maps. These are dropped from all of the village samples. Estimates excluding the marriage-market variables obtained using all of the villages and obtained using only geo-coded villages were not qualitatively or statistically different.

direct information on the distances associated with marital migration. As can be seen in Figure 2, in both of the states included in the sample at least 92% of the imported brides had come from villages within 67 kilometers of their origin villages. Based on this information pertaining to marriage migration and the geo-codes in our data set, we therefore encircled each of the 234 surveyed villages that we could locate using a radius of 67 kilometers to form a set of village groups that would share the same geographic marriage market. We then constructed aggregates of the technical change variable and the relevant variables characterizing the parents of the newly married and of young children from those households residing in the sampled villages within each of the radius-based marriage markets for the two survey years.[28]

Given the evidently limited breadth of the marriage market relative to the vast size of India, without spatially-clustered sampling it would be almost impossible to obtain reasonably reliable estimates of marriage market aggregates. Due to the cluster design of the survey, however, the average number of sample villages within each 67-kilometer marriage "market" is 3.79, corresponding to an average of over 50 households per marriage-market. Figure 5 displays the location of the sample villages, Indian district boundaries and, to scale, the 67 km-radius marriage market boundary.[29]

Correlations between the village variables and the radial-based marriage-market aggregates are high, as expected given the scope of the markets, but are not perfect. The correlations between the village and marriage-market aggregates for three of the key variables in the analysis - the change in land prices, the change in HYV yield growth, and the change in profits net of investment effects - are approximately .74, .75

[28]The choice of the 67-kilometer radius is obviously somewhat arbitrary. We assess below to what extent our results are sensitive to this choice and conform to the observed distributions of marital moves in the two-state survey. We do not, however, given the limited number of villages explore whether the extent of the marriage market varies across areas. Such variation, if random, would reduce the precision of our estimates. However, it is also possible that the scope of marriage markets is endogenously determined by the same forces altering the returns to human capital investments. Investigating these effects is beyond the scope of this paper, but of importance in understanding human capital formation and growth over a long time frame.

[29]Many studies based on Census data use administrative boundaries to form units of analysis. As can be seen from Figure 5, using radial distance rather than district boundaries yields a significantly different set of marriage markets for each village. Indeed, two or more districts are represented in almost 30% of the marriage markets defined by radial distance, and in over 30% of the districts there were at least two distinct distance-based marriage markets. In a previous version of this paper we show that using marriage-markets defined by the districts in which the villages are located leads to less precise results.

and .49, respectively. The existence of spatial autocorrelation of the key variables is the reason why inattention to the marriage market in the presence of patrilocal exogamy leads to incorrect inferences about growth effects based only on the relationship among locally-based variables, as indicated in equation (25).

We first examine the operation of the marriage market directly by estimating a linear approximation to equation (34) determining the equilibrium human capital of brides. The model suggests that if literate mothers contribute to the production of the human capital of sons, then there will be a higher current demand for literate wives in villages where agricultural technology is expected to be higher in the future. Moreover, given the short-run fixed supply of educated brides and as long as more educated local boys are more profitable where technical change is high, expected higher rates of technical change in the relevant marriage market will result in an equilibrium in which less educated brides are imported in the village, for given expectations of future growth in the village. However, this latter negative marriage market effect is offset somewhat because expected higher marriage market returns increase directly the demand for more educated brides in the local area because such they will also contribute to the more profitable export of more educated future daughters.

The equation we estimate is

$$
\begin{aligned}
h_{wit} = {} & \alpha_1\theta_{it} + \alpha_2 p_{Ait} + \alpha_3 A_{it} + \alpha_4 h_{hit} + \alpha_5 p_{xt} + \alpha_6 \mu_i + \alpha_7 \bar{\theta}_t + \alpha_8 \bar{p}_{Ait} + \alpha_9 \bar{A}_{it} \\
& + \alpha_{10}\bar{h}_{hit} + \alpha_{11}\bar{h}_{wit} + \alpha_{12}\bar{p}_{xit} + \alpha_{13}\bar{\mu}_i + \epsilon_{wit} + \bar{\epsilon}_{wit}
\end{aligned}
\tag{43}
$$

where the subscript t denotes time; the bars above variables denote that they are marriage-market aggregates, so that $\bar{A}_{it}$ measures the average asset in villages constituting the marriage-market for village i and so forth; μ_i captures unobserved culturally-determined aspects of the return to female on-farm employment (κ_i) and soil qualities (ν_i) that are time invariant; ϵ_{wit} denotes an i.i.d. mean-zero taste shock, and $\bar{\epsilon}_{wit}$ is the marriage-market average of these shocks.

Because maternal human capital affects investments in children who then remain on the farm (sons) or who are exported to other households in the marriage market (daughters), OLS estimation of (20) given the unobservability of the cultural variables will in general yield biased estimates of the coefficients. In addition, cross-sectional variation in land prices will reflect variations in permanent qualities of the soil, rather than just expectations of future changes in agricultural technology. These problem may be addressed in part by estimating (43) in cross-time differences:

$$\Delta h_{wit} = \alpha_1 \Delta\theta_{it} + \alpha_2 \Delta p_{Ait} + \alpha_3 \Delta A_{it} + \alpha_4 \Delta h_{hit} + \alpha_5 \Delta p_{xt} + \alpha_7 \Delta\bar{\theta}_t + \alpha_8 \Delta\bar{p}_{Ait} + \alpha_9 \Delta\bar{A}_{it} + \alpha_{10} \Delta\bar{h}_{hit} + \alpha_{11} \Delta\bar{h}_{wit} + \alpha_{12} \Delta\bar{p}_{xit} + \Delta\epsilon_{wit} + \Delta\bar{\epsilon}_{wit} \tag{44}$$

in which the fixed unobservables are swept out.

There are three additional problems, however. First, because an exogenous (say, taste-driven) shock to the demand for wives' human capital in period t will, given the model, result in, among other things a higher level of husband's human capital (because period t+1 husbands are the sons of the period t wives) and possibly higher levels of wealth if more educated wives work and are more productive, there will be a correlation between the differenced regressors in (44) and the differenced residual. To eliminate this correlation, we employ instrumental variables, using the initial values of the variables in (44), including the survey information on pre-1971inherited assets, which will be uncorrelated with the differenced residuals given the assumption of i.i.d. taste shocks, as instruments.[30]

A second estimation problem is that the model suggests that the residuals, containing aggregated taste shocks, will be spatially correlated within marriage markets. Moreover, to the extent that marriage markets overlap, there may be correlations across marriage markets. We divided the 234 geo-coded sample villages into 84 clusters in such a way that any two villages not in the same cluster are separated by more than 67 kilometers. Given the spatial clustering of villages and the resulting non-overlapping marriage market structure, standard errors are corrected for the presence of within-cluster error spatial correlations using the standard Huber-White procedure.

A third problem is that land prices, as noted, may measure expectations of future profitability with error. Moreover, expectations of future yields, and thus land prices, may reflect expectations about the future human capital of cultivators. Thus, contemporaneous shocks ε in the demand for schooled wives will be correlated with contemporaneous land prices. In addition, HYV yields on irrigated land measure θ with error,

[30]We use the information on inherited assets rather than the 1971 wealth level as an instrument because it is likely that wealth, as in most surveys, is measured with error. We assume that the correlation between the measurement error in the inherited wealth variable and the measurement error in the 1971-82 wealth change variable is substantially less than that between the error in the initial wealth level and the change in wealth.

in part because they incorporate input choice. We use instrumental-variables estimation to deal with these problems. We employ as instruments four technical change variables: the estimated change in profits net of investments at the village and marriage-market level over the two 1968-1971 and 1971-82 periods, based on the methods described in Foster and Rosenzweig (1996). Increases in exogenous profitability over the latter period, which corresponds to the period over which the land price change is measured, should have raised raise land prices where they occurred, net of current yields, to the extent that farmers forecast future profitability based on prior observed technology, as assumed in the model. For given technological advances over the 1971-82 period, however, an increase in technical change experienced in the prior period 1968-71 may have either a negative or positive effect on price change in the 1971-82, depending on how expected and actual growth after 1971 are related to pre-1971 growth.

In addition to these variables measuring technical change, we use the IADP and IAADP program variables. The results in Table 3 suggested that the existence of these well-publicized programs affected positively farmer's expectations about future growth. But as with the technical change variable for the pre-1971 period, the relationship between the presence of the program and the change in prices between 1971 and 1982 is unclear, depending on the relationship between early- and later-stage advances in crop productivity across the program and non-program areas.

The first column of Table 4 reports the first-stage estimates of the determinants of the change in the log of village-level land prices, which include as determinants the initial 1971 schooling variables, the inherited asset variables, and the technical change estimates at the village-level of aggregation and the two dummy variables indicating whether the village was located in a district with the one or the other of the two green revolution programs.[31] The set of these village-level and program variables is statistically significant at the .01 level.[32] As expected, moreover, real land prices increased significantly more in areas that experienced

[31]Tables A1 and A2 in the Appendix report the first-stage estimates for the HYV yield change, the change in husband's schooling, the change in maternal schooling, and the wealth change variables for villages and marriage markets, respectively.

[32]Note that measures of the local and marriage-market prices of human capital inputs other than maternal human capital which appear in the theoretical model (equations (33) and (34)) are excluded from the specifications reported in this and subsequent tables. Preliminary analysis included the presence of a

more rapid technical change over the survey interval, as measured by the estimates of profit change net of endogenous inputs.[33] The negative signs for the pre-1971 technical change and program variables suggests the presence of technological catch-up: farmers who did not benefit from the early stages of the green revolution in the pre-1971 period may have achieved or at least expected to achieve relatively high growth rates in the late 1970s and early 1980s as the seeds were adapted to a greater variety of local conditions.[34]

In the second column of Table 4, we add the marriage-market counterparts to the village-level variables. The coefficient on the marriage-market technical change variables are of particular interest, as they indicate to what extent farmers used information outside of their village in forming their expectations. The set of coefficients on the joint set of village- and marriage-market variables is statistically significant, and it is evident that the variables are highly collinear. The third column of Table 4 presents the estimates of the determinants of the marriage-market change in the log of land prices. In this specification, as expected, the marriage-market variables are statistically significant determinants of the land price changes at the marriage-market level.

Table 5 reports the fixed effects instrumental-variables (FE-IV) estimates of the determinants of the proportion of new brides - women married in the five years preceding the survey - who are literate as a function of the own village and marriage-market variables. The first column includes only the set of village variables - the village price of land, the proportion of grooms with primary schooling, and household wealth. As is conventionally found, there is positive assortative mating with respect to the schooling of mates, with a higher proportion of literate brides marrying in villages in which a higher proportion of grooms have completed primary schooling. However, contrary to the model, the expectation of future productivity gains,

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health clinic as a measure of this price, but the variable was never significant and was therefore dropped.

[33]Because the measures of technical change are based on estimated values and are thus imprecise, the t-ratios are inflated and the coefficients may be biased. These problems do not afflict the second-stage estimates based on the estimated instruments.

[34]ICAR (1978, 1985) discuss in detail the process of innovation in seeds and HYV adoption in India over the relevant period. An alternative but related explanation for this negative effect is that farmers benefitting from the new seeds in the late 1960s over-estimated the extent to which they would continue to realize relatively high growth rates in the 1970s.

as reflected in land prices is only marginally statistically related to the literacy rates of new brides. This is the result evidently of ignoring the full operation of the marriage market, and the spatial correlation of village and marriage market variables, as implied by equation (25). When the marriage market land price and current yield variables are added to the specification, the village land price coefficient increases by more than sixfold and becomes statistically significant. The village land price coefficient further increases when the variables characterizing the schooling of the competitor grooms in the marriage market and the wealth levels and parental schooling of households supplying brides to the market are additionally included in the third column.

The estimates in Table 5 thus indicate that, for given marriage-market conditions outside the village, higher expected future productivity in a village is associated with a higher demand for literate wives. Based on the estimated relationship between land prices and expected future yields estimated from Table 3, the point estimates suggest that a 2 percentage-point increase in the expected annual local growth would increase the proportion of literate brides by 27 points (74 percent).[35] However, as the model suggests, if the village is situated in a marriage market that also has a higher expected rate of technical change, that makes it more expensive to attract literate brides in the village.[36] Even if the expectation of the increase in productivity is

[35]A 2 percentage-point increase in expected annual growth increases expected yields over an 11 year period of .22. Multiplying by the inverse of the coefficient on land price in the final column of Table 3 (.718), this implies a 31 percent increase in land prices. Multiplying by the coefficient on land price in Table 5 (.892) yields .27.

[36]It is worth considering whether the negative sign on the regional price of land might be the result of some form of misspecification. Simple models of measurement error, however, do not yield this sign pattern because land price and regional land price are instrumented with measures of local and regional technical change. This removes measurement-error bias as long as measurement error in the variable and its instrument are not correlated, which seems quite plausible given that the land price data come directly from reported information on land value and area and the technology measure is derived from information on profitability. Input prices unavailable to us that might contaminate the technology measure, for example, will not influence the land price measure which is based on expected profitability from the perspective of farmers. Even if these measurement errors were correlated with each other, the usual assumption of independent measurement error across space would not produce a negative marriage-market effect unless land prices and technology were negatively spatially autocorrelated, which is clearly not the case. In order for the land price coefficients to exhibit opposite signs, the common component of the measurement error of these two variables must itself be spatially autocorrelated and that autocorrelation must be stronger than that for the systematic components of these measures.

uniform in the relevant market, the net effect of an increase in growth of this magnitude is to increase the demand for literate brides in the villages by 9 points (25 percent).

6. Determinants of Sex Bias: Mortality and Schooling

We employ a similar estimation procedure to estimate growth effects on sex biases in human capital investment and preferences using the marriage-market aggregates. The major difference in specification is that, as discussed above, we now condition on maternal literacy. As for the wives demand equation, differencing the linear approximation to the human capital supply for children of sex k, given by (33), across time periods removes fixed cultural attributes:

$$\begin{aligned}\Delta h_{kit} = {} & \beta_{1k}\Delta\theta_{it} + \beta_{2k}\Delta p_{Ait} + \beta_{3k}\Delta A_{it} + \beta_{4k}\Delta h_{hit} + \beta_{5k}\Delta p_{xt} + \beta_{6k}\Delta\bar{\theta}_{t} + \beta_{7k}\Delta\bar{p}_{At} + \beta_{8k}\Delta\bar{A}_{it} \\ & + \beta_{9k}\Delta\bar{h}_{hit} + \beta_{10k}\Delta\bar{h}_{wit} + \beta_{11k}\Delta\bar{p}_{xit} + \beta_{12k}\Delta h_{wit} + \Delta\epsilon_{kit} + \Delta\bar{\epsilon}_{kit}\end{aligned} \tag{45}$$

where Δh_{kit} is measured both (inversely) by the death rate of children of sex k in the five-year period preceding t and by the preferred number of children of sex k reported by mothers. The variables with bars are the relevant period-one marriage market variables in time-period t that forecast the demand for and supply of female human capital in the second period, including the average wealth and schooling attainments of the parents of children born in the past five years in the regional marriage market.

We also difference the human capital equations across children of opposite sex in order to obtain the effects of technical change and other variables on differences in human-capital investment by sex, in conformity to the theoretical expressions (35) and (36):

$$\begin{aligned}D\Delta h_{kit} = {} & D\beta_{1k}\Delta\theta_{it} + D\beta_{2k}\Delta p_{Ait} + D\beta_{3k}\Delta A_{it} + D\beta_{4k}\Delta h_{hit} + D\beta_{5k}\Delta p_{xt} + D\beta_{6k}\Delta\bar{\theta}_{At} + D\beta_{7k}\Delta\bar{p}_{At} + D\beta_{8k}\Delta\bar{A}_{it} \\ & + D\beta_{9k}\Delta\bar{h}_{hit} + D\beta_{10k}\Delta\bar{h}_{wit} + D\beta_{11k}\Delta\bar{p}_{xit} + D\beta_{12k}\Delta h_{wit} + D\Delta\epsilon_{kit} + D\Delta\bar{\epsilon}_{kit}\end{aligned} \tag{46}$$

where $D\beta_{1k}=\beta_{1s}-\beta_{1d}$ and so forth and $D\Delta h_{kit}$ is the over-time change in the mortality or schooling sex differential and the preferred difference in numbers of boys and girls. Note that by differencing across children by sex we also remove to a first-order the effects of changes in unmeasured factors that influence total family size and thus, indirectly, the overall level of mortality. In particular, because parents cannot determine *ex ante* the sex of a particular child, variables such as contraceptive availability, fecundity, or tastes for children that influence mortality by affecting the timing of a particular birth and which are both unmeasured and may vary over time should, to first order, have the same impact on the probability of death regardless of the sex of the child. Differencing by sex removes the confounding effects of these fertility-related factors.[37]

As for the marriage equation, period-t shocks to human capital supply will in general be correlated with the right-hand-side time-differenced human capital measures and other time-differenced state variables and initial period state variables can serve as instruments for the over-time differenced variables. However, wives' human capital in period t is not a legitimate instrument for differenced wives' human capital because the shocks to maternal human capital demand at the level of the village (ϵ_{wit}) and marriage market ($\bar{\epsilon}_{wit}$) and those from child human capital supply ($D\epsilon_{kit}$ and $D\bar{\epsilon}_{kit}$, respectively) will be correlated. For example, early period shocks that affect human capital investment in female children will be manifested in the change in the stocks of capital of young mothers in the marriage markets over the 11-year interval of the data. In this case, the values of θ in the village and the regional marriage market at the time when the mothers in periods t and t+1 were married are legitimate instruments because the demand for wives' human capital at a particular point in time is affected by the local and regional technology levels to the extent that they influence expected rates of technological progress at that time. Lagged technology shocks in the village and in the marriage markets thus affect the human capital of mothers but do not have a direct effect on current human capital investments given the current local and marriage-market expectations of future technology, as indicated by values of p_A and $\bar{p}_A$.

Table 6 presents the estimates of the determinants of the difference (boys minus girls) in the sex-specific mortality of children born in the last five years prior to the survey date. We first report in column one estimates based only on the 1971 cross-section and that exclude the marriage-market variables. The specification thus ignores both the existence of unmeasured, area-specific cultural factors and exogamy, as in many of the studies of Indian sex-specific survival rates. These cross-sectional results with respect to differential mortality rates indicate favoratism to girls in villages with high land prices and where mothers are more likely to be literate. The first result appears contrary to the model, which suggests that boys would be favored where agricultural technology in the future is expected to be more advanced; the second result.

[37]The post-birth fertility interval may also affect mortality, and this may be influenced by the gender of the child born.

However, these findings may reflect difference across areas in preferences (κ) and in soil properties. For example, in 1971 Kerala, the state with the least bias toward girls, as seen in Figure 1, had the second-highest land price and the highest rates of female literacy, both of which have been marked characteristics of this state for many decades.

The second column presents results based on the FE procedure with instruments but again ignoring the effects of marriage-market characteristics. While these estimates yield a statistically significant effect of maternal literacy on differential mortality favoring girls, there appears to be little evidence of an effect of expected future technical change, as indicated by land prices, on the mortality differentials, and thus no evidence that mortality differentials by sex respond to economic growth.

If, however, as predicted by the model, local and regional-specific technical change have opposite effects on sex differences in mortality and if, as seems plausible, technical change is spatially autocorrelated, then one might expect based on (25) that estimates that do not control for technical change in the relevant marriage market would bias towards zero the estimates of technical change effects at the local level. Moreover, to that extent that literate mothers are imported from the marriage market, their characteristics will be correlated with conditions in the marriage markets. This is confirmed by the results in column 3. With land prices and yield rates for both the village and the marriage-market included in the specification, consistent both with exogamy and with the responsiveness of human capital investments to investment returns, the estimate of the effect of the local land price on the mortality differential is negative and statistically significant and the estimate of the effect of changes in land prices occurring in the marriage market on the local differential is positive and statistically significant. Moreover, inclusion of the marriage-market land price cuts by over 80% the estimate of the effect of maternal literacy.

The estimated effects of marriage-market specific technical change might be biased, given the model, if marriage-market conditions other than land prices and yields are correlated with local land prices and influence differential mortality. Indeed, when these characteristics are also included (column 4), the absolute values of the effects of land price variation are larger, particularly for the marriage-market land price coefficient. The point estimates in column 4 indicate that an exogenous 2 percentage-point increase in expected annual local growth, which would increase the current land prices by 31 percent, results in a 12.7 point drop in male relative to female child mortality, while a similar increase in expected growth in the marriage market results in a relative decrease in female mortality of 13.3 points. Resource allocations by parents to girls and boys appear to respond to growth prospects, and a uniform increase in expected future growth induced by agricultural technical change actually appears to favor girls slightly, although the difference is not statistically significant.

Several other aspects of the preferred specification (column 4) are also of note. As might be expected given that other villagers in the marriage market are, in effect, competitors in the supply of human capital, the effects of the other included variables on mortality differentials at the local and regional level, are of opposite signs, although in most cases the estimates are not significantly different from zero. In particular, consistent with the cross-sectional evidence from the literature (e.g., Drèze and Sen 1998) there appear to be no effects of wealth on differential mortality. The lack of importance of income effects evidently provides a misleading picture of the responsiveness of human capital investments in girls and boys to income growth fueled by technical change. Economic growth evidently can reduce the number of missing women - depending on where it occurs - even in the absence of changes in cultural institutions and even when household gender bias is insensitive to income variation.

Finally, to assess whether the 67-kilometer radial boundary is appropriate, as suggested by the PGIRCS, we add to the fourth-column specification the log land price and log of the current yield variables aggregated using radii of 314 kilometers and 1000 kilometers, respectively. Accordingly we also add to the instrument set the technical change measures for these expanded market areas. The estimates for this specification are reported in the last column of Table 6. As can be seen, neither of the log land price coefficients for the distances beyond 67 kilometers are statistically significant (they are also not jointly significant), and their magnitudes are substantially below that of the land price computed for the marriage market defined by the 67-kilometer radius. Moreover, the inclusion of these variables does not alter significantly any of the other coefficients relative to their magnitudes in the specification in which these variables are excluded, although the precision of the 67-kilometer log price coefficient is reduced.

An alternative explanation for the estimates in Table 6 is that rather than capturing differential incentives for sex-specific investments they merely reflect the demand for overall health care and changes in the level of health care which might, given different prevailing rates of mortality by sex, differentially affect survival of male and female children. Table 7 presents the same specifications replacing the mortality differential by the reported family-size preferences by sex. The estimates of local and marriage-market land price effects mirror those arising from the mortality data, consistent with the hypothesis that the mortality differences at least in part reflect sex preferences and not only biological influences.[38] In particular, without controls for either fixed factors that may influence land prices and/or marriage-market specific changes in land prices and yields there is an insignificant effect of the village-level land price on sex-composition preferences. Again, however, when both local and regional land prices are included (column 3) they are both significant, and opposite in sign from the corresponding coefficients in Table 6. These results are also robust to the inclusion of the characteristics of the households in the marriage market and to the expansion of the bounds of the marriage market. The lack of significance of the land price coefficients in areas beyond 67 kilometers again suggests that the grouping of villages into clusters based on the 67-kilometer radius criterion provides a reasonable approximation to the relevant set of marriage-markets for the survey data.

In the preferred specification which includes marriage-market aggregates of all the included village-level right-hand side variables, the land price point estimates, in conjunction with those in Table 3, indicate that an exogenous 2 percentage-point growth in expected annual local growth results in a .77 increase in the preferred "deficit" of girls. The same change, expected to occur in the areas to which girls are exported, results in a .70 decrease in the deficit.

Finally, our basic approach views mortality rate differentials as reflecting underlying differentials in human capital investments. The model thus is relevant as w ell to other indicators of such investments. Table 8 reports estimates using the same specifications of the determinants of differences in completion rates of primary schooling among boys and girls aged 13 and 14. The patterns are similar to those of Tables 6 and 7.

[38]Of course, the preferences expressed by the mothers may in part reflect, and rationalize, their experience of mortality, so the measures are not entirely independent.

First, the cross-sectional estimates, reported in column one, indicate that maternal literacy favors the school completion rates of girls and there is no effect of wealth. In addition, the schooling of fathers appears to favor the school completion rate of boys. When fixed, area-specific cultural and other influences are removed (column 2), however, the maternal literacy effect disappears, although not the father's schooling effect. Inclusion of the full set of marriage-market variables (column 4) again indicates that schooling investments favors boys when prospects for agricultural growth are locally higher, as indicated by higher village land prices, but favor girls when growth prospects improve outside the village in the marriage-market area, but not beyond (column 5). Although the marriage-market land price effect is estimated in the preferred specification (column 4) with somewhat less precision than it is for mortality differences and for the sex-preference variable, the magnitude of the coefficient is similar to the local effect in absolute value, as for those dependent variables. Sex-specific differences in human capital investments, whether measured by mortality or schooling, and sex preferences thus all appear to be related to expectations of sex-specific rewards to such investments that are induced by growth.

6. Conclusion

While there is general agreement that sex differences in child survival in South Asia are related to the perceived economic value of girl and of boy children, there is little consensus about the underlying sources of variation in these values as well as the potential for economic and policy change that might reduce excess female mortality. The results of this paper address two significant aspects of this debate: whether household gender bias and the relative survival rates of boys and girls are responsive to economic returns and the extent to which sex differentials in mortality can be influenced by income growth without radical alteration of social institutions.

Because most of the literature on sex differentials in mortality in India has made use of cross-sectional data, it has tended to emphasize the importance of relatively unchanging and perhaps unchangeable attributes of different regions of India. Regardless of whether the characteristics of interest are modes of agricultural production (Bardhan, 1974) or cultural mores such as those arising from kin intermarriage (Dyson and Moore) this perspective, combined with weak cross-sectional relationships between income and sex-specific survival rates, has led to policy prescriptions that are pessimistic about growth-promoting initiatives compared with effecting direct social change as the best means of reducing gender differentials in investments. Our results based on panel data covering the initial years of the Indian green revolution, which are consistent with the cross-sectional findings on the weakness of income effects, however, provide support for the proposition that increases in productivity arising from technical change without radical alterations in cultural institutions can significantly affect differentials in mortality through their effects on the returns to human capital investments.

In addition to providing support for the general hypothesis that sex-differentials in mortality are sensitive to returns to human capital, our results show the importance of accounting for institutional details in the analysis of sex differentials in mortality. Indeed, we used the attributes of one major cultural institution in India, exogamous marriage, within a general equilibrium framework, to aid in the identification of the effects of technical change on sex-specific household preferences and investments. Consistent with this, and interactions between agricultural technology and human capital returns, we found evidence that (i) high human capital women tend to be in demand within areas in which agricultural productivity is expected to be higher in the future, as indicated by elevated land prices conditional on current yield rates, and (ii) relative preference for female children, the relative survival of female children, and their primary school completion rates relative to boys increase when increases in agricultural productivity are anticipated in the marriage-market destination areas for girls. By contrast, expected local technical change tends to favor sons. Because in this context the local and regional technical change effects are offsetting and technical change is spatially autocorrelated, an analysis that did not distinguish between local and regional effects that arise from marriage-related migration might incorrectly conclude that mortality differentials are only weakly affected by changes in economic returns arising from economic growth.

The pattern of results relating expectations of agricultural productivity advances by region, as signaled by changes in land prices, to sex preference, mortality and schooling differentials, and the demand for wives' human capital, also suggests that, at least at the margin, marriage markets operate sufficiently well to reward parents for investment in their daughters if there are returns to those investments in the economy.

The migration of daughters from their parental homes is not the root cause of gender differences in parental investments as many have suggested. This result may have additional implications for social policy. In the absence of such marriage-market rewards, attempts to redistribute resources such as with legislation requiring daughters to provide support for their parents as discussed, for example, in DasGupta (1987) may have the desired effect of reducing female mortality. On the other, hand, if marriage markets operate efficiently and price returns appropriately, intergenerational redistributive policies will have little effect on parental investments in girls. The evidence in this paper that parents' decisions about the allocation of scarce resources toward their daughters are importantly responsive to expected economic conditions in the relevant marriage market support the latter view. While our results suggest that spatially-uniform growth induced solely by agricultural technical change would not on net alter sex differentials in mortality, they point to the potential effectiveness of changes in policy that augment economic growth and increase the overall economic value of women's human capital in reducing the number of "missing" Indian women.

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Table 1
Ratio of Rural Migrants to the Rural Population Aged 15+,
by Extent of Migration, Sex and Location: 1981 Indian Census

	All India	NCAER Survey Districts (100)		
Sex group	Total	Total	Northern	Southern
		Migration from Village		
Men	.176	.174	.134	.226
Women	.685	.667	.718	.610
		Migration Across Districts		
Men	.055	.052	.045	.079
Women	.160	.147	.173	.116

Table 2
Population and Village Characteristics in 1970-71 and Change 1971-82

	1970-71	Change: 1971-82
Mean boy-girl difference in death rates, children ages 0-4	-.0146	-.0161
	(.111)[a]	(.975)
Mean number of preferred boys - preferred girls in ideal family reported by mothers age 15-50	.531	.161
	(.898)	(.975)
Mean boy-girl difference in proportions completing primary school, age 13-14	.294	-.192
	(.486)	(.665)
Percent of new brides in last five years literate	18.5	15.0
	(31.1)	(41.7)
Laspeyres-weighted HYV output per irrigated acre	320.9	259.1
	(284.8)	(415.8)
Price of irrigated land per acre, 1971 rupees	4404	10726
	(3581)	(9604)
Percent of new grooms in last five years completed primary school	21.2	28.5
	(32.9)	(41.6)
Percent of mothers 15-50 literate	11.2	25.6
	(18.3)	(34.5)
Percent of husbands of mothers completed primary school	23.4	25.9
	(22.6)	(35.5)

[a]Standard deviation in parentheses.

Table 3
Do Land Prices Predict Future Crop Yields?
1971 (Log) Land Prices and 1982 (Log) Crop Yields

Variable	Log of 1971 Land Price	Log of 1982 HYV Crop Yield	
Estimation procedure	OLS	OLS	2SLS
Log of 1971 land price	-	.232 (3.08)	.718 (1.71)
Log of 1971 HYV yield	-	.0718 (0.81)	-.119 (0.57)
Estimated change in real profits yield net of investments, 1968-71 ($x10^{-3}$)	.0318 (2.08)	-	-
IADP	.747 (3.38)	-	-
IAADP	.150 (0.86)	-	-
Adverse weather in 1971	-.0124 (0.04)	.204 (1.57)	.0385 (0.15)
Adverse weather in 1982	.159 (0.59)	.110 (0.95)	.171 (0.94)
Constant	7.92 (61.5)	3.79 (6.21)	.860 (0.35)
R^2	.074	.120	-
F (d.f.,d.f.)	3.15 (5,230)	5.92 (4,231)	2.62 (4,231)
N	236	236	236

[a]Absolute value of t-statistic in parentheses.

Table 4
OLS First-Stage Equations:
Determinants of the Change in the Log of Village and Marriage-Market Land Prices, 1971-82

Variable	Change in Log of Village Land Price		Change in Log of Marriage-Market Land Price
Estimated change in real profits yield net of investments, 1971-82 - village	.0198 (2.60)[a]	.0117 (1.75)	.00314 (1.13)
Estimated change in real profits yield net of investments, 1971-82 - marriage market	-	.0169 (1.10)	.0239 (2.04)
Estimated change in real profits yield net of investments, 1968-71 - village ($x10^{-3}$)	-.0198 (2.28)	-.00640 (0.80)	-.00560 (2.07)
Estimated change in real profits yield net of investments, 1971-82 - marriage-market ($x10^{-3}$)	-	-.0488 (1.47)	-.0609 (2.02)
Intensive Agricultural District Program (IADP) in district in 1968	-.586 (2.35)	-.629 (2.45)	-.451 (3.52)
Intensive Agricultural Assistance Development Program (IAADP) in district in 1968	-.166 (0.90)	-.181 (0.92)	-.0313 (0.33)
Irrigated land inherited prior to 1971 - village ($x10^{-3}$)	.544 (0.64)	.194 (0.32)	.160 (0.49)
Irrigated land inherited prior to 1971 - marriage market ($x10^{-3}$)	-	1.54 (1.01)	.950 (0.72)
Unirrigated land inherited prior to 1971 - village ($x10^{-3}$)	.383 (0.87)	.427 (1.43)	.212 (1.77)
Unirrigated land inherited prior to 1971 - marriage market ($x10^{-3}$)	-	-.287 (0.46)	.118 (0.25)
Proportion married women literate in 1971 - village	.0902 (0.29)	.309 (0.65)	.137 (0.84)
Proportion married women literate in 1971 - marriage market	-	-.0718 (0.12)	-.0445 (0.09)
Proportion married men with primary schooling in 1971 - village	.184 (0.56)	.442 (1.13)	-.110 (1.44)
Proportion married men with primary schooling in 1971 - marriage market	-	-.772 (1.33)	-.0841 (0.29)
N	448	448	448
F (df,df)	4.00(8,80)	2.67(15,80)	3.83(15,80)
R^2	.123	.166	.201

[a]Absolute value of t-statistic in parentheses.

Table 5
FE-IV Estimates: Determinants of the Proportion of New Brides Who Are Literate

Variable	(1)	(2)	(3)
Log of land price - village[b]	.125 (1.56)	.796 (2.36)	.892 (2.12)
Mean log of land price - marriage market[b]	-	-.624 (2.11)	-.593 (1.56)
Mean log of yield - village[b]	.0103 (0.13)	.00205 (0.12)	.0853 (0.40)
Mean log of yield - marriage market[b]		-.0550 (0.22)	-.199 (0.65)
Proportion of grooms with primary schooling - village[b]	.286 (2.46)	.276 (1.66)	.367 (1.25)
Proportion of grooms with primary schooling - marriage market[b]	-	-	-.236 (0.52)
Mean household wealth ($x10^{-5}$) - village[b]	-.0634 (0.66)	-.140 (0.92)	-.132 (0.66)
Mean household wealth ($x10^{-6}$) - marriage market[b]	-	-	-.241 (1.00)
Proportion of bride mothers literate - marriage market[b]	-	-	.386 (0.63)
Proportion of bride fathers who completed primary school - marriage market	-	-	-.186 (0.76)
N	336	336	336

[a]Absolute values of t-ratios in parentheses corrected for marriage-market common error.
[b]Endogenous variable

Table 6
Determinants of the Difference in Mortality Rates of Boys and Girls:
Children Aged 0-4

Variable/Estimation procedure	OLS: 1971	FE-IV: 1971-82	FE-IV: 1971-82	FE-IV: 1971-82	FE-IV: 1971-82
Log of land price - village[b]	.0944 (1.82)[a]	.00238 (0.08)	-.373 (2.37)	-.415 (2.41)	-.407 (2.34)
Mean log of land price - marriage market (Radius=67Km)[b]	-	-	.343 (2.09)	.434 (2.20)	.482 (2.49)
Mean log of land price - marriage market (Radius>67, <314Km)[b]	-	-	-	-	-.343 (1.08)
Mean log of land price - marriage market (Radius>314, <1000Km)[b]	-	-	-	-	.304 (1.15)
Mean log of yield - village[b]	-.0292 (1.60)	-.0105 (0.36)	.00794 (0.08)	.0364 (0.32)	.0336 (0.30)
Mean log of yield - marriage market[b]	-	-	-.0115 (0.10)	-.0466 (0.36)	-.0667 (0.54)
Mean household wealth ($x10^{-5}$) - village[b]	-.0838 (1.48)	.00740 (0.10)	.104 (0.98)	.197 (1.21)	.252 (1.33)
Mean household wealth ($x10^{-6}$) - marriage market[b]	-	-	-	-.247 (1.04)	-.309 (1.00)
Proportion mothers literate - village[b]	.0918 (1.94)	.181 (2.79)	.0418 (0.38)	.0312 (0.22)	.0273 (0.19)
Proportion mothers literate - marriage market[b]	-	-	-	-.0169 (0.11)	-.0282 (0.15)
Proportion of fathers who completed primary school - village[b]	-.0354 (0.41)	-.00706 (0.10)	-.0523 (0.64)	.00011 (0.01)	.0168 (0.15)
Proportion of fathers who completed primary school - marriage market[b]	-	-	-	-.144 (1.13)	-.165 (1.05)
N	216	432	432	432	432

[a]Absolute values of t-ratios in parentheses corr

ected for marriage-market common error.
[b]Endogenous variable.

Table 7
Determinants of the Difference in the Mother's Preferred Number of Surviving Boys and Girls

Variable/Estimation procedure	OLS: 1971	FE-IV: 1971-82	FE-IV: 1971-82	FE-IV: 1971-82	FE-IV: 1971-82
Log of land price - village[b]	-.483 (1.12)[a]	.290 (1.64)	2.34 (2.36)	2.51 (2.45)	2.23 (2.11)
Mean log of land price - marriage market (Radius=67Km)[b]	-	-	-1.95 (1.93)	-2.27 (1.91)	-1.84 (1.39)
Mean log of land price - marriage market (Radius>67, <314Km)[b]	-	-	-	-	-.878 (0.47)
Mean log of land price - marriage market (Radius>314, <1000Km)[b]	-	-	-	-	.915 (0.59)
Mean log of yield - village[b]	.0757 (0.59)	-.286 (1.65)	.0522 (0.05)	.158 (0.15)	.0954 (0.09)
Mean log of yield - marriage market[b]	-	-	-.421 (0.35)	-.495 (0.38)	-.444 (0.37)
Mean household wealth ($x10^{-5}$) - village[b]	.862 (1.76)	-.273 (0.45)	-.683 (0.83)	-1.12 (0.94)	-.788 (0.60)
Mean household wealth ($x10^{-6}$) - marriage market[b]	-	-	-	.885 (0.53)	.288 (0.16)
Proportion mothers literate - village[b]	.156 (0.32)	-.149 (0.18)	.125 (0.14)	.194 (0.19)	.0289 (0.03)
Proportion mothers literate - marriage market[b]	-	-	-	.0660 (0.87)	-.515 (0.56)
Proportion of fathers who completed primary school - village[b]	.0379 (0.61)	.445 (0.85)	.563 (1.03)	.729 (1.19)	.741 (1.18)
Proportion of fathers who completed primary school - marriage market[b]	-	-	-	-.174 (0.29)	-.0311 (0.05)
N	215	330	330	330	330

[a]Absolute values of t-ratios in parentheses corrected for marriage-market common error.
[b]Endogenous variable.

Table 8
Determinants of the Difference in Primary School Completion Rates of Boys and Girls: Children Aged 13-14

Variable/Estimation procedure	OLS: 1971	FE-IV: 1971-82	FE-IV: 1971-82	FE-IV: 1971-82	FE-IV: 1971-82
Log of land price - village[b]	-.161 (0.66)[a]	.183 (1.24)	.735 (1.88)	.888 (2.20)	.902 (2.21)
Mean log of land price - marriage market (Radius=67Km)[b]	-	-	-.595 (1.46)	-.808 (1.86)	-.606 (1.24)
Mean log of land price - marriage market (Radius>67, <314Km)[b]	-	-	-	-	-.655 (0.85)
Mean log of land price - marriage market (Radius>314, <1000Km)[b]	-	-	-	-	.195 (0.29)
Mean log of yield - village[b]	.0146 (0.17)	-.144 (1.45)	-.133 (0.51)	-.113 (0.43)	-.0227 (0.08)
Mean log of yield - marriage market[b]			.0460 (0.13)	.0500 (0.16)	-.0334 (0.09)
Mean household wealth ($x10^{-5}$) - village[b]	.156 (0.41)	-.502 (1.24)	-.533 (1.28)	-1.18 (1.63)	-1.15 (1.55)
Mean household wealth ($x10^{-6}$) - marriage market[b]	-	-	-	.770 (1.05)	1.36 (1.74)
Proportion mothers literate - village[b]	-.466 (2.38)[a]	-.196 (0.71)	-.132 (0.31)	-.281 (0.37)	-.278 (0.34)
Proportion mothers literate - marriage market[b]	-	-	-	.375 (0.33)	.698 (0.59)
Proportion of fathers who completed primary school - village[b]	.654 (5.04)	.573 (3.61)	.485 (2.29)	.653 (2.06)	.754 (2.10)
Proportion of fathers who completed primary school - marriage market[b]	-	-	-	-.299 (0.58)	-.590 (1.04)
N	172	344	344	344	344

[a]Absolute values of t-ratios in parentheses corrected for marriage-market common error.
[b]Endogenous variable

Table A1
OLS First-Stage Equations: Determinants of the Change in the Village-Level Mean Log of HYV Yields, Literacy Rate of Mothers, Primary Schooling Rate of Fathers, Mean Wealth, 1971-82

Variable	Mean Log of HYV Yields	Mean Wealth	Maternal Literacy Rate	Father's Primary Schooling
Estimated change in real profits yield net of investments, 1971-82 - village	.0118 (0.83)	1742 (2.34)	.0105 (1.36)	.00374 (0.48)
Estimated change in real profits yield net of investments, 1971-82 - marriage market	.0733 (3.13)	-34.4 (0.05)	.00139 (0.23)	-.00748 (1.07)
Estimated change in real profits yield net of investments, 1968-71 - village ($x10^{-3}$)	.0221 (1.05)	-503 (1.17)	-.0181 (5.08)	.0186 (2.32)
Estimated change in real profits yield net of investments, 1971-82 - marriage-market ($x10^{-3}$)	.0262 (0.39)	-2581 (1.52)	.0152 (1.45)	-.0484 (3.82)
Intensive Agricultural District Program (IADP) in district in 1968	.132 (0.38)	-2515 (0.24)	.0769 (1.04)	.0262 (0.32)
Intensive Agricultural Assistance Development Program (IAADP) in district in 1968	.255 (1.52)	-969 (0.11)	-.0314 (0.53)	-.0352 (0.48)
Irrigated land inherited prior to 1971 - village ($x10^{-3}$)	.0279 (0.04)	-.703 (0.30)	-.246 (0.85)	-.145 (0.44)
Irrigated land inherited prior to 1971 - marriage market ($x10^{-3}$)	-2.42 (2.22)	144.7 (2.69)	-.0807 (0.13)	.124 (0.23)
Unirrigated land inherited prior to 1971 - village ($x10^{-3}$)	.286 (0.69)	23.1 (1.64)	-.449 (2.21)	-.193 (1.01)
Unirrigated land inherited prior to 1971 - marriage market ($x10^{-3}$)	.405 (0.64)	-47.5 (1.78)	.00830 (0.02)	-.380 (1.12)
Proportion married women literate in 1971 - village	-.690 (1.20)	-9221 (0.28)	-1.05 (2.77)	.116 (0.56)
Proportion married women literate in 1971 - marriage market	.536 (0.78)	-4404 (0.13)	.647 (1.60)	.0255 (0.10)
Proportion married men with primary schooling in 1971 - village	-.0673 (0.22)	21387 (0.79)	.171 (1.20)	-.554 (4.26)
Proportion married men with primary schooling in 1971 - marriage market	-.638 (0.62)	-49431 (1.33)	-.108 (0.50)	-.102 (0.54)
N				
F (15,80)	3.46	2.78	5.74	4.57
R^2	.254	.172	.211	.222

[a]Absolute value of t-statistic in parentheses.

Table A2
OLS First-Stage Equations: Determinants of the Change in the Marriage-Market-Level Mean Log of HYV Yields, Literacy Rate of Mothers, Primary Schooling Rate of Fathers, Mean Wealth, 1971-82

Variable	Mean Log of HYV Yields	Mean Wealth	Maternal Literacy Rate	Father's Primary Schooling
Estimated change in real profits yield net of investments, 1971-82 - village	.000009 (0.01)	79.8 (0.38)	.00783 (2.37)	.00338 (1.44)
Estimated change in real profits yield net of investments, 1971-82 - marriage market	.0818 (3.46)	132.7 (0.38)	.00116 (0.27)	-.00784 (1.92)
Estimated change in real profits yield net of investments, 1968-71 - village ($x10^{-3}$)	.00151 (0.25)	-40.8 (0.37)	-.00136 (1.06)	-.00206 (1.82)
Estimated change in real profits yield net of investments, 1971-82 - marriage-market ($x10^{-3}$)	.0258 (0.45)	-118.9 (1.54)	-.00523 (0.58)	-2.29 (2.13)
Intensive Agricultural District Program (IADP) in district in 1968	.0746 (0.25)	-14338 (3.10)	.0814 (1.24)	-.00784 (0.10)
Intensive Agricultural Assistance Development Program (IAADP) in district in 1968	.141 (0.98)	5165 (1.57)	.0399 (0.71)	-.0350 (0.75)
Irrigated land inherited prior to 1971 - village ($x10^{-3}$)	.355 (0.61)	3519 (0.47)	-.321 (2.12)	-.218 (1.24)
Irrigated land inherited prior to 1971 - marriage market ($x10^{-3}$)	-2.39 (2.48)	129290 (3.51)	-.0363 (0.09)	.205 (0.57)
Unirrigated land inherited prior to 1971 - village ($x10^{-3}$)	.178 (0.81)	6199 (1.37)	-.00022 (0.01)	.00322 (0.04)
Unirrigated land inherited prior to 1971 - marriage market ($x10^{-3}$)	.588 (1.01)	-14826 (0.99)	-.312 (1.06)	-.476 (1.89)
Proportion married women literate in 1971 - village	.0471 (0.25)	-3136 (0.67)	-.0416 (0.78)	.00436 (0.08)
Proportion married women literate in 1971 - marriage market	.0142 (0.03)	14222 (1.16)	-.399 (2.26)	.166 (1.31)
Proportion married men with primary schooling in 1971 - village	.151 (1.32)	-3598 (1.17)	-.0125 (0.35)	-.0198 (0.58)
Proportion married men with primary schooling in 1971 - marriage market	-1.05 (1.04)	16837 (1.55)	.197 (1.42)	-.575 (4.54)
N				
F (15,80)	4.73	2.95	1.73	2.80
R^2	.353	.337	.166	.211

[a]Absolute value of t-statistic in parentheses.

Figure 1

Actual and Preferred Rural Sex Ratios of Children in 1971, by Indian State

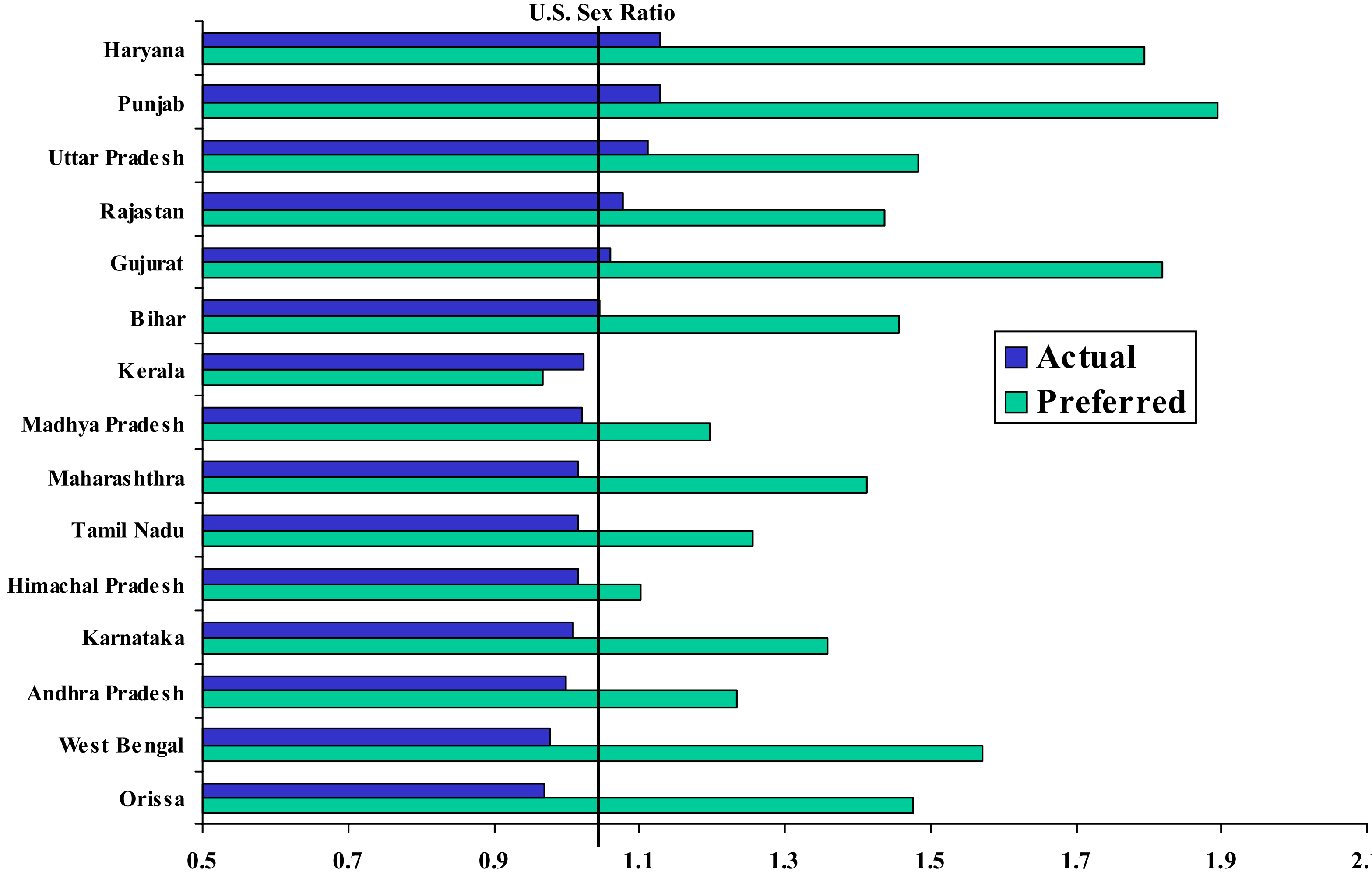

Figure 2
Cumulative Distributions of Marital Migration in Two Indian States, 1994

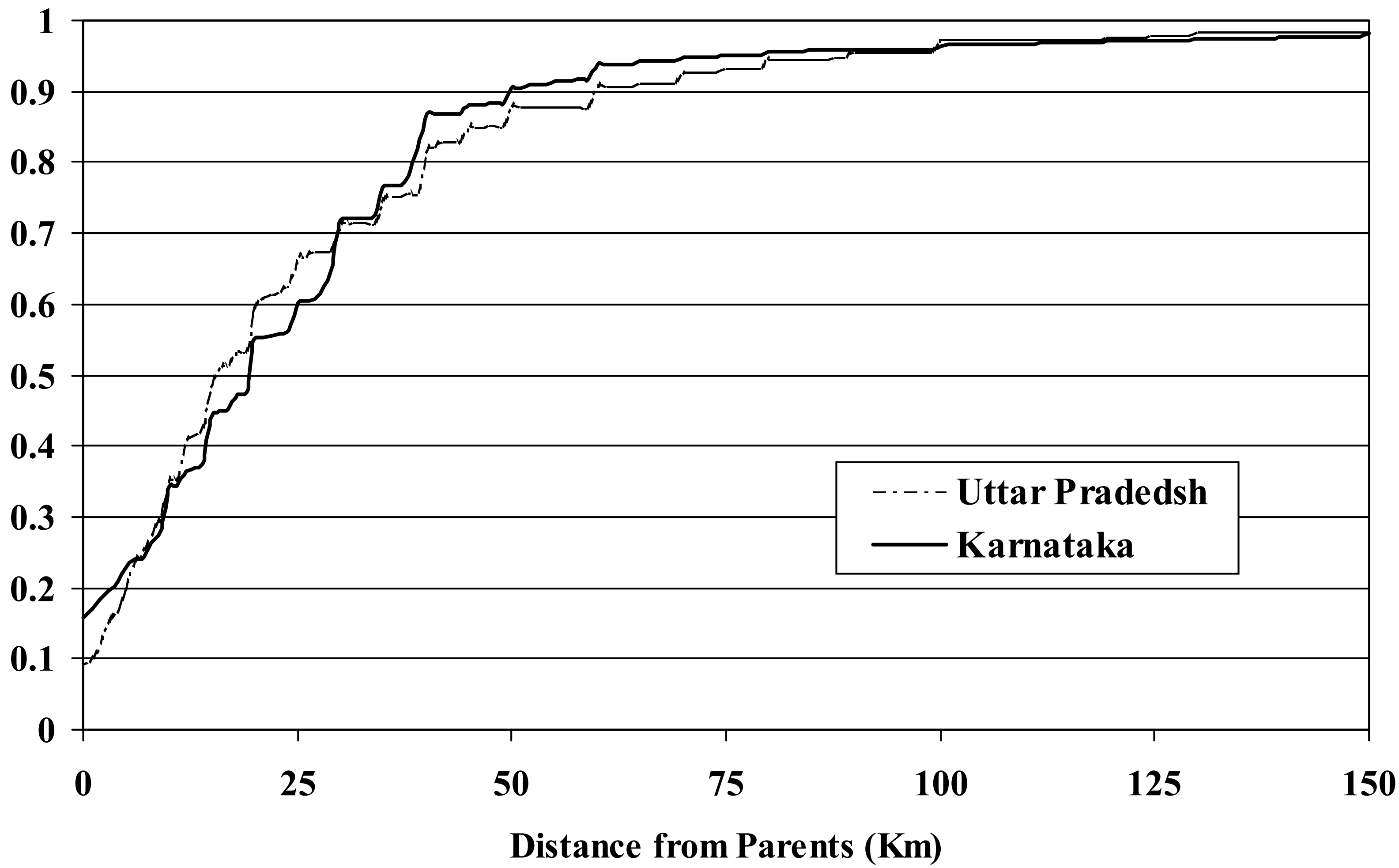

Figure 3

Proportionate Change in Crop Output per Acre and the Change in Preferred Boys Minus Girls Among Rural Households Across Indian States, 1971 - 1982

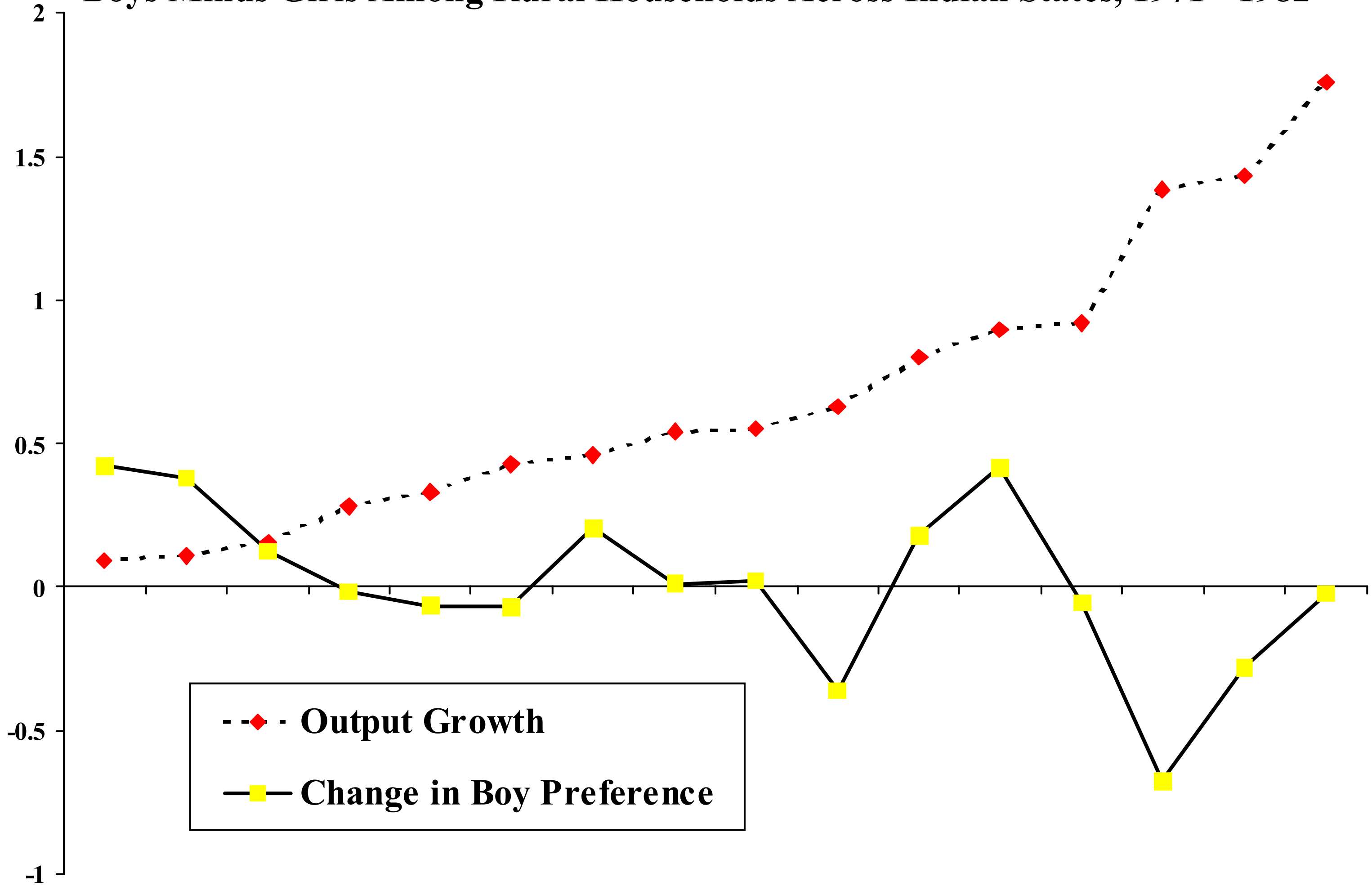

Figure 4
Proportions of Children Female and of Boys and Girls with Completed Primary Schooling in 1971, by Age

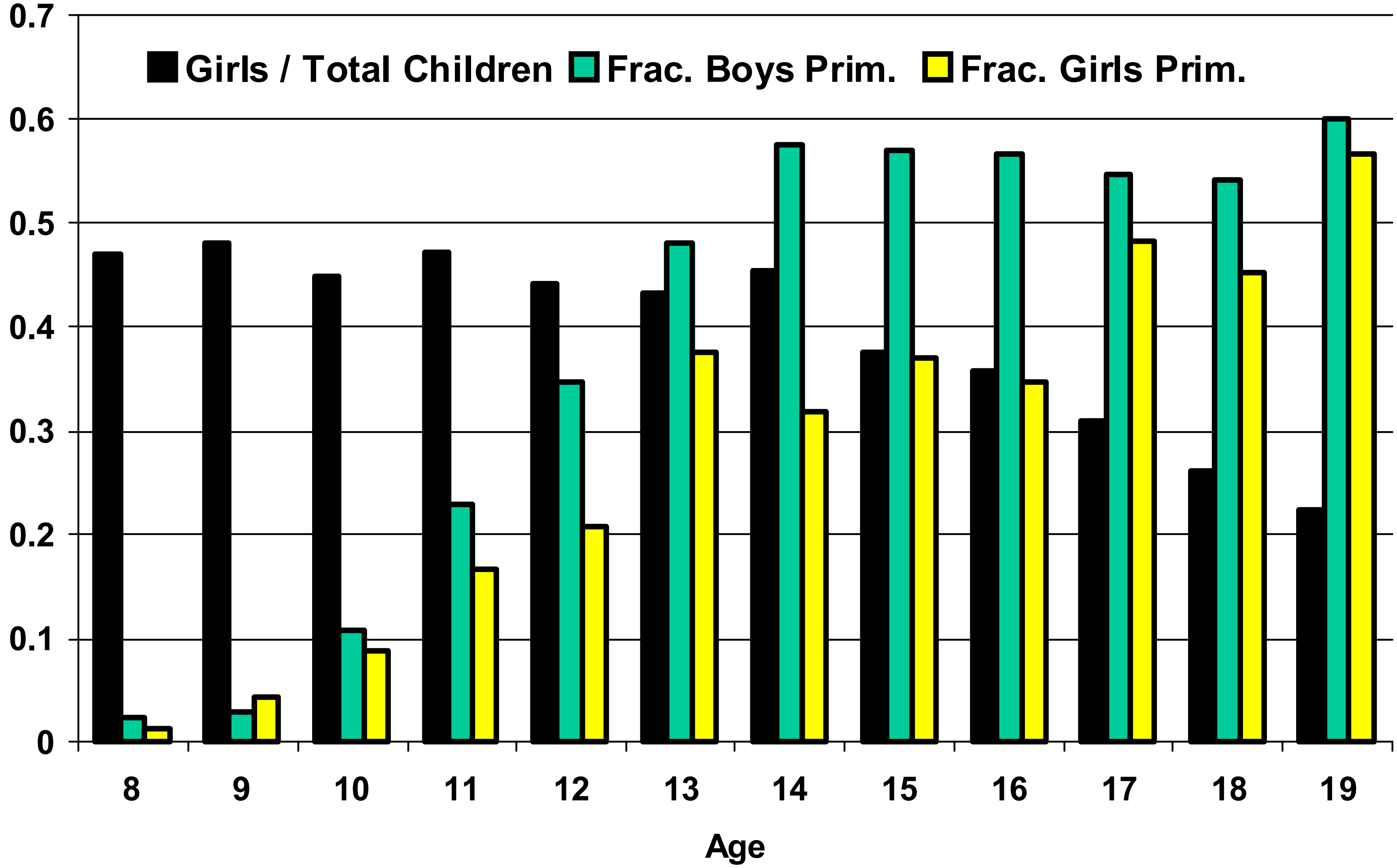

Figure 5
Location of ARIS/REDS Sample Villages
with District Boundaries