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Women's Schooling, Home Teaching, and Economic Growth

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The hypothesis that increases in the schooling of women enhance the human capital of the next generation and thus make a unique contribution to economic growth is assessed on the basis of data describing green revolution India. Estimates are obtained that indicate that a component of the significant and positive relationship between maternal literacy and child schooling in the Indian setting reflects the productivity effect of home teaching and that the existence of this effect, combined with the increase in returns to schooling for men, importantly underlies the expansion of female literacy following the onset of the green revolution.

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I. Introduction

Increased investment in schooling is often promoted as a key development strategy aimed at promoting economic growth. Most of the micro evidence that has been used to support the importance of schooling in augmenting incomes in low-income countries comes mainly from data describing the returns to schooling for men (e.g., Psacharopoulos 1994). Given the relatively low rates of participation by women in formal-sector labor markets in such countries, information on the potential contribution of women's schooling to income is less available and, where found, problematical to interpret because of labor market selectivity. Advocates of development and poverty reduction policies that emphasize investments in female schooling, however, suggest that significant returns to women's schooling are to be found in the household sector, where the schooling of women has important effects on the human capital of future generations (World Bank 1991; United Nations Development Program 1996). One argument of development strategists, in particular, is that better-educated mothers are superior teachers in the home, so that investments in women's human capital complement those in schools (e.g., Forum for African Women Educationalists 1995).

There are many estimates from low-income countries of a positive relationship between maternal schooling and the human capital of children that control for family characteristics such as income and paternal schooling. However, an important alternative interpretation of this association, based on conceptions of households in which individuals optimize and bargain, is that mothers with higher levels of schooling have superior options outside the household that confer to them a greater command of resources within the household, which they choose to allocate to children at higher levels than men would (Folbre 1984, 1986; Thomas 1990; Haddad, Hoddinott, and Alderman 1997). While this view is not incompatible with the hypothesis that schooling actually augments home skills for women, it presupposes that women's schooling has returns outside the household. More important, it implies that the expansion of options for women in the labor market along with enhanced investments in women's schooling is necessary to achieve greater investments in children. However, growth in female employment opportunities, which may be difficult to effect via specific program interventions, is not a necessary condition for achieving greater schooling investments if schooling enhances women's productivity in the home production of human capital and there are returns to schooling men.[1]

[1] Of course, the observed positive associations between the schooling of mothers and that of their children admit to a number of other interpretations. More schooled

In this paper we develop a model of household decision making in order to assess empirically the contribution of maternal schooling to investments in children's schooling while taking into account the roles of preferences for schooling in the home and in the marriage market; the effects of schooling on home productivity, household bargaining power, and the time costs of household activities; and differential returns to schooling for men and women in the labor market. The framework is applied to data describing the demand for educated wives and household investments in schooling in rural India before and during the ''green revolution,'' a time in which the returns to men's but not women's schooling rose substantially in the farming sector but the apparently limited role of women in agricultural decision making or in rural formal-sector employment activities remained unchanged.

The estimates indicate that the demand for schooled wives increased more rapidly in the areas of high agricultural growth despite the absence of market returns to female schooling. Consistent with the interpretation of this as derived demand for female schooling as an input in the production of child schooling, estimates that exploit the extended structure of Indian households to reduce the influence of male preferences for schooling and wealth effects indicate significantly higher levels of study hours among children with literate mothers. Finally, estimates of the determinants of dowry values indicate that, consistent with the view that female literacy has a value to men rather than providing an improved postmarriage bargaining position for women, literate women command a premium in the marriage market. These results thus suggest that increasing labor market opportunities for women is not necessary to justify increased investments in female schooling, which have payoffs even in settings in which there is increased demand for schooling solely in male-dominated occupations.

II. The Setting: Women and the Indian Green Revolution

The green revolution in India began in the mid to late 1960s with the importation of new, high-yielding seeds developed outside of India that substantially augmented agricultural productivity and economic growth where soil and weather conditions within India were

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women may contribute more income to the household, which may lead to increased investments in child schooling even if all household incomes are pooled and schooling has no in-home productivity effects. Also, men with greater preferences for schooling may marry women with higher levels of schooling and invest more heavily in their children's schooling.

hospitable. Agricultural incomes rose fastest in those areas with the most appropriate soil and climate characteristics and, within those areas, among farmers who adopted the new seeds most rapidly and most efficiently. Rosenzweig (1995) and Foster and Rosenzweig (1996) have shown that the schooling of farmers played a key role in the adoption of new seeds and in increasing the profitability of the new seeds. In particular, there was a substantial increase in the returns to primary, but not higher, schooling levels for farmers in areas in which potential farm productivity rose fastest because of the sustained supply of suitable new seeds with improved characteristics over time.

Foster and Rosenzweig did not examine the role of women's schooling or its returns. However, as we show below, the direct contribution of women's schooling to agricultural productivity appears to have been minimal in the first 15 years after the introduction of the new seeds. The early green revolution setting therefore has potential for illuminating the home schooling production effect of women's schooling. We use data from the two surveys used by Foster and Rosenzweig, which describe rural households across India over the period 1968–82. The first data set, the National Council of Applied Economic Research (NCAER) Additional Rural Incomes Survey (ARIS), was initiated in the first years of the green revolution and provides longitudinal information for a national sample of 4,118 households pertaining to the crop years 1968–69, 1969–70, and 1970–71 on the use of high-yielding seed varieties, household structure, schooling, income, and agricultural inputs and outputs. The villages (250), districts (96), and states in which the households reside are also identified in the coded data, enabling identification of spatial differentials in productivity growth.

In the crop year 1981–82, NCAER conducted a resurvey of the 1970–71 households, the Rural Economic Development Survey (REDS), as well as a survey of newly formed households to obtain a stratified representative sample of all Indian households in 1981–82. These data thus provide panel information on a subset of the original 1970–71 households covering the period 1971–82 and a second data set describing the rural population in India in 1982 based on the same survey design as in the ARIS. A useful element of the REDS data for the purpose of this analysis is detailed information on the allocation of time, by season, of all women and children during the crop year 1981–82.

To assess the direct effects of women's schooling in agricultural production in the context of the green revolution, we modify and reestimate the equation on new seed adoption in Foster and Rosenzweig (1996) and the equation on farm profits in Rosenzweig (1995)

TABLE 1

RELATIONSHIP OF MALE AND FEMALE SCHOOLING AND LITERACY TO HYV ADOPTION: MAXIMUM LIKELIHOOD LOGIT ESTIMATES, 1971

Variable	(1)	(2)	(3)
Any adult male with primary schooling	.846	.845	.822
	(6.15)	(6.23)	(5.83)
Any adult male literate	...	...	.0745
			(.41)
Any adult female with primary schooling	...	.00586	.0789
		(.04)	(.40)
Any adult female literate	...	...	−.0907
			(.49)
Owned land area	.00370	.00371	.00360
	(.67)	(.67)	(.65)
Farm equipment value ($\times 10^{-3}$)	.113	.113	.113
	(1.72)	(1.73)	(1.73)
Irrigation equipment value ($\times 10^{-3}$)	.0531	.0531	.0533
	(1.89)	(1.89)	(1.89)
IADP district	.613	.612	.615
	(2.47)	(2.46)	(2.48)
Agricultural extension service in village	.167	.167	.167
	(.77)	(.77)	(.77)
Constant	−1.59	−1.59	−1.62
	(8.88)	(8.89)	(7.81)

NOTE.—Absolute values of asymptotic *t*-ratios are in parentheses.

from the early ARIS data to include the schooling of adult women in the household as well as the schooling of adult men. Table 1 reports, for a sample of 2,532 farm households residing in districts in which at least one sample farmer was cultivating with high-yielding varieties (HYV) of seeds, maximum likelihood logit estimates of the relationship between the probability that a farm household ever adopted the new HYV seeds by 1970–71, the highest level of schooling attainment of any adult man and adult woman in the household, the amount of owned land, and variables indicating residence in a district with a government program designed to facilitate the adoption of the new seeds, the Intensive Agricultural District Program (IADP), or a village with an extension program. The highest schooling level is divided into two categories: primary schooling and literacy. The logit estimates reported in column 1 replicate the finding in Foster and Rosenzweig that when land size, farm equipment, and irrigation facilities were controlled for, farm households containing at least one adult who had completed primary schooling were significantly more likely to have adopted the new seeds by 1970–71. However, as shown in columns 2 and 3, having primary-schooled or literate adult women in the household does not appear to significantly affect whether a household adopted the new technology.

TABLE 2

CONTRIBUTIONS OF MALE AND FEMALE SCHOOLING AND LITERACY TO HYV PROFITABILITY: FIXED-EFFECTS INSTRUMENTAL VARIABLE ESTIMATES, 1969–71

Variable	(1)	(2)	(3)
HYV area planted	−.145	−.144	−.0306
	(.78)	(.77)	(.14)
HYV × any adult male with primary schooling	.277	.262	.303
	(2.54)	(2.14)	(2.18)
HYV × any adult male literate	...	...	−.0972
			(.61)
HYV × any adult female with primary schooling	...	.0393	.234
		(.24)	(.98)
HYV × any adult female literate	...	...	−.241
			(1.13)
Farm equipment value	6.00	5.93	5.97
	(2.72)	(2.73)	(2.73)
Irrigation equipment value	.199	.211	.480
	(.29)	(.26)	(.53)
Adverse village weather	−405.1	−402.1	−415.7
	(2.22)	(2.23)	(2.25)

NOTE.—The number of farm households is 1,756. Absolute values of robust *t*-ratios are in parentheses.

The data also indicate that the schooling of women did not contribute to the efficient use of the new seeds once adopted, in contrast to the schooling of men. Table 2 reports results, based on a methodology similar to that used in Foster and Rosenzweig (1995), from the ARIS panel data that relate the profitability of HYV seeds to the maximum schooling of adult men and women in the household among farm households that had adopted the new seeds in the 1969–70 and 1970–71 crop years. The estimation procedure exploits the panel dimension of the data to eliminate the influence of fixed, household-level unmeasured attributes such as land quality and farmer skills as well as lagged shocks to profitability by differencing across years and instrumenting the differenced variables. In this interactive specification, the differential effects of the planting (acreage) of HYV seeds on farm profits by male and female schooling are identified. The results indicate that HYV profitability was significantly higher in farm households in which at least one adult male had completed primary schooling, as found in Rosenzweig (1995), but HYV profitability was evidently no higher in households in which any adult women had completed primary schooling or were literate given male schooling.

The results from tables 1 and 2 indicate that female schooling played a minimal role in the agricultural production sector even during the green revolution, although such effects were evident for male schooling. It is possible, however, that female schooling impor-

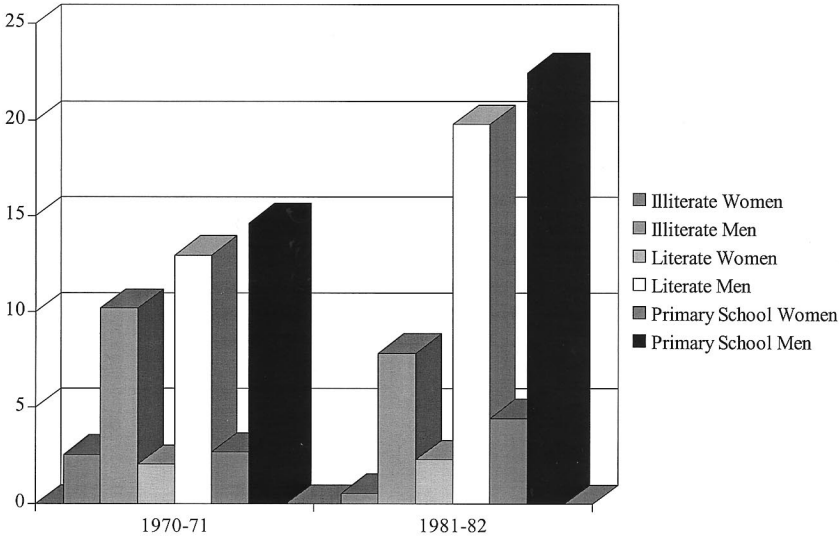

FIG. 1.—Percentage married farm women and men working for nonagricultural wages or salaries: 1970–71 and 1981–82.

tantly contributed to household income and to the bargaining position of married women through the nonagricultural sector. It appears, however, that there was only a limited increase in the participation of women in the nonagricultural wage and salary sector in which schooling-augmented skills are potentially rewarded, and no increase for literate women. Figure 1 displays nonagricultural sector participation rates in 1970–71 and 1981–82 for married adult men and women in farm households for three schooling groups: illiterate, literate, and completed primary schooling. As can be seen, in 1970–71 less than 3 percent of married farm women participated in this sector in all schooling groups, with no discernible pattern by schooling. In contrast, there is a positive relationship between schooling level and nonagricultural work participation by farm men in the same year, with the participation rate of primary-schooled men in the nonagricultural sector 40 percent higher than that of literate men and almost five times higher than that of women who were primary school graduates. In 1981–82, schooling level and nonagricultural labor force participation are positively related for both farm men and women, with women who are primary school graduates having almost twice the participation rate of women who are only literate, although in this later period less than 5 percent of farm women who are primary school graduates are working outside of agriculture.

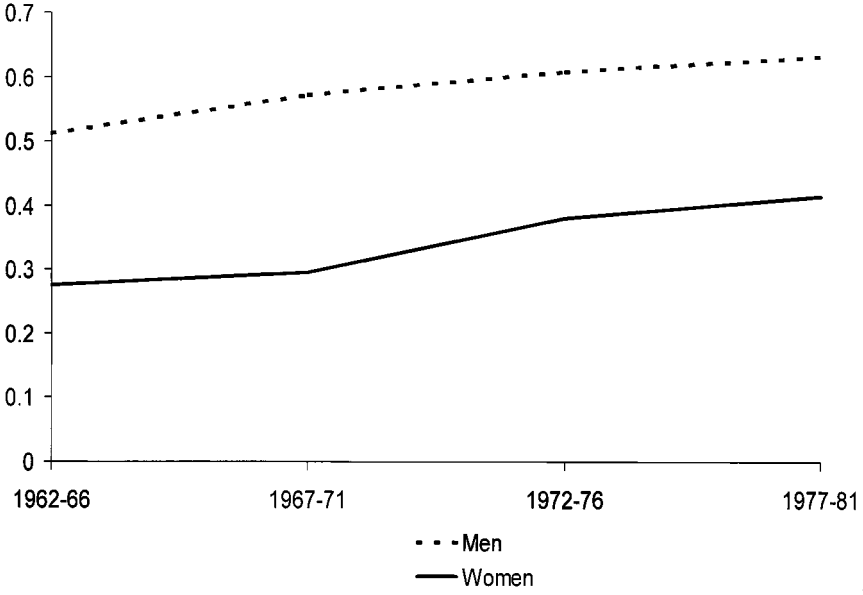

FIG. 2.—Literacy rates of farm newlyweds, by sex and date of marriage: 1962–81

The data thus suggest that while the green revolution enhanced the value of men's schooling in farm production and was associated with increased participation by men residing in farm households in nonagricultural employment, the contribution of women's schooling to household income from the farming sector or from the rural nonagricultural sector remained minimal. If there were no other contribution of women's schooling, we would expect a widening of the gap between male and female schooling attainment subsequent to the arrival of a steady stream of new, more productive seeds that evidently raised the return to male schooling. However, despite the absence of any significant increase in returns to female schooling or literacy in the labor market caused by the green revolution, rates of both female literacy and male literacy rose in rough parallel after the onset of the green revolution.

The marriage histories provided in the 1970–71 ARIS and 1981–82 REDS data permit the construction of aggregate time-series data on the schooling of newlywed men and women in farm households, men at approximately age 25 and women at age 20, prior to and after the start of the green revolution. Figure 2 displays by quinquennia from 1962–66 through 1977–81 the literacy rates of newly married men and women in farm households for all of India, except the state of Assam, based on the retrospective marriage histories merged

from the two data sets. The graph indicates that the rate of young farm men's literacy rose from 51 percent to 63 percent whereas that of their brides rose from 28 percent to 41 percent between the 1962–66 and 1977–81 quinquennia. Brides' literacy remained essentially unchanged between the 1962–66 and 1967–71 period but rose by almost a third by 1972–76 and continued to rise in the next 5 years by about 10 percent. Thus, despite the almost 25 percent increase in literacy rates in the 15-year period after the onset of the green revolution for young farm men and the evident absence of any increases in the market returns to female schooling, the gap between bride and groom literacy rates in farm households remained roughly constant at about 22 percentage points.

III. Theoretical Framework

A. *Maternal Schooling, Household Bargaining, and Household Production*

To provide a framework for assessing the extent to which, if at all, the increase in female schooling attainment in an environment of technical progress but low participation of women in earnings activities reflects the increased home productivity of female schooling, we formulate a model incorporating home productivity of schooling and household bargaining. We initially assume that each family in the economy is exogenously formed and composed of two parents, the mother and father, and a single child. Each parent cares about his or her own private consumption as well as a child good. In particular, the utility for each parent i in family j is

$$u_i(c_{ij}, z_j) = \ln(c_{ij}) + \eta_i z_j, \tag{1}$$

where c_{ij} denotes private goods consumption by parent i in j; $i = M, F$ for mother and father, respectively; and z_j denotes the level of the composite child good. Note that preferences for the child good, captured by η_i, may differ between men and women.[2] The child good is produced according to a production function $z(\cdot)$ that has as inputs the level of human capital h_j of the child and the level of market goods x_j provided to the child:

$$z_j = z(h_j, x_j). \tag{2}$$

[2] Preferences for the child good may also differ among men and women. We defer the discussion of the implications of preference heterogeneity for identifying the effects of parental schooling on child schooling to Sec. V below.

We assume that maternal time, child time, and school goods are perfect complements in the production of human capital, with the father playing a negligible part in home production:

$$h_j = \min[\exp(\phi^H h_{Mj}) H_{Mj},\ H_j,\ b_j], \tag{3}$$

where H_{Mj} is the own time of the mother in household j devoted to child human capital production, H_j is the time of the child spent in his or her own human capital production, and b_j denotes school goods purchased in the market such as books and supplies as well as school fees. Equation (3) incorporates the possibility that the efficiency of maternal time in the production of human capital depends on her level of schooling h_{ij}, where ϕ^H reflects the home productivity of maternal schooling. For simplicity we assume that children, mothers, and fathers work up to T units of time, with wages per unit of time of w^c, w^M, and w^F. Consistent with the data, we also assume that women as well as children work in earnings activities that do not reward schooling.

We characterize the programming problem in terms of optimization by the father, who maximizes his own utility, given by (1), subject to (2), (3), and the budget constraint, which incorporates the additional constraint that he must provide his wife a given level of utility $v_{Mj} = v_M(h_{Mj})$:

$$\begin{aligned} p_x x_j + p_{cM} c_M^*(z_j, v_{Mj}) + p_{cF} c_{Fj} + \omega_j h_j \\ = R_j + T[w^F(h_{Fj}) + w^M + w^c], \end{aligned} \tag{4}$$

where, given (1), $c_M^*(z_j, v_{Mj}) = \exp(v_{Mj} - \eta_M z_j)$ is the minimum level of private consumption that must be provided to the mother so that she achieves her reservation utility v_{Mj} for some given level of the child good z_j; $\omega_j = w^M \exp(-\phi^H h_{Mj}) + w^c + p_b$ is the minimized cost to the household of producing each unit of human capital for the child; and R_j is nonearnings income.

The first-order condition for the father's problem with respect to the schooling of the child is

$$\eta_F \frac{\partial z_j}{\partial h_j} = \lambda\left(\omega_j - p_{cM}\eta_M c_M^* \frac{\partial z_j}{\partial h_j}\right), \tag{5}$$

where λ is the father's marginal utility of income. This expression indicates that the shadow price of a son's schooling is affected by the opportunity cost of the child's and mother's time as reflected in ω_j. In addition, the marginal cost of child schooling is influenced by the bargaining position of the mother, as determined by her reservation utility and her preferences. The effect of an increase in ma-

ternal schooling on the education of the child reflects its effects on both maternal productivity and maternal ''bargaining power'':

$$\frac{\partial h_j}{\partial h_{Mj}} = \phi^H w^M \exp(-\phi^H h_{Mj}) \frac{\partial h_j^c}{\partial p_b} + w^M \phi^H (T - H_{Mj}) \frac{\partial h_j}{\partial R_j} + \frac{\partial v_{Mj}}{\partial h_{Mj}} \left[p_{cM} \frac{c_{Mj}}{c_{Fj}} \left(\frac{\eta_M}{\eta_F} - 1 \right) \frac{\partial h_j^c}{\partial p_{cF}} \right], \tag{6}$$

where the superscript c denotes a compensated effect (i.e., both husband's and wife's utility held constant). Equation (6) has two components: the first two terms are the standard substitution and income effects, respectively, that arise only in the presence of a home schooling productivity effect ϕ^H. The second part reflects the necessity of providing the wife her reservation utility—the bargaining effect. It can be seen from (6) that if higher levels of maternal schooling are associated with higher reservation utilities for women, then the sign of the bargaining term depends on the relative preferences of men and women for the child good z, that is, on the ratio η_M/η_F.[3]

Expression (6) makes clear that it is difficult to identify the home productivity effect ϕ^H from the association between a mother's and her child's schooling, even in a setting in which mother's schooling does not contribute to household earnings, because that relationship may also reflect the effect on maternal bargaining power (given asymmetric preferences between men and women). It is possible, however, to draw inferences about home productivity and bargaining power effects of maternal schooling by examining the demand for wives' schooling in the marriage market. To examine these issues, we extend the model to two stages and add a marriage market and an agricultural production sector.

At the beginning of the first stage, each adult male is assumed to choose a spouse and to have two children, one of each sex. He then chooses the allocation of time across activities and private good consumption for himself and his spouse and time allocation for his two children subject to (i) time and budget constraints and (ii) the reservation utility requirement for his wife. In the second stage he marries off his daughter and allocates his and his wife's time and that of his

[3] Expression (6) shows that the usual assumption (e.g., Thomas 1990) that a greater claim by the mother on household resources tends to result in greater child schooling requires asymmetric preferences, and in particular that $\eta_M/\eta_F > 0$. For $\eta_M = \eta_F$, in which case preferences exhibit transferable utility, the schooling of the child is invariant to changes in either the relative well-being or bargaining power of the two parents. This is a standard implication of transferable utility in the presence of household public goods (see Bergstrom 1997).

grown son, providing both his son and wife with sufficient consumption to keep the household intact.

The household is assumed to own a farm asset A_j. Farm profitability depends on the level of technology θ and on the speed with which technology is changing. As established in Foster and Rosenzweig (1996), the effect of technological change τ on profitability is assumed to be influenced by the maximum schooling within the household, $h_i^{\max}$, as would be expected if the more schooled individuals in a given household have a particular advantage in the management and adoption of new agricultural techniques and there is no market for these entrepreneurial activities. Under these conditions, agricultural profits given A_j are $\pi_j = \pi(A_j, h_j^{\max}, \theta, \tau)$, with $\partial\pi/\partial\tau\partial h > 0$.

In the first stage, children have no human capital, and, by assumption, the father has at least as much schooling as the wife.[4] In the second stage, the son and daughter have completed their schooling and the daughter has been married out. Marriage by the daughter has resulted in a net marital payment (dowry) of δ_G that depends on her level of human capital and conditions in the marriage market. Also the son must be provided a level of consumption sufficient to keep him from setting up a separate household.

Given the patrilocal setup in which boys remain on the farm and wives are imported to (daughters exported from) the local area, locality-specific technological change increases the return to schooling of boys, but not of girls, if agricultural technological change and men's schooling are complements and women do not participate in farm decision making. However, if women's schooling increases their home productivity in the production of human capital or increases their bargaining position in the household, then the effect of technical change will increase the demand for maternal schooling in the marriage market as long as technical change increases the demand for the schooling of boys.[5] In particular, if for simplicity we assume that there is only one child, a son, in the household,

$$\frac{\partial h_{Mj}}{\partial \tau} = \frac{-\left(\frac{\partial h_{Bj}^*}{\partial \tau}\right)\phi^H \exp(-\phi^H h_{Mj}) - p_{cM}\eta_M c_{Mj}\frac{\partial v_{Mj}}{\partial h_{Mj}}\left(\frac{dz_j^*}{d\tau}\right)}{\Psi}, \quad (7)$$

[4] In our data, wife's schooling exceeds husband's schooling in only 3 percent of the cases.

[5] This will be true if an increase in the speed of technical change raises farm profits more than it raises the son's income claim and this differential is increasing in child schooling. This follows if there are constant returns to scale in production, the son in autarchy faces the same technology as the father, and the son's schooling exceeds the father's.

where Ψ is the derivative of the first-order condition for maternal schooling with respect to h_{Mj}, with $\Psi < 0$ for an interior maximum, and $\partial h^*_{Bj}/\partial\tau$ is the derivative of the son's schooling with respect to technical change conditional on maternal schooling. Note that, in contrast to the relationship between child and maternal schooling in (6), the sign of the bargaining power effect of technical change on the demand for maternal schooling is not dependent on the relative magnitudes of husbands' and wives' preferences for the child good: it is always positive.[6]

IV. The Demand for Schooled Wives

We now use the ARIS-REDS data to test the implications of the model in which maternal schooling plays a productive role in the home in facilitating the education of children. The first implication we test, suggested by expression (7), is that the demand for maternal schooling should increase in high–technical change areas for given levels of men's schooling, even in the absence of any increased labor market return to women's schooling, if women's schooling facilitates the production of child education and there is an increase in the returns to and therefore the demand for men's schooling in such areas. The ARIS and REDS marital histories can be used to construct a time series on the schooling of newlyweds at the village level that can be used to assess whether the schooling of brides in high–technical change areas, for given schooling of young men, rose more than the schooling of brides marrying in slow-growth areas. Note that given the spatial differentials in the productivity-enhancing effects of the availability of new seeds caused by differences in agroclimatic conditions, the schooling of brides is a more sensitive and immediate indicator of changes in the locale-specific demand for female schooling than that of grooms given the common practice of village exogamy: while it is not possible to instantaneously increase adult male or female schooling attainment in response to perceived increases in schooling returns in any locality, the schooling attainment of brides can be increased quickly in an area by importing educated women from other areas (with presumably lower rates of technical change).

[6] This follows from the fact that with technological change, men will demand higher levels of schooling for their children for any given level of maternal schooling. As child schooling also is valued by the wife, this implies that at higher levels of technical change the incremental private good consumption required to compensate a woman with incrementally higher reservation utility is lower ($\partial^2 c^*_{Mj}/\partial z_j \partial v_{Mj} = -\eta_M c^*_{Mj} < 0$) in high–technical change areas.

The equation we estimate is

$$h_{Mjt} = \sum_k \beta_k S_{jkt} + \beta_\theta \theta_{jt} + \beta_\tau \tau_{jt} + \mu_j + v_{jt}, \quad (8)$$

where h_{Mjt} is the schooling of a bride in village j at time t; the S_{jkt} are family composition variables, such as the age and schooling composition of the groom's household and the groom's age and schooling; θ_{jt} is the level of agricultural technology in j at time t; τ_{jt} is technical change at t in j; μ_j captures time-invariant village characteristics such as land quality, soil and weather conditions, marriage customs, and groom preferences; the v_{jt} are independently and identically distributed errors; and the β's are coefficients.

We assume, as in Foster and Rosenzweig (1996), that technology shocks are autocorrelated. In particular, we assume that technical change in village j at time t, $\tau_{jt} = \theta_{jt} - \theta_{jt-1}$, exhibits first-order autocorrelation: $\tau_{jt} = \rho\tau_{jt-1} + \epsilon_{jt}$. With $\rho > 0$, this expression captures in a relatively simple way the notion that areas that are well suited to the adoption of new seeds in one period are also likely to be well suited to the adoption of seeds that become available in subsequent periods. This structure is consistent with the evidence that in the Indian green revolution, areas benefiting from early growth exhibited more rapid growth in subsequent periods.

It is difficult to measure θ_{jt} and τ_{jt}, in particular, to distinguish in the cross section between the level of technology and local fixed endowments in an area, as reflected in μ_j. However, the ARIS panel data can be used as in Foster and Rosenzweig (1996) to estimate area-specific measures of technical change τ_{jt} for the initial green revolution period 1968–71 by estimating in first differences and thus eliminating the influence of μ_j and time-invariant components of local agricultural technology, a conditional, farm-level profit function incorporating village dummy variables and individual farm assets, inclusive of schooling. The coefficients on the village dummy variables measure village-specific differences in profit growth rates net of changes in farm assets, that is, the τ_{jt}, for the period 1968–71.

To obtain estimates of the determinants of the schooling of brides, we use data describing newlyweds' schooling and farm household characteristics for 227 villages for which we could estimate the τ_{jt} for the first three quinquennia depicted in figure 2. If there was no significant technical change in the pre–green revolution period 1962–66 and the profit function estimates from the ARIS panel provide τ_{jt} for the first green revolution period (1967–71), then in first differences (8) becomes

$$Dh_{Mjt} = \sum_k \beta_k DS_{jkt} + D\gamma_t \tau_{j0} + Dv_{jt}, \quad (9)$$

where D is the first-difference operator, τ_{j0} is the village-level measure of technical change in 1967–71, and $\gamma_{62-66} = 0$, $\gamma_{67-71} = \beta_\theta + \beta_\tau$, and $\gamma_{72-76} = \beta_\theta(1 + \rho) + \beta_\tau\rho$, given the autocorrelated technology structure. By estimating (9), we can eliminate the influence of the fixed factor μ_j and the pre–green revolution technology and still identify whether the effect of technological change on bride's schooling is positive ($\beta_\tau > 0$), whatever the value of the technology level effect β_θ, given positive autocorrelation in technology shocks, if $\gamma_{67-71} > \gamma_{72-76}$. Indeed, if the effect of the level of technology on the demand for schooled wives β_θ is negligible, the autocorrelation coefficient ρ is identified from the ratio of the two period-specific τ coefficients. However, because brides become mothers, shocks to wives' schooling in an earlier period may influence the characteristics of grooms and the groom's household composition contained in the S_{jkt} in a subsequent period. To eliminate the covariance between the differenced family variables and the lagged errors contained in Dv_{jt}, we apply instrumental variables to (9), where the differenced family state variables from the prior level serve as instruments. They include the household head's literacy and age and the total numbers of married women, literate married women, men, and literate men, which should be uncorrelated with subsequent shock differences (e.g., changes in weather) that appear in (9).

Table 3 reports the fixed-effects instrumental variable estimates of the determinants of wives' schooling based on the aggregate village quinquennial time series. We use three categories of wives' schooling—literate, literate without completion of primary schooling, and completed primary schooling—and two categories for the groom's schooling—literate and completed primary schooling. Also included in the specification, besides the technical change measure and the schooling and age at marriage of the groom, are variables that measure the importing groom's current household composition, including the total number of adult men and married women and the number of literate men and married women. The combined technology change and level effect on the demand for literate wives is statistically significant (.05 level, one-tailed) and positive in all specifications. The point estimates from column 2, where both period-specific technical change parameter estimates are significantly greater than zero at the .05 level, indicate that $\gamma_{67-71} > \gamma_{72-76}$, which implies that $\beta_\tau > 0$ as long as technical change is positively autocorrelated (and $\rho = .55$ if $\beta_\theta = 0$). An interesting feature of table 3 is that, across the three columns, the differences in the τ coefficient estimates are consistent with the hypothesis that there is a greater demand for literate, but not primary-schooled, wives in high-τ areas, given the schooling attainment of the groom.

TABLE 3

QUINQUENNIAL VILLAGE OBSERVATIONS: DETERMINANTS OF THE SCHOOLING AND LITERACY OF NEWLY MARRIED FARM WIVES, 1961–76
(Fixed-Effects Instrumental Variable Estimates)

Variable	Proportion of New Wives Literate (1)	Proportion of New Wives Literate but Not Primary School Graduates (2)	Proportion of New Wives Completed Primary Schooling (3)
Proportion of new husbands completed primary schooling*	.276	−.00829	.282
	(2.26)	(.10)	(3.30)
Proportion of new husbands literate*	−.0069	.240	−.118
	(.04)	(1.96)	(1.98)
Average age of new husbands at marriage*	.0174	.0141	−.00137
	(1.86)	(1.71)	(.25)
γ_{67-71}	.0000430	.0000361	.0000055
	(1.76)	(1.67)	(.36)
γ_{72-76}	.0000368	.0000198	.0000016
	(1.40)	(1.71)	(.09)
Average number of men in the household*	−.817	−.541	.431
	(1.07)	(1.67)	(1.00)
Average number of literate men in the household*	1.95	−.440	.244
	(1.43)	(.57)	(.25)
Average number of married women in the household*	.453	.0164	.163
	(1.40)	(.08)	(.57)
Average number of literate, married women in the household*	−1.70	.657	−.164
	(1.22)	(1.16)	(.21)

NOTE.—Absolute values of robust *t*-ratios are in parentheses.
* Endogenous variable.

V. Mother's Schooling and Children's Study Hours

The evident absence of any significant rise in the returns to women's literacy in the labor market after the onset of the green revolution suggests that the increase in demand for schooled (literate) wives in high-growth areas, net of the effects of the rising schooling levels of men, indicated in table 3 may reflect the existence of increased returns to the schooling of women in the household sector. In this section we directly examine the relationship between maternal schooling and the time allocation of children and mothers in the household to assess whether, in particular, maternal literacy plays a productive role in the schooling of children. The REDS data provide information on time allocation—hours per day in three seasons of the crop year 1981–82 for ''typical'' days in those seasons—for women and children in 11 categories, one of which is study hours (including time in school and homework).

As noted, a striking feature of the estimates in table 3 is that the demand for literate wives increased relative to the demand for wives who either were illiterate or had higher levels of schooling in high-τ villages. One plausible way in which mothers may aid in children's schooling is to help with homework, where a mother's ability to read and write is essential but higher schooling levels may be less important. Indeed, the REDS data on the study hours of children in farm households also indicate the special importance of maternal literacy. Figure 3 presents the average number of study hours per day (averaged over the three seasons) for school-age farm children aged 7–14 by three levels of mother's schooling and for fathers who either are literate or have completed primary school.[7] These graphs suggest two patterns: first, whether fathers have completed primary school or are just literate does not appear to matter much for children's study hours. Second, farm children with mothers who are literate but have not completed their primary schooling study almost one hour more per day than children with illiterate mothers and slightly less than one hour more per day than children with mothers who have completed primary school. This nonlinear pattern with respect to children's study habits is consistent with the nonlinear demand for schooled wives, for which literacy appeared to have the highest marriage market premium.

Examination of the time allocation of the mothers also reveals nonlinear relationships with respect to their schooling level that ap-

[7] Only 7.2 percent of all illiterate male farmers who are also fathers were married to a woman who had any schooling. More than two-thirds of male farmer-fathers are at least literate.

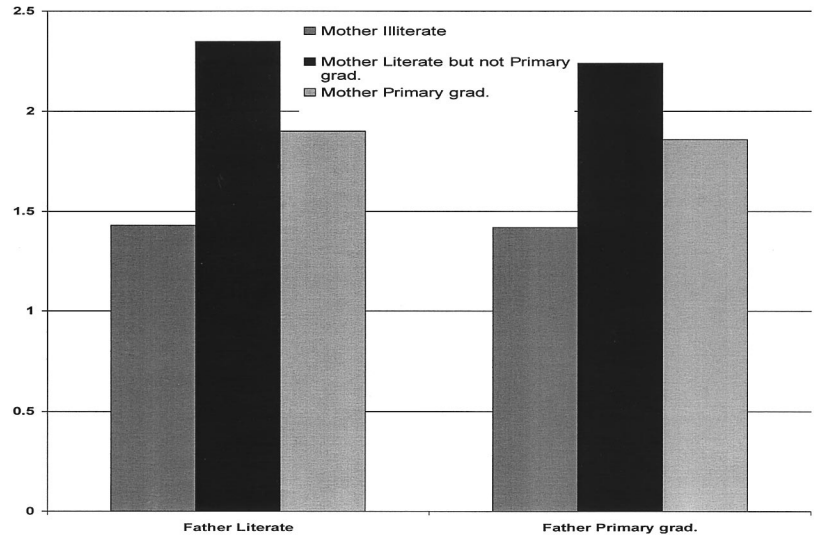

FIG. 3.—Average study hours per day among farm children, by schooling level of mother and father.

pear consistent with a complementary relationship between literacy, but not higher levels of schooling, and maternal child development. There are three time allocation categories in the data that characterize the mother's nonmarket time: (i) ''home care,'' which includes child care, cooking, and cleaning; (ii) ''domestic production,'' which includes grinding and pounding grain, collecting fuel, and fetching water; and (iii) ''leisure,'' which includes sleeping and bathing. Figure 4 depicts the average hours per day in which married farm women spend their nonleisure time for the three schooling classes. As can be seen, there is an inverted U–shaped relationship for the principal time allocation category ''home care'': married, literate farm women who are not primary school graduates evidently spend 1.5 hours more per day in home care than illiterate women and about one hour more than women who are primary school graduates. As a consequence, literate, nongraduate women on net spend less time in other combined work activities than either illiterate women or women who are graduates. In particular, literate, married farm women spend less time in both domestic production and off-farm salary and wage work than other married farm women, although, on average, such women spend more time than primary-school graduates in very small amounts of on-farm work. These time allocation data thus confirm our earlier findings that, unless literate women are more productive than primary school graduates in non–

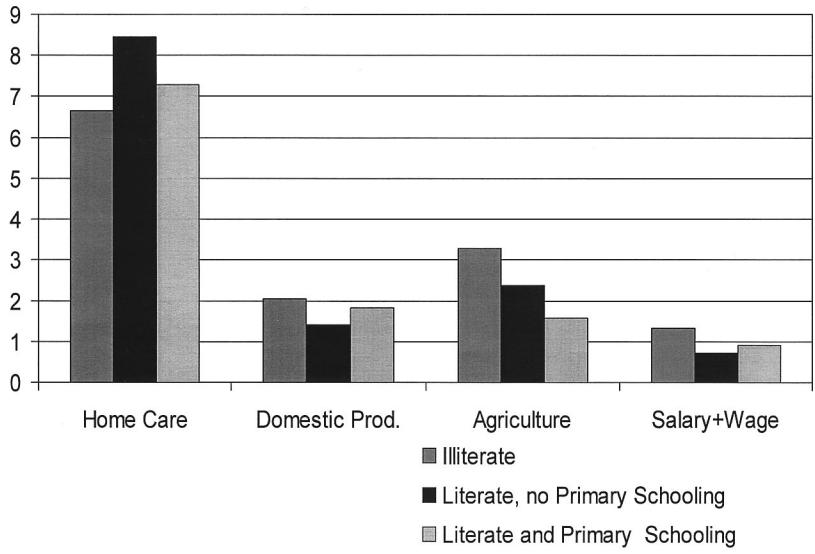

FIG. 4.—Time allocation of married farm women, by literacy and schooling: average hours per day in 1981–82.

home care activities, it is unlikely that the enhanced marriage market demand for literate wives reflects their greater contribution to household income.

Figures 3 and 4 may be misleading as evidence of a productive role for maternal schooling in schooling production in the home, even in the context in which off-farm market work is relatively unimportant, for a number of reasons. First, the schooling level of the mother may simply reflect the preferences of the father for his children's schooling; maternal schooling is endogenous in the model, and its demand has as a determinant η_F, which is positively related to both the mother's and the child's schooling, conditional on the mother's schooling. Second, preferences may be intergenerationally correlated, so that the schooling preferences of the father for his children may be correlated with his own schooling, which was determined in the same household. Third, the schooling of the wife (and the husband) may be related to wealth levels, which may also directly affect child schooling as well as maternal work patterns.[8]

To see the problem for estimation of the existence of correlated household preferences within the male's household, assume that the intergenerational transmission of the child preference parameter

[8] There may also be a relationship between a mother's schooling and the age of her children, which is highly correlated with schooling.

within the family of the father η_F is characterized by a random walk. Then the preference parameter η_{Fij} for the ith father in family j is $\eta_{Fij} = \eta_j + \eta^*_{Fij}$, where η_j is the preference parameter for family j and η^*_{Fij} is the independently and identically distributed idiosyncratic (across individual fathers in j) component to i's preferences.

The linearized demand equation for the schooling of the child in the family of father i in family j is

$$h_{ij} = \alpha_F h_{Fij} + \alpha_M h_{Mij} + \alpha_A A_{ij} + \alpha_\theta \theta_j + \alpha_\tau \tau_j + \eta_{Fij} + \kappa_j + e_{ij}, \quad (10)$$

where the α_k are coefficients, κ_j captures all household attributes, and e_{ij} is a father-specific random error. Given the random walk assumption, a father ij's own preferences will be correlated with his schooling h_{Fij} since his schooling is a function of his parents' preferences, which are correlated with his own. In addition, of course, his preferences will be correlated with his wife's schooling h_{Mij}, which is chosen by him in the marriage market. Because the preference parameters are unmeasured, estimation of (10) will yield biased and inconsistent estimates of the schooling effects coefficients.

We can exploit the fact that many farm households in India are extended and eliminate the influence of own father's preferences on own schooling (as well as the effects of local technology and its change) by differencing across coresident fathers (sons or brothers of the household head) in the same family, resulting in

$$Dh_{ij} = \alpha_M Dh_{Mij} + \alpha_F Dh_{Fij} + \alpha_A DA_{ij} + D\eta^*_{Fij} + De_{ij}, \quad (11)$$

where D is the difference operator for fathers within a family j.[9] Equation (11) now contains in the residual only the idiosyncratic components η^*_{Fij} of fathers' preferences, which by assumption are not correlated with own schooling. As indicated in the model, these preference components are, however, correlated with wives' schooling h_{Mij} via the marriage market. One method of eliminating this correlation is to use instruments that will predict wives' completed schooling and are not correlated with children's contemporaneous schooling investments. One set of candidates consists of variables known at the time of the father's marriage that affected his choice of a marital partner. An important example is technical change in the local area that was experienced prior to the marriage, that varies across areas, and that, from table 3, affects the mate-schooling choice of grooms. Because current values of τ_j that affect current

[9] A sample of extended families is not a random sample of all households. Such households, e.g., might have different preferences for joint living, which could be correlated with schooling preferences. Differencing across subfamilies within an extended household eliminates any common preferences or unobserved costs of coresidence that are household-specific.

schooling choices are eliminated from (11), prior values of τ_j at the time of marriage are valid instruments and vary across fathers because of differences in their years of birth and thus when they married. We create dummy variables representing three periods of technical change: years prior to the onset of the green revolution (before 1966), the immediate post–green revolution period 1967–71, and the subsequent period 1972–76 (all fathers with children over age 6 in 1982 married prior to 1976). The instruments for Dh_{Mij} in (11) are then interactions between village dummies and one of the three technical change interval dummies corresponding to the period in which the father reached age 24, the mean age at marriage for men in the sample.

In addition to variables characterizing the father's and mother's schooling, in the three categories, we also include in the specification of child study hours the age and sex of the child as well as the child's years of schooling completed prior to the current year. The latter variable is included because the dependent variable is a flow measure of schooling, which will depend on the child's accumulated stock of human capital. A child's achieved schooling is also likely to be correlated with the parental preferences, however. We therefore also treat this state variable as endogenous, using as instruments interactions between village dummy variables and the year in which the child was born. These variables reflect the local history of technical change and school access experienced by children born in different years that should have influenced their prior schooling investments.

Finally, we include total household wealth in the specification and a variable characterizing whether the child's father is a son of the household head or the head's brother. Because a father's relationship to the head, given partible inheritance rules, affects his claim on household assets, the variable may pick up his bargaining power within the extended household. For example, a coresident brother of the head has a contemporaneous claim on the household's assets that is equal to that of the designated household head and is thus a primary claimant, whereas a son of the head has a claim on his father's asset share only at his father's (head's) death. Because changes in total household wealth may therefore have different effects depending on familial asset claims, we also interact household wealth with the relationship variable.

Column 1 of table 4 reports ordinary least squares (OLS) estimates of the determinants of average study hours per day. This specification also includes a measure of the district-level technical change for the period 1970–71 through 1981–82, from Foster and Rosenzweig (1996), and the household's total wealth, all of which are

TABLE 4

DETERMINANTS OF FARM CHILDREN'S AVERAGE DAILY STUDY HOURS IN 1981–82

VARIABLE/ESTIMATOR	ALL HOUSEHOLDS: OLS (1)	EXTENDED-HOUSEHOLD SAMPLE			SON SAMPLE: WITHIN-HOUSEHOLD IV (5)
		OLS (2)	Within-Household (3)	Within-Household IV (4)	
Mother literate*	1.03	1.42	1.04	1.78	2.38
	(5.29)	(3.16)	(2.21)	(2.02)	(1.69)
Mother completed primary school*	.0581	−.029	−.756	−1.05	−1.29
	(.25)	(.08)	(1.36)	(.91)	(.78)
Father literate	.260	.460	.458	.339	−.632
	(1.42)	(1.08)	(.94)	(.68)	(.73)
Father completed primary school	.706	−.567	.0136	.0217	.361
	(3.83)	(1.21)	(.03)	(.05)	(.44)
Child's years of schooling*	.812	.891	.626	.721	.593
	(34.1)	(15.8)	(11.5)	(7.39)	(4.89)
Child's age	−.420	−.462	−.327	−.382	−.330
	(21.1)	(9.97)	(6.48)	(5.46)	(3.83)
Child is girl	−.621	−.163	−.596	−.487	−.711
	(6.81)	(.79)	(3.01)	(2.29)	(2.67)
Father primary claimant	.054	.270	−1.41	−1.23	...
	(.36)	(.65)	(2.35)	(1.99)	
Primary claimant × household wealth ($\times 10^{-3}$)	.000959	.00529	.00863	.00868	...
	(.81)	(1.87)	(1.98)	(1.98)	
Household wealth ($\times 10^{-3}$)	.000564	−.000721	...	...	...
	(.57)	(.51)			
τ_{71-82}	.0291	.060	...	...	...
	(3.13)	(2.95)			
Constant	6.39	6.73	...	...	...
	(25.4)	(12.29)			
Number of children	5,595	938	938	938	561
Households	2,473	262	262	262	172

NOTE.—Absolute values of robust *t*-ratios are in parentheses.
* Endogenous variable.

otherwise impounded in the household fixed effect in subsequent columns. The sample consists of all farm households with children aged 7–14. Because there are multiple subfamilies within a substantial portion of the households, coefficient standard errors are corrected for arbitrary within-household error correlations. The OLS estimates indicate, again, that children with literate mothers spend, on average, one hour more per day in study than other children of the same age, sex, and prior schooling with mothers who are not literate. Moreover, children of mothers who both are literate and have completed primary schooling study no more hours than the children whose mothers are literate but are not graduates of primary school. The OLS estimates also suggest, however, that whether or not the child's father completed primary school also affects study habits: children with such fathers spend 0.7 hour more per day in study, an estimate that is also statistically significant.

In column 2 we report OLS estimates from the sample of households that have two or more mothers with school-age children. These estimates are generally similar to those obtained from the full sample of households, indicating that sample selection by number of subhouseholds is not very important. The only striking difference is the coefficient on the father's primary schooling, which is neither positive nor significant in the extended sample but is positive and significant in the full sample. This change is consistent with household income's dependence on the maximum schooling of household males, since the effect will be zero for males in extended households with less than maximum schooling. The within-household (cross-mother) estimates eliminate the family component of father's schooling preferences that is potentially correlated with the father's own schooling and the common contribution of each parent's schooling to child outcomes in the extended households inclusive of the maximum schooling effect. As can be seen, eliminating the correlation with father's preferences lowers the estimate of the maternal literacy effect, consistent with the model. The coefficient is still statistically significant, indicating that children with literate mothers spend one hour more per day in study. The schooling coefficients for the father are not jointly significant by conventional standards in this specification.

When the endogeneity of the mother's schooling and child's schooling from mate choice and prior household investments, respectively, are also taken into account, the influence of the schooling of the father on children's allocation of time to study is reduced still further, whereas that of the literacy of the mother is augmented and is statistically significant. The within-household instrumental variable estimates, reported in column 3, still indicate a nonlinear pat-

tern for maternal schooling and little role for paternal schooling. The point estimates suggest that the children of literate mothers devote 1.8 hours more to study than otherwise identical children of illiterate mothers in the same household and 1.1 hours more than similar children with mothers who are primary school graduates, although the latter estimate is not statistically different from zero. One possible reason for the marginally significant decrease in study time for the children of primary-schooled relative to literate women is that primary-schooled women are devoting more of their time to activities in which schooling has a return, such as in nonagricultural employment as shown in figure 1. In contrast, children with literate fathers spend only a statistically insignificant third of an hour more in study than children with illiterate fathers and less than a few minutes more than that if the father has completed primary school.

To eliminate the possible influence of heterogeneous maternal preferences, we also estimated (11) using only fathers who are sons of the head (fathers with the same parents). The sample size is reduced to 172 households with 561 children. These estimates, reported in column 5 of table 4, are similar to those obtained using all family members, although somewhat less precise, and a Hausman test indicates nonrejection of the hypothesis that the set of within-household and within-sibling instrumental variable estimates are identical ($\chi^2(7) = 8.32$).

The estimates of the relationship between maternal schooling and maternal time allocation that take into account differences in paternal preferences and mate choice suggest that the association between maternal literacy and children's study hours reflects what mothers do in the home. The model implies that as long as maternal time is an important input in the production of child schooling, the effect of maternal schooling on child schooling and on her own time devoted to child schooling will have the same sign if the own price elasticity of demand for child schooling in the household is sufficiently large.

Columns 1–3 of table 5 present within-household instrumental variable estimates of the determinants of the time allocated by farm wives to home care, which is the only time allocation category that includes child care. As in the estimates for the allocation of children's time for study, the wife's (mother's) schooling variables are treated as endogenous along with the average schooling attainment (in years) of any children. The within-household estimates in column 1, obtained from farm households with at least two married women, replicate the inverted U–shaped pattern for maternal schooling and average home care hours seen in figure 4, with literate farm wives spending 1.4 hours more in this activity than illiterate

TABLE 5

DETERMINANTS OF FARM WIFE'S AVERAGE DAILY HOME CARE HOURS AND HOUSEHOLD CLOTHING EXPENDITURES PER CHILD: WITHIN-HOUSEHOLD INSTRUMENTAL VARIABLE ESTIMATES, 1982

	WIFE'S AVERAGE DAILY HOME CARE HOURS			CLOTHING EXPENDITURES PER CHILD: WIVES WITH SOME CHILDREN
COEFFICIENT	All Wives (1)	Wives with Some Children (2)	Wives with No Children (3)	(4)
Wife literate*	1.36	1.96	−.643	15.1
	(2.89)	(3.25)	(.53)	(.89)
Wife completed primary school*	−.911	−1.04	.655	−28.1
	(1.68)	(1.50)	(.34)	(1.57)
Husband literate	−.241	−.375	−1.41	−31.9
	(.82)	(1.02)	(1.19)	(2.47)
Husband completed primary school	.190	.152	1.94	19.1
	(.71)	(.45)	(1.83)	(1.69)
Husband primary wealth claimant	.126	−.351	.890	−5.19
	(.37)	(.77)	(1.17)	(.48)
Primary claimant × household wealth	−.0281	−.0317	−.0395	.000240
	(2.10)	(1.38)	(1.28)	(3.20)
Wife's age	−.139	−.238	−.284	3.61
	(2.06)	(2.16)	(1.69)	(.90)
Wife's age squared	.00194	.00383	.00412	−.0492
	(1.88)	(2.20)	(1.53)	(.84)
Average schooling attainment of children 7–14*	−.116	.0055	...	1.47
	(1.62)	(.02)		(.46)
Proportion own children 0–6 male	.372	.421	...	.567
	(1.70)	(1.67)		(.08)
Proportion own children 7–14 male	.0782	.103	...	7.62
	(.27)	(.34)		(.71)
Any own children 0–6	.0474	...	...	...
	(.30)			
Any own children 7–14	.323	.220	...	13.6
	(1.43)	(.77)		(1.93)
Number of wives	2,602	1,452	248	1,452

NOTE.—Absolute values of robust asymptotic *t*-ratios are in parentheses.
* Endogenous variable.

wives and 0.9 hour more than primary-school graduate wives. These differentials in time allocation by maternal schooling appear to be related to child care since they are more pronounced for mothers with children under 15 (col. 2). Indeed, among wives with no children under 15, there is no significant relationship between wives' schooling and their average hours devoted to home care (col. 3). The point estimates in columns 2 and 3 suggest that, within the same household, literate mothers with similarly aged young children devote almost 2 hours more to home care than illiterate mothers. In contrast, among wives with no young children in the household, those who are literate appear to spend 0.6 hour *less* per day in home care than their illiterate counterparts.

VI. Distinguishing between Bargaining and Home Productivity Effects

The within-household instrumental variable estimates of table 4, which indicate a pronounced role for maternal literacy in affecting the study hours of children while taking into account the influence of paternal schooling preferences, and the estimates in table 3 showing an increase in the demand for literate wives in high-τ areas despite the absence of any evident significant agricultural sector or rural, nonagricultural return to female literacy are both consistent with the theoretical predictions of the model in which maternal schooling (literacy) plays a productive role in augmenting the human capital of children. It may still be possible that more schooled, in this case literate, mothers have superior options outside of marriage that are not adequately measured by labor market returns in the rural (or urban) sector, in which case, as was demonstrated, it is not possible from those estimates to distinguish between productivity and bargaining or reservation utility interpretations of the role of maternal schooling in the household sector.

In this section we carry out the two additional tests suggested by the model that provide evidence on the productivity of maternal schooling in producing human capital. One method of identifying the existence of a productivity effect of maternal schooling in child schooling investment when the effect of schooling on maternal bargaining power cannot be ruled out, with some added structure, is to examine the effect of maternal schooling on child goods for which there is no direct own productivity effect of maternal schooling. One example is child consumption x. The assumption that parents care about x only through its effect on the composite child good z, along with the additional assumptions that the production of the child z good is characterized by homotheticity, the human capital

production function is constant returns to scale, and the children's financial returns to schooling are constant, imply that the difference in the elasticities of child human capital and the child good with respect to maternal schooling is

$$\epsilon_{h_B h_M} - \epsilon_{x h_M} = -\phi^H w^M \exp(-\phi^H h_{Mj})(\epsilon^c_{h_B p_b} - \epsilon^c_{x p_b}), \qquad (12)$$

where ϵ_{ij} is the elasticity of i with respect to j and ϵ^c_{ij} is the corresponding compensated elasticity (we have again assumed for simplicity that the couple has only a son). Because changes in the wife's reservation utility have the same percentage effect on the demand for x and the child schooling input under these assumptions, the elasticities of the two inputs with respect to maternal schooling will be equal only if maternal schooling does not directly influence the cost (efficiency) of schooling production. Moreover, because the difference in compensated elasticities on the right-hand side of (12) must be negative, the left-hand side of (12) identifies the presence of a home productivity effect ϕ^H even if there are bargaining effects of schooling.

In column 4 of table 5, we present within-household instrumental variable estimates of the determinants of clothing expenditures per child, using the sample of households with at least two mothers who coreside with one or more children aged less than 15. The model suggested that if a mother's schooling improves only her bargaining power, then given that women prefer child services more than men, the elasticities of any child input, whether clothing or schooling, with respect to maternal schooling should be equal. The estimates in table 5, however, suggest that there is essentially no relationship between maternal literacy and expenditures on children's clothing: literate mothers spend a statistically insignificant 15 rupees more per year per child on their clothing, less than 5 percent of average expenditures per child, than illiterate mothers. If mothers cared more about children than fathers and literacy raised their ability to influence household decisions, then we would have expected to see maternal literacy to be significantly associated with this type of expenditures, given the marked effect of maternal literacy on their hours in home (child) care and on their children's hours in study.

It is also possible to test for the existence of a bargaining effect by examining the pricing of schooled women in the marriage market. The model implies that, in the absence of market returns to female schooling or of a productivity effect of maternal schooling within the home, female schooling, by increasing women's bargaining power, imposes a cost on men. In particular, if the maternal schooling effect operates only by requiring an increase in transfers

from the husband to the wife within marriage in order to meet the reservation utility requirement, then an optimizing man would not find it in his interest, ceteris paribus, to select a more educated wife. To see this, we note that the first-order condition for the optimal maternal schooling chosen by the man is

$$\phi^H(h_{Bj} + h_{Gj}) \exp(-\phi^H h_{Mj}) + \frac{\partial \delta_{Mj} h_{Mj}}{\partial h_{Mj}} - p_{cM} c^*_{Mj} \frac{\partial v_{Mj}}{\partial h_{Mj}} = 0, \quad (13)$$

where h_{Bj} and h_{Gj} are the human capital levels of the son and daughter determined in the first stage, and δ_{Mj} is the dowry function. The first term captures the effect of an increase in maternal schooling on the shadow cost of child schooling, which will contribute positively to the left-hand side of (13). The second term reflects the market relationship between dowry and schooling. The final term captures the effect of the wife's schooling on her reservation utility and thus on the level of her claim on private consumption in the household. This term is negative where a woman's schooling increases her bargaining power.

Expression (13) shows that, for a given dowry payment δ_{Mj} and with maternal schooling having no productivity benefits ($\phi^H = 0$), the net value of maternal schooling *to men* is negative if schooling has positive bargaining power effects for women in marriage that do not arise from labor market productivity effects. That is, in the presence of bargaining effects but not market or home productivity effects of women's schooling, men would require higher levels of transfers (net dowry) to marry more schooled women. Bargaining power effects would be manifested in a positive relationship between net dowry and wife's schooling. The presence of a negative female schooling–dowry gradient where labor market schooling returns for women are low, however, would suggest that the contribution of women's schooling to home production is positive.[10]

Neither the REDS nor the ARIS data provide information on dowry. However, 1984 survey data from the households that participated in the Village Studies Surveys of the International Crops Research Institute of the Semi-arid Tropics (ICRISAT) of India provide dowry information as well as characteristics of marital partners and their parents. The survey, undertaken in 10 villages in four districts in the semiarid tropics of India, provides the dowry associated with the marriages of the household heads and their daughters in each of the 40 surveyed households in nine of the 10 villages, the school-

[10] Indeed, where female schooling is unproductive in the home and in the market, the dowry–female schooling gradient should exactly equal the marginal value of the loss to the man's utility from marrying a women with an additional year of schooling.

ing of the head and wife, the schooling of the parents of the head, and the landholdings of the head's parents when the head was age 15.

An interesting feature of the ICRISAT survey is that qualitative information was ascertained on the principal reason why the dowry associated with each of the head's daughters differed from the average across daughters. There are 365 daughter marriages recorded in the data. In 34.1 percent of them, schooling differences among daughters were given as the reason for the dowry differential. The next-highest category, property of the groom, was given in 32.7 percent of the responses, followed by the physical characteristics of the daughter, in 8 percent of the responses. Thus the data indicate that, among the respondents, schooling is a salient bride attribute determining dowry amounts. It is necessary, however, to estimate the direction of the relationship between a bride's schooling and her dowry from the marriages of the heads of households since there is no information on the actual schooling of daughters who married.

The data suggest that the ICRISAT survey area is not atypical of rural India as a whole in the early 1980s with respect to the role of women. Information on the occupation of family members indicates that none of the wives of the heads participated in nonagricultural wage or salary jobs, and schooling was not related to whether or not a farm woman also carried out craft or trading activities. Moreover, the relationships between parental schooling and, in this case, son's schooling are similar to those observed in the NCAER-REDS survey data.[11] The association between maternal literacy and son's schooling does not appear to merely reflect improved maternal bargaining power, since the information on the dowries associated with the heads' marriages suggests that female literacy is positively valued by men despite the absence of a prominent nonhousehold role for female literacy. Table 6 presents within-village estimates of the determinants of dowries paid to the grooms' families for farm households in the nine villages with complete information and for marriages taking place as early as 1940 and as late as the survey year, 1984. In addition to the schooling of the husband and wife, the specification includes in the three categories the owned dry and wet landholdings

[11] Logit estimates of the determinants of the probability that a farm head had completed primary school indicate that, as in the NCAER-REDS data, maternal literacy has the strongest relationship with the schooling attainment of the son: a son with a literate mother has more than twice the probability of finishing primary school than a head with average family characteristics does. The effect of the father's literacy is one-third that of the mother, and the effect of his father's having completed primary school on the probability that the head completes primary school is essentially zero.

TABLE 6

ICRISAT DATA: DETERMINANTS OF DOWRY PAID TO HUSBAND'S FAMILY IN NINE VILLAGES, 1940–84

Variable	Mean (Standard Deviation)	Village Fixed-Effects Coefficient
Dowry paid (1983 rupees)	6,455	...
	(11,466)	
Wife literate	.0502	−4,816
	(.219)	(1.74)
Wife with primary schooling	.0618	−394
	(.241)	(.19)
Husband literate	.108	25.8
	(.311)	(.01)
Husband with primary schooling	.205	7,659
	(.404)	(3.04)
Owned family dry land when husband aged 15 (acres)	12.5	156
	(24.3)	(3.57)
Owned family irrigated land when husband aged 15 (acres)	1.19	544
	(4.04)	(2.36)
Father literate	.0849	4,025
	(.279)	(1.03)
Mother literate	.0154	−4,177
	(.124)	(.76)
Father with primary schooling	.0618	1,501
	(.241)	(.30)
R^2	...	.58
Number of households (villages)	259 (9)	259 (9)

NOTE.—Absolute values of robust *t*-ratios are in parentheses.

of the husband's family when he was age 15 and the schooling of the husband's parents.

The results reported in table 6 are consistent with the qualitative survey data pertaining to daughters, which indicated a role for both schooling and groom household resources, among the measured variables, in determining dowry levels.[12] The most striking feature of the estimates in table 6 is the importance of female literacy and the lack of importance of female primary schooling, which parallels what was observed in both the relationship between technical change and the demand for bride's schooling and between maternal schooling and children's study hours. In particular, the estimates indicate that men are willing to forgo a substantial amount of dowry for a literate bride, almost three-fourths of the average dowry payment, but do not pay any additional premium for a bride who has also completed primary school. In contrast, men with primary schooling command a substantial premium in the ICRISAT area

[12] Rao (1993) obtains similar results using these data based on a very different specification. Schooling is not differentiated by level in that study, however.

marriage market, but husbands who are merely literate are not valued. The importance of schooling, although at different levels, in determining dowries is consistent with the qualitative survey data. The fact that greater resources in the head's family attract higher dowries, with landholdings that are irrigated being valued at 3.5 times those that are not, is also consistent with these data. Finally, the schooling of the head's parents, given his own schooling and land, does not have any effect on the dowry payment. The schooling of parents was not mentioned by respondents as being important in differentiating dowries.

VII. Conclusion

In this paper, we have examined the hypothesis that increases in the schooling of women enhance the human capital of the next generation and thus make a unique contribution to economic growth. We pay particular attention to whether and how educational opportunities for women in the labor market affect the relationship between the schooling of mothers and school investments in children. On the basis of a household model incorporating individual optimization, differences in parental preferences for child schooling, a marriage market, and a labor market, we established conditions under which it is possible to evaluate the relative importance of earnings and bargaining effects of maternal schooling and thus the extent to which any observed relationship between maternal and child schooling reflects the productivity of home teaching.

The framework is applied to data describing green revolution India, a setting that has a number of features that provide insights into the precise mechanisms by which increases in female schooling are manifested in augmented human capital investments in children. In particular, because of relatively low levels of female nonagricultural employment and evidently low levels of involvement of women in management decisions in agriculture over the sample period studied, we are able to rule out important effects of female schooling on earnings, particularly for women with less than primary schooling. This absence of labor market returns to schooling for women, coupled with evidence of increased demand for literate women in high–technical change areas, a significant effect of maternal literacy on the study hours of children that is robust to variation in the schooling preferences of fathers, lower dowries received on average by men marrying literate women, and the absence of an effect of maternal schooling on child clothing expenditures, indicates that any bargaining effects, if present, also had a limited impact on household decision making. Thus we conclude that at least some

component of the significant and positive relationship between maternal literacy and child schooling in the Indian setting reflects the effects of maternal schooling on the efficiency of maternal time in the production of child human capital and that the existence of this effect, combined with the increase in returns to schooling for men, importantly underlies the expansion of female literacy following the onset of the green revolution.

An important implication of our results is that increasing labor market opportunities for women is not necessary to justify increased investments in female schooling, which have payoffs even in settings in which there is increased demand for schooling solely in male-dominated occupations. It is important to recognize, however, that our conclusions about the productive role of maternal schooling, and in particular female literacy, in home teaching in India in this period do not necessarily generalize to all times and places. Our framework suggests that in other low-income areas in which female participation in nonagricultural employment is high or women are directly involved in farm management decisions, it is quite possible, even likely, that a significant fraction of any relationship between maternal schooling and child outcomes reflects both the earnings contributions of educated women to the household and the implications of enhanced female earnings opportunities for the ability of the mother to influence household decisions. Indeed, our approach opens the question whether the substantial conformity in findings in the vast empirical literature examining the effects of maternal schooling on child outcomes is misleading in that it may obscure substantial variability across settings in the underlying mechanisms, differences that have important implications for the growth consequences of specific interventions targeting female education.

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