

ECONOMIC GROWTH CENTER

YALE UNIVERSITY

Box 1987, Yale Station
New Haven, Connecticut

CENTER DISCUSSION PAPER NO. 239

FERTILITY, SCHOOLING AND THE ECONOMIC CONTRIBUTION
OF CHILDREN IN RURAL INDIA: AN ECONOMETRIC ANALYSIS

Mark R. Rosenzweig and Robert Evenson*

November 1975

Note: Center Discussion Papers are preliminary materials circulated to stimulate discussion and critical comment. References in publications to Discussion Papers should be cleared with the author to protect the tentative character of these papers.

*Agricultural Development Council, University of the Philippines

1. Introduction

One of the basic properties of the household production model applied by economists to the determination of fertility is that the quantity of children a family has is the outcome of one of a large set of family decisions influenced by a common set of relative shadow prices corresponding to different activities ([2], [17], and [28]). In this study an economic framework derived from the general household model is applied to household behavior in rural-agricultural areas of less-developed countries (LDCs) where the pecuniary contributions of children may not be insignificant. Decisions which are jointly associated with child investment -- family size, schooling, and child labor-force participation--are examined simultaneously in an econometric analysis utilizing district-level data from the 1961 Census of India to obtain a multi-dimensional test of the applicability of the household economic framework to developing countries and to identify possible policy instruments which might alter the demand for children and child schooling. It is also shown that the joint estimation approach utilized, by taking advantage of the symmetry properties of the household model, provides potentially more information on the relative magnitudes of price and income elasticities when data on potential full family income are not available than the more common technique of estimating one behavioral relationship, such as fertility(as in [5], [27], [28]).

The empirical results obtained support the usefulness of the household model in the LDC context and suggest the importance of price effects associated with the economic contribution of children as well as the mother in the allocation of family

resources to children and child schooling. Variables positively correlated with the pecuniary returns to child labor--size of landholdings, agricultural productivity, and child wage rates--appear to be positively related to fertility and child labor-force participation and negatively correlated with child schooling. The wage rates of adult women, however, have a negative effect on family size and a positive influence on the school enrollment rates of children.

2. Economic Framework

A large number of household models can be carved out of the general household production framework (see [5], [7], [16], and [28]) by both restricting the set of commodities Z providing utility to the parental decision-makers and/or by imposing restrictions on the characteristics of the household production relations. To focus on the multiple activities of children in LDCs we assume that parents maximize a utility function, $U(Z_j)$ composed of four commodities,

$$(1) \quad U(Z_j) \quad j = N, E, L, S$$

the quantity of children N , the schooling E and leisure L per child, and a composite commodity representing the standard of living of the household, S .

The production of the four commodities are described by linear homogenous production functions, given by (2), but of the time inputs only that of the wife T_{jw} is used to produce N and S and only child time T_{jc} is assumed to

$$(2) \quad Z_j = \gamma_j(X_j, T_{ji}) \quad \begin{aligned} i = w \text{ for } j = N, S \\ i = c \text{ for } j = E, L \end{aligned}$$

contribute significantly to the production of E and L.² Aggregated bundles of goods X_j , purchased in the market at price P_j are used in the production of each commodity j. Children also work T_{wc} units of time at a wage rate w_c and the husband and wife spend T_{wm} (full time) and T_{ww} units of time in employment and earn wage rates W_H and W_w respectively. Child schooling, in the traditional rural environment of an LDC for which the model is formulated, is assumed to yield negligible pecuniary returns.³

Noting that expenditures on goods must equal total income, including non-earnings income V, and that the time allocated by the wife and children to household production and market work cannot exceed their full time Ω_w and Ω_N , the full income (F) constraint can be written as (3), where x_j , t_{ji} are the marginal

$$(3) \quad W_c \Omega_N + W_w \Omega_w + W_H T_{wm} = N(P_N x_N + t_{Nw} W_w) + NE(P_E x_E + t_{Ec} W_c) \\ + NL(p_L x_L + t_{Lc} W_c) + S(p_S x_S + t_{sw} W_w)$$

(= average) input coefficients of goods and time used in the household production of commodity j.

Maximization of (1) subject to (3) yields a set of commodity shadow prices π_j corresponding to the commodity set: $\pi_N = P_N x_N + t_{Nw} W_w - T_{wc} W_c + E p_E x_E + L p_L x_L$, $\pi_E = N(p_E x_E + t_{Ec} W_c)$, $\pi_L = N(p_L x_L + t_{Lc} W_c)$, $\pi_S = x_S + t_{sw} W_w$. The shadow price of children is thus a positive function of the price of the goods used to produce children, the wage of the wife and the levels of child schooling and leisure⁴ chosen but is negatively related to total earnings per child. The shadow prices of child schooling and leisure, however, are positively correlated with the number of children and the opportunity cost of school attendance and child leisure, the child wage rate.

The compensated substitution elasticities of the three child investment commodities with respect to the child wage $\eta_{jW_c}^*$, derived by totally differentiating the first order conditions, noting that the symmetry of the bordered Hessian implies that the sum of own and cross compensated substitution elasticities must equal zero, can be written as (4):

$$(4) \quad \eta_{jW_c}^* = \eta_{j\pi_N}^* (-\theta_N) + \eta_{j\pi_E}^* \theta_E + \eta_{j\pi_L}^* \theta_L$$

where

$$\theta_j = \frac{T_{jc} W_c}{\pi_j} \quad j = E, L \text{ and } \theta_N = \frac{T_{wc} W_c}{\pi_N}$$

Second-order conditions restrict $\eta_{j\pi_j}^* < 0$, all j , so that the sign of (4) depends on the complementarity-substitution relationships between N, E, and L. If both E and L are substitutes for N but are themselves complements, then $\eta_{N\pi_L}^*, \eta_{L\pi_E}^* < 0$, and (4) is unambiguously positive for $j = N$ and negative for $j = E, L$.

The observed market child wage rate may not always reflect the true marginal value product of children if there are market imperfections, however, as may be likely in LDCs. In the absence of a well-functioning child labor market, it would be expected that the economic contribution of children at the margin \hat{W} would be influenced by a vector of agricultural production inputs A , such that $\hat{W}_c = \xi(A)$, $\xi' > 0$ ⁵ and thus the sign of the compensated A -elasticity of the j th commodity η_{jA}^* would be identical to that observed for $\eta_{jW_c}^*$;

$$(5) \quad \eta_{jA}^* = [\eta_{j\pi_N}^* (-\hat{\theta}_N) + \eta_{j\pi_E}^* \hat{\theta}_E + \eta_{j\pi_L}^* \hat{\theta}_L] \eta_{W_c A}^*$$

where $\hat{\theta}_j = \frac{T_{jc} \hat{W}_c}{\pi_j}$ $j = E, L$ and $\theta_N = \frac{T_{wc} \hat{W}_c}{\pi_N}$.

Thus, π_j under the sufficient but not necessary conditions relating to the assumed signs of the cross-compensated substitution relations, a compensated rise in the child wage rate or factors positively associated with the marginal pecuniary contribution of children would increase the demand for numbers of children and decrease both the schooling and leisure of each child, the strength of the effects depending on the child earnings intensity of each commodity. Moreover, because of the symmetry of the model, the finding that $\eta_{EW_c}^*$ or $\eta_{EL}^* < 0$, would necessarily imply η_{NW_c} or $\eta_{NL} > 0$, since at least one θ_j must exceed 0.

Mutatis mutandis, the compensated substitution elasticities with respect to the wife's wage rate, given by (6), is negative for $j = N$ and positive for $j = E, L$.

$$(6) \quad \eta_{jW_w}^* = \eta_{j\pi_N}^* (\alpha_N - \alpha_S) - \alpha_S (\eta_{j\pi_c}^* + \eta_{j\pi_L}^*)$$

where

$$\alpha_j = \frac{t_{jw} W_w}{\pi_j} \quad j = N, S$$

if the shadow price of children is more earnings intensive in the wife's time than is the shadow price of S. Compensated increases in the wife's wage would thus lead to a substitution of child schooling, leisure and S for numbers of children.

If full income cannot be held constant, the uncompensated substitution elasticities become relevant. The uncompensated wage elasticity formula, expression (7),

$$(7) \quad \eta_{jw_i} = \eta_{jw_i}^* + \psi_i \epsilon_j \quad i = c, w$$

where ϵ_j is the pure income elasticity for the j th commodity and $\psi_c = w_c^{NT} / F$, $\psi_w = w_w^{TL} / F$, indicates that of the uncompensated child wage rate elasticities, only the sign of η_{Nw_c} is unambiguous (>0) since an increase in the child wage would both reduce the relative price of child quantity and increase income (inferiority ruled out).⁶ Similarly, η_{NA} would be positive. While the signs of the uncompensated child schooling and leisure elasticities with respect to the child wage and A are not similarly restricted, (7) suggests that the greater the share of child earnings in the shadow prices (α_j) and the smaller the contribution of each child to full family income (ψ_c) the more likely the compensated and uncompensated child wage effects will be alike in sign. Similarly, while η_{EN_w} and η_{LW_w} must exceed zero, no restriction is placed on the sign of the uncompensated elasticity of N with respect to the wife's wage, but the compensated substitution effect is more likely to dominate the income effect on demand for children the higher the time value intensity differential between π_N and π_s , the greater α_s , and the lower the wife's contribution to full family income.

Expressions (4), (5), (6), and (7) thus give the partial elasticities of child quantity, schooling per child and leisure per child with respect to the wage and child-earnings-augmenting parameters in the set of reduced-form household demand equations derived from the model, given by (8).⁷

$$(8) \quad Z_j = \omega_j(W_c, W_w, W_H, A, P_j)$$

3. Data and Estimation Techniques

The simple economic framework described above, because it yields few unambiguous predictions regarding uncompensated price effects in any one household demand equation, even under a large number of restrictive assumptions, suggests that estimating only the fertility relationship when information on the total potential income of the family is not available, (as is likely in rural-agricultural areas of LDCs) would provide little evidence on the importance of the economic contribution of children in the commodity shadow price structure faced by LDC households. In the absence of such income data, positive coefficients for agricultural input variables, such as landholdings, in the fertility regression equation would be obtained even if the child earnings components in the shadow prices were negligible ($\theta_j=0$) since such variables would be positively associated with family income. However, the finding that the estimated coefficients of these variables displayed negative signs in a child schooling equation, a result possible only if substitution effects dominated income effects, would imply that $\theta_j > 0$ and, given (5) and (7), would suggest that the relevant positive parameter estimates in the fertility regression also represent a substitution effect.

To assess the importance of the economic contribution of children in child investment decisions we thus exploit the symmetrical properties of the model by simultaneously estimating five regression equations explaining the cross-sectional variation in fertility, sex-specific child school enrollment and child labor-force participation rates in the rural population

of India in 1961, utilizing district-level data from 13 states.⁸ The five structural estimating equations (9) corresponding to (8) but assumed to be embedded in a simultaneous equations system, contain identical sets of endogenous and exogenous variables,⁹

$$(9) \quad Y_i = \beta_x X_i + \beta_z Z_i + u_i \quad (i = 1 \dots n)$$

where Y_i are 5x1 vectors of dependent variables, X_i are 2x5 vectors of endogenous variables, Z_i are 10x1 vectors of exogenous variables, β_x and β_z are 5x2 and 5x10 matrices of coefficients to be estimated, and U_i are 5x1 vectors of random disturbances. The variables used are defined and their sample means and standard deviations listed in Table 1; data sources are given in the Appendix.

Child wage rates and land productivity are the variables assumed to be endogenous, functions as well as determinants of the fertility behavior of families and the labor force and schooling behavior of children at the aggregate level. To obtain consistent parameter estimates the equations are thus estimated using two-stage least squares (TSLS).¹⁰ The exogenous variables excluded from (9) used to identify the system are also listed in Table 1.

The matrix of coefficient signs of the empirical counterparts to the exogenous variables of the model forthcoming under conditions in which substitution dominate income effects (noting that child labor-force participation is the complement of child time in school and at leisure) is given in Table 2. These signs are not "predictions" of the model, with the exceptions

Table 1

VARIABLE DICTIONARY AND SAMPLE MEANS
RURAL DISTRICTS OF INDIA 1961

Variables	Definintion	Mean	S.D.
<u>Dependent:</u>			
CWR	Children 5-9 per women 15-44 (x 100), age-adjusted ^a	358.4	39.4
ENRF	Per cent female children enrolled in school 5-14	29.8	25.1
ENRM	Per cent male children enrolled in school 5-14	68.6	23.2
CLABF	Per cent female children engaged in cultivation, herding, or as hired labor	21.3	12.8
CLABM	Per cent male children engaged in cultivation, herding, or as hired labor	26.4	12.0
<u>Endogenous:</u>			
PROD	Rupees per net acre sown ^b	38.5	22.9
WAGEC	Daily field wages wages of children, in rupees (cash & kind)	0.82	0.29
<u>Exogenous, included</u>			
WAGEM	Daily field wages of adult males, in rupees (cash & kind)	1.51	0.40
WAGEF	Daily field wages of adult females, in rupees (cash & kind)	1.08	0.34
LAND	Average land holdings per household, in acres	12.6	9.81
KUS	Kuznets index of landholdings inequality ^c	82.3	15.9
PRMM	Per cent males 15-44 who completed primary school	12.1	9.10
PRMF	Per cent females 15-44 who completed primary school	3.49	4.29
MATM	Per cent males 15-44 who matriculated	2.60	2.55
MATF	Per cent females 15-44 who matriculated	0.35	0.86
RUR	Proportion of population classified as rural	0.82	0.12
<u>Exogenous, excluded:</u>			
	Average annual rainfall 1956-60 in centimeters	335.6	610.7
	Per cent of cultivated acres irrigated	13.7	17.9
	Number of factories and workshops in district	7743	7675
	Per cent of factories and workshops employing 5 + persons	8.82	3.55
	Per cent of factories and workshops powered	18.6	18.5

Notes to Table 1

^aChild-woman ratio divided by $\sum_i P_{ij} B_i$, where i = age-group of women, ($i = 15 \dots 44$), P_{ij} = proportion of women aged 15-44 of age i in district j , B_i = birth rate of women aged i in India.

^bAgricultural productivity in district $j = \frac{\sum_i P_i C_{ij}}{\sum_i L_{ij}}$, where C_{ij} = total production of crop i in district j , P_i = national price of crop i , L_{ij} = net acres sown for crop i in district j .

^cKuznets index for district $j = \sum_i \left| \frac{l_{ij}}{\mu_j} - \theta_i \right|$
 where l_{ij} = mean acres of land owned for population group i in district j ($i = 1 \dots 8$), μ_j = mean acres owned per household in district j , θ_i = ratio of population in group i to total population in district j .

Table 2
Expected Coefficient Signs^a

	CWR	ENRF	ENRM	CLABF	CLABM
LAND	+	-	-	+	+
PROD	+	-	-	+	+
WAGEC	+	-	-	+	+
WAGEF	-	+	+	-	-

^aCompensated substitution effects are assumed to dominate income effects. Otherwise all but the coefficient signs of LAND, PROD and WAGEC in the CWR equation of WAGEF in the CLABF and CLABM equations are unknown a priori.

of those for the coefficients of LAND, PROD, and WAGEC in the CWR equation and of WAGEF in the child labor-force equations, and are presented as a benchmark case. If obtained empirically, this sign configuration would constitute the strongest evidence, within the dimensions of the test, of the existence of substitution effects caused by variations in the economic contribution of children and the earnings of women in the family size, schooling, and child employment decisions of rural Indian families.

The expected effects of the additional variables included in the set of regressors are as follows:¹¹

- (i) The male wage coefficients, given the specialization assumed in the model, would be expected to embody pure income effects and thus should display positive signs in the family size and schooling equations and negative signs in the child employment regressions.
- (ii) The summary measure of the distribution of landholdings, the Kuznets ratio, is used to test for possible non-linearities in the effects of land holdings on the decision variables. Among small landholders the returns from (unpaid) family labor may be negligible and thus increases or decreases in land size might not have a significant impact on fertility or school enrollment. Similarly, for parents owning very large land holdings, the returns to schooling children might be higher and the economic contribution of children less important since schooling might improve the child's ability to eventually manage and operate a large enterprise. Thus, the higher the ratio of inequality, i.e., the greater the number of small landholders and the larger the holdings of the large landowners, the lower would be aggregate fertility and the higher school enrollment in the district.

(iii) The effects of the male and female parental schooling attainment variables on the dependent variables are difficult to predict, given the portmanteau nature of education, particularly when the 'market' productivity effects of schooling are at least partially impounded in the parental wage rate coefficients. Loebner and Driver [15] have shown schooling in India to be positively associated with knowledge of contraception techniques, suggesting that some of these variables may display negative coefficients in the fertility equation. Two levels of schooling variables are employed to capture potential non-linear schoolings effects, as found by Ben-Porath [5] in Israel.

(iv) The proportion of the total district population defined as 'rural' is included in the set of independent variables to assess the effects of proximity to urban areas on rural child investment behavior. Since all the other data used in this study pertain to the rural population, the coefficient of this variable should not therefore be interpreted as an indicator of rural-urban behavior differentials. The rurality of a district may negatively influence rural school enrollment to the extent that the returns to schooling are higher in non-agricultural jobs and the probability of obtaining non-agricultural employment is positively correlated with proximity to urban areas; similarly, the more rural the district the more likely children are to be employed in agriculture.

4. The Results

The TSLS coefficient estimates for the five structural equations are reported in Table 3. Elasticities, computed at the sample means for the most significant variables are displayed in Table 4. The results as a whole suggest the general importance of price effects in the allocation of resources among child-related activities in rural India, as indicated by the conformity of the sub-set of coefficient signs corresponding to the wage and agricultural input variables to the matrix of expected signs of Table 2. Conclusions derived from the individual equations are as follows:

(i) Family size. The parameter estimates of the family size equation appear to support the hypothesis that where variables positively associated with the economic contribution of children have high values, family size is also high--a 10 percent increase in the child wage rate appears to be associated with a 6 percent rise in the age-adjusted child-woman ratio¹². Land size, assumed to be complementary with child labor, also has a positive and significant effect on the child-woman ratio and its relation to the fertility measure appears to be non-linear, as expected. The sign of the Kuznets ratio coefficient thus suggests that reducing the inequality of landholdings would increase family size in India. The coefficient of the land productivity variable is insignificant, however.

The results also suggest that a rise in the wage rates of adult women by ten percent would decrease the child-woman ratio by almost 8 percent, indicating the dominance of the substitution over the income effect, as found by Mincer [17] for the U.S. and Wilkinson [27] for Sweden. A similar increase in the wage rates received by males, however, because of their

Table 3

TSLS Regression Coefficients

Indian Districts 1961
(t-values in parentheses)

Dependent Variable	CWR	ENRF	ENRM	CLABF	CLABM
LAND	1.94 (4.21)	-0.89 (6.85)	-1.15 (6.62)	0.37 (2.99)	0.18 (1.72)
KUS	-0.60 (2.43)	0.24 (3.41)	0.40 (4.31)	-0.05 (1.93)	-0.08 (1.48)
PROD ^a	0.16 (0.58)	-0.24 (3.03)	-0.35 (3.30)	0.10 (2.73)	0.10 (1.60)
WAGEC ^a	257.1 (2.91)	-73.5 (2.96)	-13.3 (0.40)	1.38 (0.05)	7.95 (0.41)
WAGEF	-253.0 (2.75)	77.7 (3.00)	23.58 (0.69)	-27.9 (1.84)	-16.66 (0.82)
WAGEM	71.2 (2.43)	-17.6 (2.13)	-6.17 (0.56)	-16.5 (2.13)	-4.97 (0.76)
PRMM	-0.30 (0.40)	0.18 (0.85)	0.64 (2.32)	-0.19 (0.97)	-0.80 (4.87)
MATM	1.30 (0.88)	0.69 (1.68)	1.09 (1.97)	-0.52 (1.33)	-0.01 (0.03)
PRMF	2.17 (1.12)	0.67 (1.23)	0.39 (0.54)	-0.41 (0.80)	-0.64 (1.50)
MATF	-20.2 (1.85)	21.7 (7.08)	12.77 (3.13)	-7.21 (2.50)	-9.62 (3.98)
RUR	-8.65 (0.27)	-9.79 (1.06)	-29.4 (2.41)	17.13 (1.99)	9.62 (1.33)
C	348.0	28.5	68.5	8.64	27.8
F(12,176)	3.52	65.5	25.5	9.03	17.04
R ^{2b}	.23	.85	.69	.44	.58

^aEndogenous variables.

^bR² is the multiple correlation coefficient corrected for degrees of freedom obtained from the corresponding reduced-form equation.

Table 4

Mean Uncompensated Elasticities - Child Activities in Rural India

Independent Variables	Dependent Variables				
	CWR	ENRF	ENRM	CLABF	CLABM
LAND	.07	-.38	-.21	.22	.09
KUS	-.14	.66	.48	-.19	-
PROD	- ^a	-.31	-.20	.18	-
WAGEC	.59	-2.02	* ^b	-	*
WAGEF	-.76	2.82	*	-1.41	*
WAGEM	.30	-.89	*	-1.17	*
MATF	-.02	.25	.07	-.12	-.13

^a Denotes coefficient statistically insignificant

^b Coefficient estimate rendered insignificant by multicollinearity; variable is part of set having joint statistical significance.

presumed insignificant role in household production, would increase family size by three percent, a result which suggests that the income elasticity of demand for children is of moderate size but that family size is non-inferior. Male education appears to have little relation to family size, but the proportion of women with schooling levels above the primary grades is negatively and significantly associated with the birth rate measure.¹³ No evidence is obtained that the degree of urbanization significantly influences the size of rural families.

(ii) Sex-specific school enrollment. To test for significant differences in the overall structure of the male and female enrollment equations, statistical tests ([6] and [12]) were performed, treating the two equations as if they were estimated from two separate samples. These revealed the set of coefficients in each (while alike in signs) to be significantly different at the 5 percent level. The variables assumed to be positively associated with the marginal value product of children in agriculture--land size, productivity and the child wage--display negative coefficients in both the male and female equations, however, and all are statistically significant except for that of the child wage in the male equation. In that equation, however, the three wage variables are highly collinear--the set of wage rates are jointly significant (F-test, 5 percent level). The coefficient of the Kuznets ratio is also statistically significant in both equations and displays a positive sign, opposite to that in the family size equation, suggesting that a more equal distribution of land is associated with lower school enrollment rates. These results, in conjunction with the family size equation parameter estimates, thus suggest the existence of a

shadow price structure in India favorable to large families and inducing low rates of child investment through formal schooling--the shadow wage of children appears to be a strong deterrent to schooling and at least a significant offset to the cost of large families.

The coefficient of the female wage rate is positive in both enrollment equations as predicted by the model; where women earn wage rates ten percent above the mean, the school enrollment rates of girls are higher by almost thirty percent. This relationship would appear to be due to both a substitution and an income effect, since the existence of a strong substitution away from (time-intensive) children as a consequence of a female wage rise is indicated in the family size equation. The significant positive coefficients for the high-level female schooling variable in the two enrollment equations, combined with the family size results, suggest that more highly educated as well as better-paid women in rural India tend to invest more intensively and less extensively in children.

Higher schooling levels of adult males, at both the primary and higher levels, appear to be significantly associated only with higher levels of male school enrollment; the negative signs of the male wage coefficient in both equations are a puzzle, however. Lack of proximity to urban areas significantly reduces the enrollment rates of rural males, but not of females.

(iii) Sex-specific child labor-force participation. The structures of the two sex-specific child labor-force equations differ significantly (5 percent level), with the males equation again plagued by multicollinearity--the joint effect of the wage, land and productivity variables is statistically

significant in that equation at the 5 percent level. All the coefficients of these variables, however, display signs in accordance with expectations and replicate those in the family size equation--those variables positively correlated with the returns to child labor have positive effects on child labor-force participation, while the female wage rate has a negative influence on the employment of children. The individual coefficients of land size, distribution, productivity and the female wage in the females equation are statistically significant.

In both equations, only the upper-level adult female schooling variable has a significant negative effect on child labor-force participation, consistent with the non-linear female schooling relationships obtained in the enrollment and family size equations. Of the male education coefficients, only that of the primary schooling variable is significant in the males equation. The degree of urbanization in the district appears to be negatively related to the proportion of rural children engaged in agricultural employment, but is significant only in the females equation.

5. Conclusions

The results obtained indicate that a multi-equation econometric model derived from the household production framework which focusses on the economic contribution of children and the wife can, by inference, aid in understanding the shadow price configuration jointly influencing family decisions concerning fertility and the school enrollment and labor-force participation of children in rural India. The findings support the hypothesis that one of the basic conditions motivating Indian families to bear relatively large numbers of children in the late 1950's was the high return to the use of

raw labor power of children compared to investments in skills obtained in schools¹⁴, but suggest two areas of possible policy intervention with regard to reducing the demand for children--the encouragement of female employment and schooling. Discouraging the use of child labor in agriculture would appear to reduce birth rates and increase school enrollment but such a policy is questionable from a welfare perspective. The results also suggest that a land redistribution program aimed at promoting equality, unaccompanied by other changes, would both increase fertility and depress school enrollment rates.

An earlier version of this paper was presented at the Third World Congress of the Econometric Society. Research was supported by a grant from the Ford and Rockefeller Foundations' Program in Support of Social Science and Legal Research on Population Policy. We are grateful to Simon Kuznets, T. Paul Schultz, and Barbara Anderson for helpful comments. Research and programming assistance was provided by James Devine, Anne Morgan, and Roberta Robson.

Footnotes

¹See Becker [3] for a discussion of the assumptions underlying family utility maximization.

²'Quality' per child as influenced by the mother is assumed to be fixed, as in [5], but the satisfaction provided by each child can be augmented by increasing child time in school or in leisure activities.

³See T.W. Schultz [24] for a discussion of the role of schooling in traditional agriculture.

⁴The dependence of the shadow price of the quantity of children on the levels of child leisure and schooling, and vice versa, creates a discrepancy between "true" and observed pure income elasticities, as discussed in [4].

⁵The shadow price of N is thus no longer invariant with respect to the quantity of children. For a more detailed discussion of the relationship between agricultural production inputs and the shadow price of children, see Rosenzweig [23], The price of time of the wife is assumed to be uninfluenced by these variables.

⁶Since $\sum_j \phi_j \epsilon_j = 1$, where $\phi_j = \pi_j Z_j / F$, it is unlikely that any $\epsilon_j < 0$, given the level of aggregation of the model.

⁷(8) does not, of course, represent the complete set of household demand relations; which would also include equations for the demand for S and derived demand equations for the labor force participation of the wife and the set of X_j 's. As these equations are not estimated in this study, they are ignored here.

⁸The results obtained are thus not merely representative of a small and perhaps atypical geographical area of India, as in most other studies of Indian fertility and related behavior, including [15], [18], [22],[25], and [26]. Data from 232 districts were compiled, but because of missing variables only 189 are used in the regressions reported.

⁹Thus no gains in efficiency would be achieved by employing methods relevant to the estimation of seemingly unrelated regression equations, as described in [29].

¹⁰Tests for heteroscedastic residuals, described in [23], revealed no significant relationships between residual variances and district population size. Regressions are thus unweighted.

¹¹A variable representing the proportion of Moslem to total women aged 15-19 was also entered in all regression equations to test for differences in child investment behavior associated with religious affiliation, as found by Rele [22] and others in prior studies of Indian data. The coefficients of this variable, however, did not attain significance in any equation.

¹²The inter-district variation in the child-woman ratio reflects both cross-sectional differences in birth and child mortality rates since the numerator of the variable is the stock of surviving children. This measure of "fertility" is appropriate within the framework of the household model, formulated in terms of family size, but the empirical results (and the model) therefore do not indicate how the optimal stock of children is achieved. That child mortality as well as fertility is a volitional variable is suggested by the differential sex-specific child mortality rates in India. (see [1]).

¹³An auxiliary regression, not reported, in which the proportion of married to total women aged 15-19 was regressed on the set of independent variables utilized in the five equations discussed in the text, indicated that the proportion of early marriages in a district was not significantly influenced by the proportion of women who had received schooling above the primary level. This suggests that the higher-level female schooling variable is not acting merely as a proxy for age at marriage in the family size equation.

¹⁴However, rapid changes in agricultural technology, such as occurred during the 'green revolution' period in India, may have increased the returns to schooling by disrupting the equilibrium conditions existing prior to that time and to which the data used here pertain.

Appendix: Data Sources

CWR, Table C-III, [20], rural age-specific birth rates from [21]; ENRF,M, Table B-IX, [19]; CLABF,M, Table B-I, [19] ; PROD, (23) Crop prices from Table 1, 2 [9], crop production and acres from various volumes, [11] and [14]; WAGEC,F,M, [8]; LAND, KUS, Table C-I, [20]; PRMM,F, MATM,F, Table C-III, [10]; RUR, Table C-III, [20]; rainfall, [18]; acres irrigated, Vol. II, [10].

References

- [1] Adlakha, Arjun and Dudley Kirk, "Vital Rates in India 1961-71 Estimated from 1971 Census Data," Population Studies, 28 (1974), 381-400.
- [2] Becker, Gary S: "A Theory of the Allocation of Time," Economic Journal, 75 (1965), 493-517.
- [3] _____: "A Theory of Social Interactions," Journal of Political Economy, 82 (1974), 1063-1093.
- [4] Becker, Gary S. and H.G. Lewis: "On the Interaction between the Quantity and Quality of Children," Journal of Political Economy, 81 (1973), S279-S-288.
- [5] Ben-Porath, Yoram: "Economic Analysis of Fertility in Israel: Point and Counterpoint," Journal of Political Economy, 81 (1973), S202-S233.
- [6] Chow, Gregory: "Tests of Equality Between Two Sets of Coefficients in Two Linear Regressions," Econometrica, 28 (1960), 561-605.
- [7] DeTray, Dennis N.: "Child Quality and the Demand for Children," Journal of Political Economy, 81 (1973), S70-S95.
- [8] Directorate of Economics and Statistics: Agricultural Wages in India 1961-62. Delhi. 1965.
- [9] Directorate of Economics and Statistics: Farm (Harvest) Prices of Principal Crops, 1954-55 to 1965-66. New Delhi. 1967.
- [10] Directorate of Economics and Statistics: Indian Agricultural Statistics 1961-62 and 1962-63. Volume II. New Delhi. 1970.
- [11] Economic and Statistical Adviser to the Government of India: Agricultural Situation in India, XVII-XXII, 1962-1967.

- [12] Farley, John, and Melvin Hinich: "A Test for a Shifting Slope Coefficient in a Linear Model," Journal of the American Statistical Association, 65 (1970), 1320-1329.
- [13] Goldfeld, S.M. and R.E. Quandt: "Some Tests for Homoscedasticity," Journal of the American Statistical Association, 60 (1965), 539-547.
- [14] Indian Jute Mills Association, Calcutta: Annual Summary of Jute and Gunny Statistics 1962. Calcutta. 1962.
- [15] Loebner, H. and E. Driver: "Differential Fertility in Central India: A Path Analysis," Demography, 10 (1973), 329-350.
- [16] Michael, Robert T.: "Education and the Derived Demand for Children," Journal of Political Economy, 81 (1973), S128-S164.
- [17] Mincer, Jacob: "Market Prices, Opportunity Costs and Income Effects," in Measurement in Economics, ed. C. Christ, Stanford: Stanford University Press, 1963.
- [18] Mukherjee, S.B.: Studies in Fertility Rates in Calcutta. Calcutta: Bookland Private Ltd. 1961.
- [19] Office of the Registrar General: Census of India 1961. Part IIB. New Delhi. 1965.
- [20] Office of the Registrar General: Census of India 1961. Part IIC. New Delhi. 1965.
- [21] Office of the Registrar General: Measurement of Fertility and Mortality in India, SRS Analytical Series, No. 2. New Delhi. 1972.
- [22] Rele, J.R.: "Fertility Differentials in India, Evidence from a Rural Background," Milbank Memorial Fund Quarterly, 41 (1963), 183-199.

- [23] Rosenzweig, Mark R.: "The Economic Determinants of Fertility in the Rural and Urban Sectors of the United States," Ph.D. Dissertation, Columbia University, 1973.
- [24] Schultz, T.W.: Transforming Traditional Agriculture, New Haven: Yale University Press, 1964.
- [25] Sinha, J.N.: "Differential Fertility and Family Limitation in an Urban Community of Uttar Pradesh," Population Studies, 11 (1957), 157-169.
- [26] Srivastava, M.L. : "Some Aspects of Fertility in a Social Group of India," Journal of Social Research, 12 (1969), 61-70.
- [27] Wilkinson, Maurice: An Economic Analysis of Fertility in Sweden, 1870-1965," Econometrica, 41 (1973), 633-642.
- [28] Willis, Robert J.: "A New Approach to the Economic Theory of Fertility Behavior," Journal of Political Economy, 81 (1973), S14-S64.
- [29] Zellner, Arnold: "An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias," Journal of the American Statistical Association, 57 (1962), 348-368.