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GOVERNMENTAL INTERVENTIONS AND HOUSEHOLD BEHAVIOR IN A DEVELOPING COUNTRY: ANTICIPATING THE UNANTICIPATED CONSEQUENCES OF SOCIAL PROGRAMS

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Introduction

The purpose of this paper is to provide estimates of the impact of governmental efforts to reduce population growth and augment child survival and schooling in a developing country. Our methodological approach is to integrate program assessment with an economic model of household choice. As in more conventional economic models of individual behavior, household models of fertility have stressed the role of prices and income as determinants of the desired number and characteristics of children. Viewed in the context of this economic framework, government initiatives at limiting fertility and increasing health and schooling are attempts to alter the structure of prices faced by a household in making its resource allocations decisions.

In our approach it is explicitly recognized that programs which have been designed for single objectives will, in general, have multiple consequences often unanticipated by policy makers. Although a particular program may alter the price of only one family choice variable, such as child health, the existence of non-zero cross-price effects of the usual kind will imply responses of other choice variables, such as child schooling. In this paper we consider three aspects of family behavior related to children and four types of programs. No previous work on program assessment has attempted to estimate "total" effects, i.e., intended and unintended.[1] Estimating these effects is important because, for example, it is possible within the context of the household choice-theoretic framework for the joint provision of, say, health and family planning programs to have mutually cancelling effects on fertility and health while each is effective in its single objective intention. The insight that governmental programs affect prices can also be exploited to test the symmetry conditions of compensated price effects at

least with respect to sign. We can thus reject the theory if estimated substitution relationships are not compatible across equations.

In the first section of the paper, we present a theoretical model in which fertility, child survival, and child schooling are chosen jointly according to a constrained utility maximization procedure. In the next section, we discuss the data which consist of a household-level file containing information on socio-economic and demographic characteristics merged with district level information on program availability. Programs are matched to the specific prices of the model and predictions of program effects are elicited. The following section reports results which are used to test the theory and to assess the quantitative importance of each program. In addition, we explore interactions between the efficiency of programs and household level variables. The empirical results reveal a pattern of household substitution relationships which are consistent with the theory and suggest, as a consequence, that in terms of promoting fertility decline and human capital investment, family planning, health and educational programs are mutually reinforcing; consideration of only "own" targeted effects significantly underestimates the effectiveness of each.

I. A Theoretical Framework

The basic assumption of the theoretical framework is that prospective parents have preference orderings over both family size and the characteristics--health, potential earnings, etc.-- or "quality" of their children. Two characteristics, possibly the major components of child quality in less developed countries, are considered here: survival and schooling, with child deaths assumed to have a physic cost over and above the fact that, for given numbers of children, deaths reduce the number of surviving children.[2] Prospective parents are also assumed to consume non-child related commodities. These assumptions may be conveniently characterized by the utility function

(1) $U = U(N, M, S, Z)$

where N is the number of live births, M is the proportion of children born who die prior to some given age; S is the average schooling of surviving children, and Z is a composite of other consumption items.

The net price of a live birth consists of delivery costs including the opportunity cost of mother's time less the contraceptive costs of averting births, both psychic and material. Survival is assumed to be augmented with purchased inputs, X, conditional on environmental factors which are beyond the control of parents. This relationship is given by

(2) $M = \overline{M} + M(X)$

where $\overline{M}$ is the environmentally given mortality rate and M(X) is the functional relationship between purchased inputs and the mortality rate ($M_x < 0$). The budget constraint with an exogenously given income, Y, is

(3) $Y = P_n N + P_x X + P_s S + P_z Z + P_c (N_{max} - N)$

where P_n is the gross price of a birth, P_x, P_s and P_z, are the per-unit prices of X, S and Z, and P_c is the price of averting a birth through contraception. N_{max} is the number of births that would occur in the absence of contraception (natural fertility) and $N_{max} - N$ is the number of births averted. Thus the net price of a live birth is $P_n - P_c$. A decrease in the cost of contraception increases the net price of an additional child, i.e., it acts as a tax on childbearing.

We have deliberately chosen not to embellish the model with side relations other than (2), incorporating, for example a "scale effect"--the effect of children's survival prospects on the expected returns to investments in children--or an interactive cost relation between the quantity of children and per-child investments, as modelled in Becker and Lewis, 1973. It can easily be shown that none of these additions adds to the predictive content of the model as formulated nor do they alter estimation strategies unless the identification of the preference structure is desired (see Rosenzweig and Wolpin, 1980b). Moreover, the "replacement effect", which reflects the increase in surviving children as a consequence of a mortality decline is a special case of the general model in which only surviving children and not mortality enter (1).

Assuming the household maximizes (1) subject to (2) and (3) we can derive, for small changes at equilibrium values, the effects on fertility, mortality and schooling of changes in the price of contraceptives, health goods and schooling:

$$(8) \quad \frac{dN}{dP_c} = -\left(\frac{dN}{dP_n}\right)_C + (N_{max} - N)\frac{dN}{dY}$$

$$(9) \quad \frac{dM}{dP_c} = M_x\left[-\left(\frac{dX}{dP_n}\right)_C + (N_{max} - N)\frac{dM}{dY}\right] = M_x\frac{dX}{dP_c}$$

$$(10) \quad \frac{dS}{dP_c} = -\left(\frac{dS}{dP_n}\right)_C + (N_{max} - N)\frac{dS}{dY}$$

$$(11) \quad \frac{dN}{dP_x} = \left(\frac{dN}{P_x}\right)_C + X\frac{dN}{dY}$$

$$(12) \quad \frac{dN}{dP_x} = M_x\left[\left(\frac{dX}{dP_x}\right)_C + X\frac{dM}{dY}\right] = M_x\frac{dX}{dP_x}$$

$$(13) \quad \frac{dS}{dP_x} = \left(\frac{dS}{dP_x}\right)_C + X\frac{dS}{dY}$$

$$(14) \quad \frac{dN}{dP_s} = \left(\frac{dN}{dP_s}\right)_C + S\frac{dN}{dY}$$

$$(15) \quad \frac{dM}{dP_s} = M_x\left[\left(\frac{dM}{dP_s}\right)_C + S\frac{dM}{dY}\right] = M_x\frac{dX}{dP_s}$$

$$(16) \quad \frac{dS}{dP_s} = \left(\frac{dS}{dP_s}\right)_C + S\frac{dS}{dY}$$

where C denotes a compensated price effect and $(di/dP_j)_C = (dj/dP_i)_C$, $i \neq j$.

The governmental programs, which are the focus of this research, are presumed to affect the prices P_n, P_c, P_x, and P_s. Expressions (8) through (16) thus indicate that even if a program directly influences one price, it will generally have effects on all household choices -- a program targeted at fertility by subsidizing contraceptives will thus generally affect schooling and health as well . While as will be shown such "side" or "cross" effects cannot always be predicted a priori, certain patterns should be expected given the symmetry of the compensated cross price effects.

Consider first a reduction in P_c induced, say, by the introduction of a family planning program, (8) - (10). Since own compensated price effects must be negative, the reduction in P_c would lead to a reduction in fertility. While there is a real income gain from the reduction in P_c which may increase or decrease fertility, as shown in (8), the smaller the number of averted births, the smaller this income effect; in a developing country such as India, where desired family size is likely to be relatively high even when contraceptives are freely available (see Rosenzweig and Evenson (1977)), the income effect component of a change in the cost of contraceptives is thus likely to be small unless

children are superior goods.

The model also indicates that the reduction in contraceptive costs will induce substitution and income responses in child mortality and schooling. While these relationships, given by (9) and (10), cannot be signed a priori, evidence from India (Rosenzweig and Wolpin, 1980a) suggests that the quantity and quality of children are perceived by parents as substitutes in consumption, so that $(dX/dP_n)_C$, $(dS/dP_n)_C > 0$. The reduction in P_c will, given relatively high fertility desires, thus likely increase schooling and reduce mortality. If income effects on child health and schooling are positive, these compensated cross price effects will be reinforced due to the real income gain brought about by the reduction in contraceptive costs, the magnitude again depending upon $N_{max} - N$.

Given the substitution relationship between N and components of child quality, reductions in the price of health inputs, P_x or in the price of schooling will, in addition to bringing about a decline in mortality and a rise in schooling (if income effects are positive) thus also reduce fertility as long as the substitution effect outweights the income effect. Without evidence on whether or not the two components of child quality, schooling and health of children, are substitutes or complements, however, the response of schooling to a reduction in the price of health goods (13) or the response of health goods to a reduction in the price of schooling cannot be predicted, although, with small income effects, these cross price effects should be of the same sign.

While some of the effects of changes in the program-related prices on fertility, mortality and schooling can thus be predicted with few additional restrictions on the model, a reduction in the component of mortality unaffected by family allocative decisions $\bar{M}$ will alter N, M and S in a predictable fashion

only with further assumptions about the utility function as shown in expressions (17) through (19):

$$(17)\quad \frac{dN}{d\bar{M}} = -U_{NM}\left(\frac{dN}{dP_n}\right)_C - U_{MM}\, M_X\left(\frac{dX}{dP_n}\right)_C - U_{SM}\left(\frac{dN}{dP_s}\right)_C$$

$$(18)\quad \frac{dM}{d\bar{M}} = M_x\left[-U_{NM}\left(\frac{dX}{dP_n}\right)_C - U_{MM}\, M_X\left(\frac{dX}{dP_x}\right)_C - U_{SM}\left(\frac{dX}{dP_s}\right)_C\right] = M_X\,\frac{dX}{d\bar{M}}$$

$$(19)\quad \frac{dS}{d\bar{M}} = -U_{NM}\left(\frac{dS}{dP_n}\right)_C - U_{MM}\, M_X\left(\frac{dS}{dP_x}\right)_C - U_{SN}\left(\frac{dS}{dP_s}\right)_C$$

Indeed, even the direction of change in child mortality experienced by a family due to a reduction in the environmental mortality-augmenting factor, given by (18), cannot be predicted, as parents may substitute away from health and towards other goods; the level of consumption of at least one good must rise however.[3]

II. Application

A. Data and Econometric Specification

The model as outlined yields a system of demand equations for N, S, M, and E, given by

$$(20)\quad N = N(P_n, P_c, P_x, P_z, P_s, Y, \bar{M})$$

$$(21)\quad M = \bar{M} + M\,[X(P_n, P_c, P_x, P_z, P_s, Y, \bar{M})]$$
$$= M^*(P_n, P_c, P_x, P_z, P_s, Y, \bar{M})$$

$$(22)\quad S = S(P_n, P_c, P_x, P_z, P_s, Y, \bar{M})$$

(23) $Z = Z(P_n, P_c, P_x, P_z, P_s, Y, \bar{M})$

with the first derivatives approximated by (8) through (19).

A single cross-section of household observations is unlikely to contain direct price variation of substantial degree. However, geographical variation in government interventions in the form of family planning, health care, and educational facilities, since they affect prices in predictable ways, can be exploited to both test the model and to ascertain patterns of program side or cross effects if a) the programs are effective, b) the geographical mobility of households is limited, and c) the interventions are not significantly correlated with the preference orderings of households. Evidence from India suggests that immobility of households, particularly those owning land, is marked (Rosenzweig, 1978 and 1980). However, there is also evidence that some development programs in India are targeted (Evenson and Kislev, 1977) on the basis of their anticipated success. Subsequent estimates of program effects thus must be interpreted with some caution if such targeting is relevant to the programs studied and governmental decision-makers are accurate in their forecasts of program demand.

The data utilized consist of rural Indian household survey information matched with district level Indian census data on health and family planning programs and infrastructure. The survey was conducted by the National Council of Applied Economic Research in three rounds over the years 1968-1971 for approximately 4000 rural households and was national in scope. Retrospective information on total births and child deaths was collected for each adult woman in the household in each round. Other information useful for this analysis consisted of the school attendance of children in the household, the woman's age, the educational attainment of the woman and spouse, and

land status and acreage owned.

Data on government family planning and health facilities, educational institutions and water sourceswere collected from the 1971 Indian Census. Two measures of program coverage were constructed, the fraction of villages in a district with each particular type of service and the per-capita number of facilities of each type located in the district. Although we experimented with both, the results did not widely differ and we felt that the former was somewhat more appropriate since it reflects at least minimal coverage.

About 50 percent of the districts represented in the sample survey could be matched with comparable data. In addition, the final sample was restricted to women between the ages of 15 and 44 because pregnancy and child mortality histories are unlikely to be accurate for older women. The total sample reflecting all of these restrictions consists of 1137 women.[4] Descriptive statistics and variable definitions for this sample are presented in Table 1.

The measure of fertility used is the number of children born to the mother in the 2.5 years prior to the date of the last survey round in 1971. This measure was chosen because it minimizes recall bias, prevalent in developing countries, as it is based on changes in actual fertility in each of the three rounds of the survey. Additionally, since no information was available on the date of implementation of the village-level programs, a measure of cumulative fertility which includes fertility experienced many years prior to the date of the survey might in many cases mainly reflect pre-program conditions, given the rapid growth of such programs in the 1960's (see below). Because of the stochastic nature of fertility, however, we would expect that the proportion of explained variance

Table 1

Descriptive Statistics and Definition

Variable	Definition	Mean	S.D.
Endogenous Household	Children born in 2.5 years prior to survey	.393	.531
	Mortality rate, number of children died per live birth	.052	.143
	Age-Standardized School Attendance Index, all children aged 5+	1.08	5.39
Exogenous Program			
FPLAN	Fraction of villages in district with a family planning clinic	.021	.026
HOSP	Fraction of villages in district with a hospital	.017	.047
DISP	Fraction....a dispensary	.057	.068
HCNH	Fraction....other health facilities (health centers, nursing homes, etc.)	.085	.151
TAP	Fraction of villages in district with water supplied by a tap	.021	.055
PUMP	Fraction....a pump	.122	.322
RIVER	Fraction...a river	.086	.134
WELL	Fraction...a well	.755	.193
TANK	Fraction...a tank	.126	.236
PRIM	Fraction of villages in district with a primary school	.707	.159
MS	Fraction...a middle or primary school	.183	.104
Exogenous Household			
AGE	Mother's age	29.9	7.25
FARM	Fraction of landed households	.714	.452
ACRES	Size of landholding in acres	9.55	12.6
EDMP	Fraction of mothers who have some primary schooling	.092	.290
EDMP	Fraction of mothers who have completed primary schooling but are not matriculated	.042	.201
EDMMP	Fraction of mothers who are matriculated	.016	.127
EDFP	Fraction of fathers...	.225	.418
EDFPP	Fraction of fathers...	.184	.387
EDFMP	Fraction of fathers...	.148	.351

for this fertility rate measure would be quite small.[5]

Because of the relatively low incidence of mortality, we use a cumulative measure of child deaths--the proportion of all live births for which the child subsequently died. The retrospective nature of this variable makes recall error likely, and, indeed, the mean rate is implausibly low. We will tentatively assume that this error is random, so that coefficient estimates will be consistent.[6]

The schooling variable is a household-specific index of the school attendance of children in the household aged 5 and over which standardizes for the age distribution of the children, given fixed age patterns of attendance based on mean population age-trajectories. The schooling index for household k, with n_i children in each age group i, I_k, is

$$(24) \qquad I_k = \frac{\Sigma n_{ki} e_{ki}}{\Sigma n_{ki} \bar{e}_i}$$

where i = 5 - 9, 10 - 14, 14+ and $\bar{e}_i$ is the mean school attendance rate for boys (or girls) in age group i in the population and e_{ki} is a dummy indicating whether or not a child in age group i in household k is attending school. Sex specific rates could be computed from the data for children aged 10 and above.

The program and facility variables are of four types--those relating to the village coverage of family planning, those reflecting the existence of medical facilities, principal sources of water and the distribution of school facilities. The family planning program and those reflecting the existence of medical facilities can be traced as far back as 1930. The effort has grown rapidly and was accorded top priority in the Five Year Plan ending in 1979 with a budget of Rs 5160 million. In the Five Year Plan commencing in 1951, only Rs

6.5 million was allocated. As of 1972, there were over 5000 rural family planning centers with over 32,000 rural sub-centers. However, construction of clinics has always lagged behind schedule due to bureacratic rather than financial problems. While these centers are part of a national contraceptive distribution system which provides contraceptives either free or at subsidized rates, our data indicate that only about 2 percent of the villages represented in our sample were covered. The overall program has not been viewed as successful, as evidenced by the declaration of an emergency in June 1975 during which time forced sterilization was emphasized. It was estimated that as of 1973, only 15 percent of all married couples employed non-traditional contraceptive methods. However, no national empirical studies which take into account family behavior and health to estimate the impact of such programs exist. The crude rural birth rate was 39 per thousand in 1967 and 35 in 1973, although the target rate was 32. The original target of 25 for 1975 has been rescheduled to 1984.

Health facilities reported in the District Census Handbooks are divided into hospitals (HOSP), dispensaries (DISP), and a general "others" category (HCNH). This latter category is primarily composed of health centers and sub-centers, and maternity and child welfare clinics. In some districts, TB clinics and nursing homes were also included. As of 1967, there were approximately 5000 primary health centers and 20,000 sub-centers in rural areas and over 6000 maternity and child health centers, but only a small fraction of villages have any health facility in our sample. The data we use do not indicate the date each facility was established.

The water supply data were divided into as many categories as could accommodate comparability across districts. There is a residual "others"

category which is quite varied across districts. The categories are not entirely mutually exclusive in the sense that some villages may have more than a single water source. However, interpreting them as the primary water source probably should not do great injustice. We would expect that the ranking of the water sources according to the quality of water associated with each source would be, from best to worst, taps, pumps and wells, rivers and tanks.

The prices of the theoretical model are matched to the programs in Table 2, which also provides predictions for the compensated effects of the programs on the three dependent variables. The signs indicated assume that, based on evidence, all components of child quality and family size are substitutes, while as a tentative hypothesis, components of child quality are complements.[7] Thus, for example, we would expect family planning programs to reduce fertility and to be associated with more investments in health (lower mortality) and in schooling; the presence of a hospital or clinic should be associated with lower child mortality and should also lead to reduced fertility and increased school investment. If income effects are small, the conformity of estimated program effects to this array of sign predictions would represent a strong test of the economic framework.

In matching programs to prices, it is not always clear that there exists a unique correspondence, so that the direct effects of some programs cannot be predicted. For example, hospitals and dispensaries not only directly reduce the price of medical services and thus P_x, but they may also reduce the cost of pre-natal care, a component of P_n. Since the former should be the predominant impact of hospitals and dispensaries, that

Table 2

Expected Signs of Price Changes and Program Effects on Fertility, Mortality and Schooling*

Price	Program	Live Births	Mortality Rate	Schooling
P_c	FPLAN	-	-	+
P_x	HOSP	-	-	+
	DISP	-	-	+
	HCNH	-	-	+
P_n	HCNH	+	+	-
$\bar{M}$	TAP	most negative or least positive	most negative or least positive	least negative or most positive
	PUMP and WELL	↑	↑	↑
	RIVER	↓	↓	↓
	TANK	least negative or most positive	least negative or most postive	most negative or least positive
P_s	PRIM	-	-	+
	MS	-	-	+

*Signs assume that income effects are small and all components of child quality and the quantity of children are (gross) substitutes, while health and schooling are (gross) complements.

is the assignment given in Table 2. However, the residual HCNH, category, since it consists of health clinics and maternity clinics, likely reduces both P_x and P_n; the net impacts are ambiguous. While the other program -price assignments are straightforward, the water source effects on all three behavioral variables can only be ranked given the previously noted ranking of their relative impacts on the exogenous mortality component $\overline{M}$. These rankings should be identical for fertility and mortality and be reversed for schooling under the restrictions imposed on the model.

With respect to household variables we would expect the following patterns to emerge: the farm, non-farm distinction, as well as the size of farm should capture income effects. The level of woman's education, however may be related to several of the prices so that its relationship to the three variables cannot be easily predicted: more highly educated women may face higher levels of P_n, P_c and P_x (if X is inclusive of own time inputs), assuming they have higher market wage rates; if they are more efficient contraceptors and more efficient health producers they will face lower levels of P_n, P_c, and P_x. The impacts of father's education, if father's time is a relatively unimportant input into the production of live births or survival after birth, should mainly reflect income effects.

B. Estimates

a. Program Effects

The coefficient estimates obtained from the estimation of linear approximations to equations (20) through (22), after substitution of the programs and facilities for prices, are given in Table 3. With respect to "own" effects, which provide estimates of the effectiveness of the programs or facilities in achieving their presumed direct goals, family planning programs

Table 3

Estimates of Program and Household Characteristics Effects on Fertility, Child Mortality and Schooling

Independent Variable	Live Births in Past 2.5 years	Mortality Rate	School Attendance Index
FPLAN	-2.41 (2.06)	-.846 (2.42)	5.17 (.417)
HOSP	-.124 (.085)	-.439 (1.03)	29.4 (1.89)
DISP	-1.38 (1.68)	-.873 (3.61)	3.19 (.37)
HCNH	1.88 (3.32)	.587 (3.54)	-3.83 (.637)
TANK	-.062 (.645)	.039 (1.34)	-.503 (.495)
RIVER	.082 (.336)	.185 (2.65)	-4.09 (1.59)
WELL	-.127 (1.14)	.071 (2.17)	-2.10 (1.78)
PUMP	.135 (2.17)	.091 (5.10)	-.037 (.056)
TAP	-.698 (1.27)	-.460 (2.91)	7.33 (1.26)
PRIM	.126 (.790)	.046 (.993)	2.29 (1.36)
MS	-.927 (2.44)	.067 (.594)	-6.86 (1.71)
AGE	.079 (4.58)	-.005 (.890)	.203 (1.11)
AGE^2	-.002 (5.65)	.000 (1.02)	-.003 (1.08)
FARM	.019 (.49)	-.020 (1.76)	.597 (1.45)
ACRES	-.002 (1.21)	-.001 (1.70)	-.011 (.740)
EDMP	-.011 (.200)	.001 (.041)	2.04 (3.50)
EDMPP	-.034 (.422)	-.015 (.631)	.702 (.822)
EDMMP	.191 (1.58)	-.058 (1.61)	.577 (.450)
EDFP	.008 (.196)	.002 (.136)	1.11 (2.64)
EDFPP	.018 (.415)	-.007 (.579)	.865 (1.86)
EDFMP	-.006 (.121)	.004 (.235)	.719 (1.31)
Intercept	-.293 (1.06)	.042 (.433)	-1.93 (.662)
No. obs.	1137	1013	1137
F	7.16	4.09	2.22
R^2	.117	.078	.039

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appear to reduce fertility, the prevalence of both hospitals and dispensaries appears to be associated with lower child mortality rates and the coverage of primary schools appears to be positively related to school attendance, although such rates appear to be lower in districts with more middle-level schools per village. While neither the hospital effect on mortality or the primary school effect on attendance are measured with much precision, the programs thus do appear to be "effective" in the sense of encouraging or discouraging targeted behavior in the direction intended, given approximate random program or facility placement.

Based on the substitution-complementarity restrictions, there are 15 coefficients which are signed by the model--the coefficients of FPLAN, HOSP, DISP, PRIM, and MS in each of the three equations. Of these, eleven are correct. In terms of statistical significance, of the 11 correct signs, all but 4 are significant at the 5 percent level (one-tailed test), while of the four incorrectly signed coefficients all but one are not significant. Moreover, of those coefficients which cannot individually be signed relating to the water sources, the sets of coefficients display a remarkable conformity to the patterns predicted--for example, where water from a tap is most prevalent, both child mortality and fertility are lowest while child school attendance takes on the highest value. Similarily, water from a river, associated with the highest child mortality of the sources considered, is also associated with the lowest schooling levels of children and the second highest level of fertility.

The matrix of coefficients associated with the programs and facilities thus appear to confirm the general symmetry properties of the household choice model and to suggest that the cross effects of the programs, or at least the

ones considered here, are not unimportant. Moreover, the coefficient patterns, which indicate that parents in India view family size and investments per child as substitutes but components of child investments as complements, suggest that if health improvement, increased schooling and lower fertility are policy goals, then the effectiveness of each of the family planning, medical facility and school facility programs, if evaluated only with respect to own or targeted effects, would be underestimated. Similarly, each of the three program types appear to be substitutes in the sense that any one encourages similar behavior with respect to the three choice variables considered.

Table 4 reports the comparative quantitative effects on fertility, mortality and schooling of doubling the coverage of the family planning program, hospitals and dispensaries and taps relative to selected other water sources based on the coefficient estimates. These estimates suggest that doubling the number of villages with family planning programs (from 2 to 4 percent in our sample) would reduce fertility rates by 13 percent; if this occurs over the entire child-bearing period this reduction would translate into a one-half child decline in completed family size (mean = 6). The effect on child health is to evidently reduce the cumulative child mortality rate by .018; or by about 10 percent if the coefficient is measured accurately and the true mortality rate for children is (approximately) 20 percent. Schooling attendance would appear to rise, however, by 11 percent as a consequence of doubling family planning coverage. Although the schooling effect is measured imprecisely, in percentage terms family planning thus appears to affect the three behavioral variables comparably--cross or indirect effects on mortality and schooling are as large as the direct effect on fertility. However, the combined fertility-mortality effect of doubling family planning coverage on surviving family size is a decline of approximately 0.4 children, i.e., a net reduction in population growth.

Table 4

Effects of Doubling the Village Coverage of Selected Health and Water Facilities on Fertility, Mortality, and School Attendance

Facility	Live Births	Mortality Rate	School Attendance Index
FPLAN	-.051	-.018	.109*
HOSP	-.002*	-.007*	.500
DISP	-.079	-.050	.182*
TAP/PUMP	-.017	-.012	.161*
TAP/WELL	-.012*	-.011	.198
TAP/TANK	-.016*	-.011	.164*

*Regression coefficient not statistically significant at conventional levels of significance.

Doubling the village coverage of dispensaries (to 11 percent in our sample) would appear to have larger impacts on all three variables than would a similar percentage increase in family planning or hospital coverage, with the exception of the schooling impact for the latter. Fertility would appear to decline by 20 percent (just over three-fourths of a child) and the mortality rate by .05 (approximately 25 percent) while schooling attendance would rise by 18 percent (again, measured imprecisely). While the impacts of doubling the coverage of hospitals (to 3.4 percent) on both mortality and fertility appear to be minimal the impact on school attendance appears implausibly large, suggesting that the geographical distribution of hospitals may not have been unrelated to the supply of human capital.

b. Income and Education Effects

The associations between the household-level variables and the three dependent variables appear to be somewhat weaker than those between the areal program measures and the household activities. The FARM and ACRES variables indicate that child mortality is lower in farm families, by about 10 percent given mean mortality rates of .2 , and appears to decline with farm size. Farm households appear also to invest significantly more in child schooling then do ruralnon-farm households, although there appears to be no relationship with size of farm. While these findings suggest that child health andschooling are positively related to wealth or income, the gross-income effect on fertility appears to be weakly negative, with larger farms exhibiting somewhat lower birth rates.

Of the sets of education dummies, only those in the school attendance equation are statistically significant ($F = 4.70, F(6,1000) = 2.01$). Thus while it appears that more educated parents tend to invest more heavily in the schooling of their offspring, they do not appear to have lower numbers of births or to

raise children with significantly greater survival prospects. Finally, in order to ascertain if program effectiveness is related in India to the schooling attainment of parents, all the educational dummies were interacted with the variables FPLAN, HOSP, DISP and HCNH. No support for the hypothesis that such programs have differential effects on education groups was found, however, as none of the sets of education-program interactions in any equation was statistically significant at conventional levels.

III. Conclusion

The results of our empirical analysis based on household-level and areal program data reveal that rural households in India view fertility and two characteristics of children, schooling and health, as substitutes, while schooling and child health are themselves viewed as complements. As a consequence, it appears that the provision or subsidization of contraceptives or medical services or the improvement of water sources are mutually reinforcing alternatives for implementing policies which seek to jointly lower population growth rates, improve child survival and augment schooling.[8] Moreover, these results suggest that if preference structures are identical over time and space, some of the unintended impacts of governmental interventions which are aimed at altering household-behavior in any one of these dimensions can be anticipated prior to implementation, information which is valuable for the formulation of cost-effective policies.

However, the methodology employed in this paper is predicated upon the assumption that the governmental program allocation process is random with respect to household decision variables. If this were not so, then a unidirectional causal interpretation of programs as affecting outcomes would not be warranted. In this case, knowledge of the specific allocation formula or of some of the political determinants of the program distribution process that are unrelated to household choice would be required to disentangle the program impact from the allocation decision rule. Future work addressing this issue would seem necessary.

FOOTNOTES

[1]The most prevalent studies assessing program impacts on a single behavioral variable are those concerned with family planning. Hermalin (1972) reviews multiple studies on the impact of family planning programs in developing countries using multivariate techniques which were published in the early 1970's. None examine impacts beyond fertility effects. Indeed, in a number of studies (Hermalin, 1972, Khan and Sirageldin, 1979) which estimate the effect of family planning on fertility, such behavioral variables as child mortality, child schooling and the mother's labor force participation are treated in a simultaneous equations framework as "structural" determinants of fertility, to be "held constant". Such studies, by artificially restricting substitution possibilities, do not provide policy-relevant estimates of program effects. For a further discussion of the appropriateness of simultaneous equations estimation strategies in the context of a household model, see Rosenzweig and Wolpin (1980b).

[2]Scrimshaw (1978) reviews the evidence that the survival of children in a developing country reflects the resource allocation decisions of households. Rosenzweig and Schultz (1980) provide evidence from India that sex-differences in child survival rates are associated with economic factors.

[3]Expression (17) indicates that an exogenous decline in the mortality of children has an ambiguous effect on fertility, depending on the characteristics of the household utility function. The assumed long-run downward adjustment of fertility in response to mortality decline, the "replacement effect", is a fundamental proposition of the demographic transition hypothesis which appears to require the imposition of restrictive assumptions about behavior.

[4]The restricted sample contains households from 50 districts, approximately one-sixth of the total number of districts in India.

[5]The large concentration of zero-value observations for this variable suggests that estimation with the Tobit procedure would be preferred to OLS. Experimentation with these alternative techniques on this variable in Rosenzweig (1979), however, revealed no significant differences in results. We thus report OLS estimates below.

[6]Feeney (1980) presents evidence that the bias regarding child dealths does not appear to reflect changes in economic conditions in a number of developing countries. Because the mortality rate is undefined for married women with no live births, we estimate the mortality regression over a sample of women with at least one live birth, resulting in a reduction in sample size of 124 women. Estimates of the program effects on the other dependent variables obtained from the restricted sample did not differ significantly from those reported below.

[7]The incorporation into the model of a scale effect, discussed above, would make it more likely that child survival and child schooling would appear to be complements, as an increase in the likelihood of survival would raise the expected returns to (and thus lowers the net cost of) investments in children. Similarly, the hypothesized quantity-quality interaction of Becker and Lewis (1973) would tend to make family size and components of child quality appear to be substitutes.

[8]As long as policy-makers have multiple objectives, more than one policy instrument or program is generally required even if all programs are substitutes in the sense defined above. The optimal program mix will, of course, depend on relative program costs as well.

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